

SCHEDULE –D: ANNEX I (PART –IV)

CONSTRUCTION SPECIFICATION / TECHNICAL SPECIFICATION

**SCHEDULE –D: ANNEX -I (PART –IV)
CONSTRUCTION SPECIFICATION**

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SCHEDULE – D: Annex I (Part-IV) CONSTRUCTION SPECIFICATIONS

PREAMBLE

These construction specifications shall be read in conjunction with other Annex of Schedule D.

The work shall be executed as per construction specifications given herein under. Items for which no separate construction specification is given shall be executed as per CPWD Specifications 2019 Volume I & II for building works and Specification of Road and Bridge works (Fifth Revision) 2013 MoRTH for pavement works with upto date correction slips as on last date of submission of tender. Items which are not covered in construction specification neither in CPWD and MoRTH specification, same shall be executed as per sound engineering practice and shall be approved by Engineer-In-Charge prior to commencement of particular item.

The construction specifications may have been divided in different sections/sub-head for convenience only. They do not restrict any cross-reference. The Contractor shall take in to account interrelations between various parts of works/trades. No claim shall be entertained on basis of compartment interpretations.

Any builder's work required as part of electrical and other installation shall be executed by the Contractor as directed under this contract.

The Contractor shall be required to submit and take approval from the Engineer-In-Charge of shop drawings of the items of work specified in the specifications or as directed from time to time. No extra payment shall be made for the same. Shop drawings shall be in metric units and shall be prepared in a format approved by the Engineer-in- Charge.

No walls, terraces shall be cut for making any opening after waterproofing has been done without approval of the Engineer in-charge. Cutting of waterproofing when authorized by the Engineer in writing shall be done very carefully so that no other portion of the waterproofing is damaged. On completion of the work at such places, the waterproofing system shall be made good and ensured that the opening/cutting is made fully waterproof as per specifications and details of waterproofing approved by the Engineer in-charge at no extra cost. No structural member shall be cut or chased without the written permission of the Engineer.

All materials intended to be used at site shall be tested in accordance with ***Schedule 'J'*** under Article 12.

Cement slurry shall be provided to create bond between plain/reinforced concrete surface and subsequent applied finishes (floor, plaster, dado, skirting etc.).

All full-fledged laboratories shall be established at site prior to start of construction. Copies of all relevant codes like BIS, EN, ASTM, MORTH, ICAO etc. as per the

requirements of the special specifications/Technical specification shall be made available in the site laboratory.

Concrete batching plant of adequate capacity shall be installed at site for all concrete works. Alternatively, use of ready-mix concrete from an approved source shall be permitted. Concrete shall be transported using concrete pumps of adequate capacity including necessary stand by.

All the water tanks and other liquid retaining concrete structures shall undergo hydro-testing as per relevant standards.

Special benches shall be provided at site for stacking reinforcement bars of different sizes as per the specifications.

Form work for beams of RCC areas shall be designed in such a way that the form work of the adjacent slabs can be removed without disturbing the props/supports of the beams.

Wherever there are tension/ suspended concrete members, which are suspended from upper level structure members, the shuttering/scaffolding of such members at lower level shall have to be kept in place till upper level supporting members gain minimum required strength. Cost of such larger durations of keeping in place the shuttering/scaffolding shall be deemed to be included in the price quoted for respective structural members.

The contractor shall ensure quality control measures on different aspects of construction including materials, workmanship and correct construction methodologies to be adopted. He shall have to submit quality assurance programme 15 days ahead before start of physical execution of work. The quality assurance programme should include method statement for various items of work to be executed along with check lists to enforce quality control. The agency shall submit a 'Methods statement' for each important activity for the approval of the Engineer-In-Charge soon after the award of work to him. The 'Methods statement' is a statement by which the construction procedures for any activity of construction are formulated and stated in chronological order. The 'Methods statement', should have a description of the item with elaborate procedures in steps to implement the same, the specifications of the materials involved, their testing and acceptance criteria, equipment to be used, Precautions to be taken etc.

As and when any important item is taken up for execution, the Agency shall submit the specifications and develop a checklist and Pour card. This sample checklist should be got approved from the Engineer-In-Charge and should be used at site. This check list should be shown to the Engineer-In-Charge or his/her designee during inspection. This procedure is to be followed for all hidden items, CC/RCC work, Steel-reinforcement, shuttering, roofing glazing, MEP, IT, Airport Systems, cast-in-situ mosaic flooring, doors & windows, plumbing, including water supply pipe lines, roof treatment, earth filling etc. Samples check list of few items is appended below:

Contractor has to develop similar check list to enforce quality control for all other items and got them approved with PMC/Engineer-In-Charge before taking up any new item/activity.

All the materials to be used in the work, to make the finished work complete in all respects, shall comply with the requirements of the specifications and shall pass all the tests required as per specifications as applicable or such specifications / standards as directed by the Engineer-in- Charge. However, keeping the Quality Assurance in mind, the Contractor shall submit, on request from the Engineer-in- Charge, his own Quality Assurance procedures for basic materials and such items, to be followed during the execution of the work, for approval of the Engineer-In-Charge. All materials and fittings brought by the contractor to the site for use shall conform to the specification and the samples approved by the Engineer-In-Charge. The contractor should get the samples of all the materials got approved from the Engineer-In-Charge before bringing the bulk quantity, which shall be preserved at site of execution till the completion of the work. The contractor shall submit the samples as per approved list of brand names given in the tender document subject to meeting the DBR requirement and construction specifications for approval of Engineer-In-Charge.

SECTION-01: CIVIL & INTERIOR WORKS

I. PRE – CONSTRUCTION ANTI-TERMITE TREATMENT WORKS

1. Scope

These specifications cover the application of pre-constructional anti-termite treatment to the structures.

2. General

The provision of the latest Indian Standards listed below form part of these specifications:

IS: 6313	Code of Practice for Anti-termite Measures in Buildings Part-2: pre-constructional chemical treatment measures
IS: 8944	Specification for Chloropyrifos Emulsifiable Concentrates.

Other I.S. Codes not specifically mentioned here but pertaining to the use of the application of pre-constructional anti-termite treatment to the structures form part of these specifications.

3. Materials

The chemicals used for the soil treatment shall be any one or combination of the following with the concentration shown against each aqueous emulsion:

Chemicals	Concentration:
Imdachloropid 30.5 SC	1.0% (by weight)
Chlorpyrifos 20 EC	1.0% (by weight)

Chemicals used should be procured from approved vendor along with details such as manufacturer's certificate, date of manufacture and date of expiry of chemicals. On completion of treatment in all respects, the contractor shall furnish a guarantee in the format as prescribed by the AAI's Representative, that the building is safe from all species of termite infestation for a period of 10 years.

4. Workmanship

The application of chemicals shall be carried out conforming to the code of Practice for Anti-termite measures in Building, IS 6313: Part-2: pre-constructional chemical treatment measures. Roding equipment & pressure pumps shall be used to carry out spraying operations to facilitate proper penetration of chemicals into the earth.

The work should be carried out through an approved specialized agency having adequate experience in dis-infestation of termites in buildings in the past. The work should be of first quality and should be carried out under strict supervision of the Employer's Representative.

II. **STRUCTURAL STEEL WORKS**

1. **Scope**

Preparation of fabrication drawings, providing all materials, fabricating, transporting, erection in position to proper lines and levels, fixing, structure in the bended profile shaped as per the drawing with special plate connectors, pinion joints, using SAW /MAW / MIG welding process including sand blasting, painting / other protection of steelwork for structures including fixtures, fittings, temporary works and supports, and ancillaries. Painting would involve cleaning as given and painting with various combinations of primary and intermediate and final coats of specified thickness.

The Contractor shall design, prepare drawings, furnish all the materials, skilled staff and labour, transportation, equipment, tools, tackles, temporary work, hoisting, erection and all other things that may be required for carrying out the work described above as per drawings, specifications and the instructions of the Engineer

2. **Codes and Standards**

The provisions of the **latest revisions** of the following IS Codes shall form a part of these specifications to the extent they are relevant.

<i>Specification</i>	<i>Description</i>
IS: 800	Code of practice for general construction in steel
IS: 808	Dimensions of hot rolled steel beam, column channel and angle sections
IS: 813	Scheme of symbols for welding.
IS: 814	Covered electrodes for manual metal arc welding of Carbon and carbon-manganese steel.
IS: 816	Code of practice for use of metal arc welding in general mild steel construction.
IS: 817	Code of practice for training and testing of metal arc welders.
IS: 818	Code of Practice for safety and health requirements in electric and gas welding and cutting operations
IS: 822	Code of procedure for inspection of welds
IS: 823	Code of procedure for manual metal arc welding of mild steel
IS: 1030	Carbon Steel castings for general engineering purposes
IS: 1161	Steel tubes for structural purposes

Specification	Description
IS: 1181	Qualifying tests for metal arc welders
IS: 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS:1363 (1&2)	Hexagon head bolts and nuts of product grade C
IS: 1364 (1-5)	Hexagon head bolts and nuts of product grade A and B
IS: 1367 (1-20)	Technical supply conditions for threaded steel fasteners
IS: 1387	General requirements for the supply of metallurgical materials
IS: 1477 (1 & 2)	Code of Practice for painting ferrous metals in buildings
IS: 1599	Method for bent test
IS: 1608	Mechanical testing of metals – tensile testing
IS: 1730	Steel plates, sheets and strips and flats for general engineering purposes – dimensions
IS: 1852	Rolling and cutting tolerances for hot rolled steel products
IS: 2004	Carbon Steel forgings for general engineering purposes
IS: 2016	Plain washers
IS: 2062	Steel for general structural purposes – (supersedes IS: 226)
IS: 2595	Code or practice for radiographic testing
IS: 3502	Steel chequered plates
IS: 3613	Acceptance test for wire flux combination for submerged arc welding
IS: 3640	Hexagon fit bolts
IS: 3658	Code of practice for liquid penetrant flaw detection
IS: 3664	Code of practice for ultrasonic pulse echo testing by contact and immersion methods
IS: 3696	Safety codes for scaffolds and ladders
IS: 3757	High strength structural bolts
IS: 4353	Submerged arc welding of mild steel and low alloy steels – recommendations
IS: 4923	Hollow steel sections for structural use
IS: 5334	Code of practice for magnetic particle flaw detection of welds
IS: 5372	Taper washers for channel
IS: 5624	Foundation bolts
IS: 6610	Heavy washers for steel structures
IS: 6639	Hexagon bolts for steel structures

<i>Specification</i>	<i>Description</i>
IS: 7205	Safety code for erection of structural steelwork
IS: 7215	Tolerances for fabrication of steel structures
IS: 7293	Safety code for working with construction machinery
IS: 9595	Metal arc welding of carbon and carbon manganese steels – recommendations
IS: 12843	Tolerances for erection of steel structures
SP: 34	Handbook of concrete reinforcement and detailing

3. Inspection of site

It is presumed that the site has been inspected and all site conditions noted that might affect the selection of erection method, plant requirements and such details. The method and units of transportation of structures from fabrication yards to site would also depend on the location of fabrication yards, the dimensions and grades of the connecting roads and the approach to the erection location. It is necessary that during the work the existing structures (where there are some) are not damaged or affected anyway by the present work.

4. Material

A. Structural Steel

- i. General requirements relating to the supply of material shall conform to the specifications of IS: 1387. Structural steel shall be MS rolled single / built-up sections of E-250 BR Grade, conforming to IS 2062.
- ii. Mild steel pipes for structural use shall be YST 310 Grade, conforming to IS 1161. Manufacturing process shall be of ERW type.
- iii. Hot and cold formed square and rectangular hollow steel sections for structural use shall be YST 310 Grade, conforming to IS 4923.
- iv. Material grade less than YST 310 shall not be allowed to use in the work. However higher grade shall be permitted without any extra cost to the client.
- v. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges and other defects. It shall have a smooth and uniform finish, and shall be straightened in the mill before shipment. They shall also be free from loose mill scale, rust, pits or other defects affecting its strength and durability.

- vi. The acceptance of any material on inspection at the mill i.e. rolling mills, foundry or fabricating plant where material for the work is manufactured, shall not be a bar to its subsequent rejection, if found defective.
- vii. In general, steelwork connections shall be by bolting and welding. Mild steel or high tensile bolts shall be used as indicated in the drawings. Bolts or welds should be independently capable of carrying the entire load.

B. Other Materials

- i. Anchor/foundation bolts, nuts and bolts to be high tensile bolts of minimum 10.9 grades having black phosphate coating. The Bolts should be as per IS 3757/ IS 4000. Bolts shall be provided with a washer of sufficient thickness to avoid any threaded portion falling within the thickness of the parts bolted together if required.
- ii. For cast steel, the yield stress shall be determined and shall not be less than 50 percent of the minimum tensile strength.
- iii. Plain washers shall be of steel. Tapered or other specially shaped washers shall be of steel, or malleable cast iron.
- iv. Parallel barrel drifts shall have a tensile strength not less than 55 kg/sq. mm, with elongation of not less than 20 percent measured on a gauge length of 4 So (So = cross sectional area).
- v. Materials for castings and forgings, fasteners and welding consumables shall be as under:

Castings and Forgings: Steel castings and forgings shall comply with the requirements of the following Indian Standards, as appropriate:

- IS: 1030 Carbon Steel Castings for General Engineering purposes
- IS: 1875 Carbon Steel Billets, blooms, slabs, bars for forgings
- IS: 2004 Carbon Steel Forgings for General Engineering purposes
- IS: 2644 High Tensile Steel Casings
- IS: 4367 Alloy & tool steel forgings for general industrial use

5. Fabrication

A. General

All work shall be in accordance with the drawings approved and released by the Engineer for construction, as per these specifications and as instructed by the Engineer. Care should be exercised by the Contractor to ensure that all parts of an assembly are so well fabricated to fit accurately together. All members shall carry a mark number and an item number and, if required, serial no.

Unless specifically required under the contract, corresponding parts for identical units need not be interchangeable, but the parts shall be match marked.

Templates and other appliances used for ensuring the accuracy of the work shall be of mild steel. All measurements for fabrication shall be made by means of accurate steel tapes or other devices properly calibrated.

All structural steel members and parts shall have straight edges and blunt surfaces. If necessary, they shall be straightened or flattened by pressure unless they are required to be of curvilinear forms. They shall also be free from twist. Pressure applied for straightening or flattening shall be such that would not injure the materials. Hammering shall not be permitted. Adjacent surface or edges shall be in close contact or at uniform distance throughout.

The contractor shall submit his program of work to the Engineer for his approval at least 15 days before commencement of fabrication. This program shall include the proposed system of identification and erection marks together with complete details of fabrication and welding procedures.

The Contractor shall prepare shop drawings for fabricating the components of steelwork and obtain approval of the Engineer a week before the start of work on the components. Complete information regarding the location, type, size and extent of all welds shall be clearly shown on the shop drawings. The drawings shall distinguish between shop and field welds.

B. Preparation of Edges and Ends

All structural steel parts, where required, shall be sheared, cropped, plasma cut and ground accurately to the required dimension and shape.

End/edge planning and cutting shall be done by any one of the following prescribed methods or left as rolled:

- a) Shearing, cropping, sawing, machining, plasma cutting.
- b) Sheared edges of plate not more than 16mm thick with subsequent grinding to smooth profile, which are of secondary use such as stiffeners and gussets.

If the ends of stiffeners are required to be fitted, they shall be ground, so that the maximum gap over 60% of the contact area does not exceed 0.25 mm.

C. Preparation of Holes

- A. Drilling and Punching: Holes for black bolts, high strength bolts and counter sunk bolts (excluding close tolerance and turn fitted bolts) shall be either punched or drilled. The diameter of holes shall be 1.5 mm larger for bolts less than 25 m. dia and 2.0 mm for more than or equal to 25 mm.

All the holes shall be drilled except for secondary members such as, floor plate, handrails etc. Members which do not carry the main load can be

punched subject to the thickness of member not exceeding 12 mm for material conforming to IS: 226.

Holes through one thickness of material or when any of the thickness exceeds 20 mm for steel conforming to IS: 2062 or 16 mm for conforming to IS: 8500, shall either be sub-drilled or sub-punched to a diameter of 3 mm less than the required size and then reamed to the required size. The reaming of material more than one thickness shall be done after assembly.

Where several plates or sections form a compound member, they shall where practicable, be firmly connected together by clamps or tacking bolts, and the holes be drilled through the group in one operation. Alternatively, and in the case of repetition work, the plates and sections may be drilled separately from templates that shall be checked periodically. All burrs shall be removed.

Shop erection / assembly shall be done wherever so required by the engineer.

B. Where block drilling is done, care shall be taken to check that the holes are not out of position or are dimensionally correct.

C. **Size of Holes:** The sizes of holes in millimetres are given in table 1 below:

Table-1: Diameter of holes for bolts

Sr. No	Nominal dia of bolts (mm)	Dia of holes (mm)	Sr. No	Nominal dia of bolts (mm)	Dia of holes (mm)
1	12	13.5	7	27	29.0
2	14	15.5	8	30	31.0
3	16	17.5	9	31	33.0
4	18	19.5			
5	20	21.5			
6	24	25.5			

D. Close tolerance bolts and barrel bolts: Holes for close tolerance and turn fitted bolts. The diameter of the holes shall be equal to the nominal diameter of the bolt shank minus 0.15 mm to 0.0 mm.

E. The member to be connected with close tolerance or turn fitted bolts shall be firmly held together by service bolts or clamped and drilled through all thickness in one operation and subsequently reamed to required size within specified limit of accuracy as specified in IS: 919 tolerance grade H8.

The holes not drilled through all thickness at one operation shall be drilled to smaller size and reamed after assembly.

F. Holes for high strength friction grip bolts: All holes shall be drilled after removal of burrs. Where the number of plies in the grip does not exceed three, the diameters of holes shall be 1.6 mm larger than those of bolts and for more

than three plies in grip, the diameter of hole in outer plies shall be as above and dia of holes in inner plies shall not be less than 1.6 mm and not more than 3.2 mm larger than those in bolts, unless otherwise specified by the Engineer.

- G. Removal of Burrs: The work shall be taken apart after drilling and all burs left by drilling and the sharp edges of all rivet holes completely removed.

6. BOLTS, NUTS AND WASHERS

6.1 Black bolts (black all over)

Black bolts are forged bolts in which the shanks, heads and nuts do not receive any further treatment except cutting of screw threads. They shall be true to shape and size and shall have the standard dimensions as shown on the drawings.

6.2 Close tolerance bolts

Close tolerance bolts shall be faced under the head and turned on the shank.

6.3 Turned barrel bolts

The diameter of the screwed portion of turned barrel bolts shall be 1.5 mm smaller than the diameter of the barrel unless otherwise specified by the Engineer. The diameter of the bolts as given on the drawing shall be the nominal diameter of the barrel. The length of the barrel shall be such that it bears fully on all the parts connected. The threaded portion of each bolt shall project through the nut by at least one thread. Faces of heads and nuts bearing on steel work shall be machined.

6.3.1 Washers

In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a steel washer under the nut of sufficient thickness of the parts bolted together and to prevent the nut when screwed up, from bearing of the bolt.

For close tolerance or turned barrel bolts, steel washers whose faces give a true bearing shall be provided under the nut. The washer shall have a whole diameter not less than 1.5 mm larger than the barrel and a thickness of not less than 6 mm so that the nut when screwed up will not bear on the shoulder of the bolt.

Taper washers with correct angle of taper shall be provided under all heads and nuts bearing on beveled surfaces. Spring washers may be used under nuts to prevent slackening of the nuts when excessive vibrations occur.

Where the heads or nuts bear on timber, square washers having a length of each side not less than three times the diameter of bolts or round washers having a diameter of $3\frac{1}{2}$ times the diameter of bolts and with a thickness not less than one quarter of diameter shall be provided.

6.3.2 Studs

Ordinary studs may be used for holding parts together, the holes in one of the parts being tapped to take the thread of the stud. Counter-sunk studs may be used for making the connections where the surfaces are required to be cleared of all obstruction, such as protruding heads of bolts, studs may also be welded on the steel work in the positions required.

6.4 Service bolts:

Service bolts shall have the same clearance as black bolts and where it is required that there should be no movement prior to final riveting, sufficient drifts or close tolerance bolts shall be used to locate the work.

6.5 Tightening bolts

Bolted connection joints with black bolts and high strength bolts shall be inspected for compliance of Code requirements.

The Engineer shall observe the installation and tightening of bolts to ensure that correct tightening procedure is used and shall determine that all bolts are tightened. Regardless of tightening method used, tightening of bolts in a joint should commence at the most rigidly fixed or stiffest point and progress towards the free edges, both in initial and in final tightening.

The tightness of bolts in connection shall be checked by inspection wrench, which can be torque wrench, power wrench or calibrated wrench.

Tightness of 10% bolts, but not less than two bolts, selected at random in each connection shall be checked by applying inspection torque. If no nut or bolt head is turned by this application, connection can be accepted as properly tightened, but if any nut or head has turned all bolts shall be checked and, if necessary, re-tightened.

6.6 Drifts

The barrel shall be drawn or machined to the required diameter for a length of not less than one diameter over the combined thickness of the metal through which the drifts have to pass. The diameter of the parallel barrel shall be equal to the nominal diameter of the hole subject to a tolerance of +0 mm and -0.125 mm. Both ends of the drift for a length equal to $1\frac{1}{2}$ times the diameter of the parallel portion of the bar shall be turned down with a taper to a diameter at the end equal to one-half that of parallel portion.

6.7 Pins and pin holes

6.7.1 Pins

The pins shall be parallel throughout and shall have a smooth surface free from flaws. They shall be of sufficient length to ensure that all parts connected thereby shall have a full bearing on them. Where the ends are threaded, they shall be turned to a smaller diameter at the ends for the thread and shall be provided with a pilot nut, where necessary, to protect the thread when being drawn to place. Where the ends are not threaded suitable cotter arrangements shall be made to prevent pin from working loose.

Pins more than 175 mm in length or diameter shall be forged and annealed.

6.7.2 Pinholes

Pinholes shall be bored true to gauge, smooth, straight at right angles to the axis of the member and parallel with each other, unless otherwise required. The tolerance in the length of tension members from outside to outside of pinholes and of compression members from inside to inside of pinholes shall be as specified in the drawings. In built up members, the boring shall be done after the members have been riveted or welded. Where specified proper brass / gunmetal bushes shall be provided in the pinholes.

The specified diameter of the pinhole shall be its minimum diameter. The resulting clearance between the pin and the hole shall be not less than 0.5 mm and not more than 1.0 mm or otherwise as specified in the drawings.

7. Shop Erection and Match Marking

Sub-sections of the steelwork, if so required by the Engineer, shall be temporarily erected in the fabrication shop before dispatch to site, for the Engineer's inspection. The quality of fabrication, and the alignment and fit of all connections would be checked. For this purpose, a sufficient number of parallel drifts and service bolts that tightly screw up, shall be employed. All parts shall fit accurately and be in accordance with drawings and specifications. After the Engineer's approval, any sub-size holes left shall be reamed to size and materials match marked and dispatched to site. The Engineer shall be the sole authority to decide the extent of shop erection required

After the work has been approved by the Engineer and before it is dismantled, each part shall be carefully marked for erection with distinguished marks and stamped with durable markings. Drawings showing these markings correctly shall be supplied to the Engineer.

Unloading, handling and storage of steel work as per these specifications shall be the responsibility of the Contractor. The cost of repairs or rejected

material, its removal and the cost of transporting replacement material to the site shall be borne by the Contractor.

8. Welding

All welding shall be done with prior approval of the Engineer and the workmanship shall conform to the specifications of IS: 823 & IS:9595 or other relevant Indian Standards as appropriate.

When material thickness is 20 mm or more, special precaution like preheating shall be taken as laid down in IS: 823. Surfaces and edges to be welded shall be welded smooth, uniform and free from fins, tears, cracks and other discontinuities. Surfaces shall also be free from loose or thick scale, slug rust, moisture, oil and other foreign materials. Surfaces within 50 mm of any weld location shall be free from any paint or other material that may prevent proper welding or cause objectionable fumes during welding.

The general welding procedures including particulars of the preparation of fusion faces for metal arc welding shall be carried out in accordance with IS: 9595.

The welding procedures for shop and site welds including edge preparation of fusion faces shall be submitted in writing in accordance with Clause 22 of IS: 9595 for the approval of the Engineer before commencing fabrication and shall also be as per details shown on the drawings. Any deviation from above has to be approved by the Engineer. Preparation of edges shall, wherever practicable done by machine methods.

Machine flame cut edges shall be substantially as smooth and regular as those produced by edge planning and shall be left free of slag. The Engineer shall permit manual flame cutting only where machine cutting is not practicable.

Electrodes to be used for metal arc welding shall comply with relevant IS specifications. Test shall be carried forward as per IS: 8613 to find out suitable wire flux combination for welded joint.

Assembly of parts for welding shall be in accordance with provisions of IS: 9595.

The welded temporary attachments should be avoided as far as possible, otherwise the method of making any temporary attachments shall be removed by cutting, and chipping and surface shall be finished smooth by grinding to the satisfaction of the Engineer.

Welding shall not be done when the air temperature is less than 10 degrees Celsius. Welding shall not be done when the surfaces are moist, during periods of strong winds or snowy weather unless the work and the welding operators are adequately protected.

For welding of any particular type of joint, welders shall qualify to the satisfaction of the Engineer-In-Charge in accordance with appropriate welders qualification tests as prescribed in any of the Indian Standards IS: 817, IS: 1393, IS: 7307(PART I), IS: 7310(PART I) and IS: 7318(PART I) as relevant.

In assembling and joining parts of a structure or of built up members, the procedure and sequence of welding shall be such as to avoid distortion and minimise shrinkage stress.

All requirements regarding pre heating of parent material and interpass temperature shall be in accordance with provision of IS: 9595.

Peening of weld shall be carried out wherever specified by the Engineer:

- a) If specified peening may be employed to be effective on each weld layer except first.
- b) The peening shall be carried out after weld has cooled out by light blows from a power hammer using a round nose tool. Care shall be taken to prevent scaling or flaking of weld and base metal from over peening.

The butt welds are to be ground flush, the loss of parent metal shall not be greater than that allowed for minor surface defects. The end of butt joints shall be welded so as to provide full throat thickness. This may be done by use of extension pieces, cross runs or other means approved by the Engineer. Extension pieces shall be removed after the joint has cooled and the ends of the welds shall be finished smooth and flush with the faces of the abutting parts.

The joints and welds listed below are prohibited type, which do not perform well under cyclic loading.

- a) Butt joints not fully welded throughout their cross section
- b) Groove welds made from one side only without any backing grip
- c) Intermittent groove welds
- d) Bevel grooves and J grooves in butt joints for other than horizontal position
- e) Plug and slot welds

The run on and run off plate extension shall be used providing full throat thickness at the end of butt-welded joints. These plates shall comply with the following requirements.

- i) One pair of run on and one pair of runoff plates prepared from same thickness and profile as the parent metal shall be attached to start and finish of all butt welds preferably by clamps.
- ii) When run on and run off plates shall be removed by flame cutting, it should be cut at more than 3 mm from parent metal and remaining

metal shall be removed by grinding or by any other method approved by the Engineer.

9. Tolerances

The tolerances in fabrications shall be governed by IS: 7215. Tolerances in dimensions of components of fabricated structural steel work shall be specified on the drawings and shall be subject to the approval of the Engineer before fabrication. Unless specified all parts of an assembly shall fit together accurately within tolerances specified in Table –2.

A machine bearing surface, where specified by the Engineer, shall be machined with a deviation of 0.25mm for surfaces that can be inscribed within a square of side 0.5 m.

TABLE -2 FABRICATION TOLERANCES

No	Description of work / item	Tolerance
INDIVIDUAL COMPONENTS		
1	LENGTH	
	a) Member with both ends finished for contact bearing	$\pm 1\text{mm}$
	b) individual components of members with end plate connection	+ 0 mm, -2 mm
	c) Other members i) up to and including 12 m	$\pm 2\text{ mm}$
	Other members ii) over 12 m	$\pm 3.5\text{ mm}$
2	WIDTH	
	a) width of built-up girders	$\pm 3\text{ mm}$
	b) Deviation in the width of members required to be inserted in other members	+ 0 mm - 3 mm
3	DEPTH	
	Deviation in the depth of the solid web and open web girder	+3 mm, -2 mm
4	STRAIGHTNESS	
	a) Deviation from straightness of columns (L – length of member)	L/3000 with max of 15 mm
	i) in elevation	+5 mm, - 0 mm
	ii) in plan	L/1000 with max. of 10 mm
5	Deviation of centre line of web from centre line of flanges in built up members at contact surfaces	3mm
6	Deviation from flatness of plate of webs of built members in a length equal to depth of member (d- depth of member)	0.005 d with a max of 2 mm

No	Description of work / item	Tolerance
7	Tilt of flange of plate girders (b – width of the member)	
	i) At splices and stiffeners, at supports, at the top flanges of plate girders and at bearings	0.005 b with a max of 2 mm
	ii) at other places	0.015 b with a max of 4 mm
8	Deviation from squareness of the flange to web of columns and box girders (L is nominal length of the diagonal)	L/1000
9	Deviation from squareness of fixed base plate (not machined) to axis of column. This dimension shall be measured parallel to the longitudinal axis of the column at points where the outer surfaces of the column sections make contact with the base plate (D- the distance from the column axis to the point under consideration on the base plate)	D/500
10	Deviation from squareness of machined ends to axes of columns (D- same as in 9 above)	D/1000
11	Deviation from squareness of machined ends to axes of beams of girder (D- same as in 9 above)	D/1000
12	Ends of member abutting at joints through cleats or end plates, permissible deviation from the squareness of ends	1/600 of depth of member subject to a max of 1.5 mm

10. PACKING AND TRANSPORT

All projecting plates and bars and all ends of members at joints shall be stiffened, all straight bars and plates shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers and small loose parts shall be packed separately in cases, so as to prevent damage or distortion. Care shall be taken during loading and unloading so that no material sustains damage and materials are not mixed up.

The materials shall be carefully transported and unloaded at site of erection, exercising great care not to damage the materials in any manner. They shall be stored as per erection marks and sizes with small materials being stored in sheds to prevent loss or mixing up.

11. ERECTION

A. General

The provisions of this item shall apply of erection of steelwork in the various structures either in the roof or elsewhere.

The contractor shall transport the fabricated steel to the erection site. This should be done without damaging the steelwork in any manner. Even so the steelwork shall be subject to the Engineer's inspection and minor rectification if needed shall be carried out as directed by the Engineer. The steelwork shall be erected in position to lines and levels as shown in the drawings with or without enabling works. It will be welded or bolted in final position all as shown in the drawings. The contractor shall take all safety precautions to prevent any damage to the work or any accident. After erection and necessary welding / bolting is approved by the Engineer, the Contractor shall touch up the shop paints as necessary and shall apply the required coats of paint as shown in the drawings. After approval of painting, further work on the structure such as sheeting etc shall be carried and do all the work required to complete the construction included in the contract in accordance with the drawings and the specification and to the entire satisfaction of the Engineer.

B. Organization and Equipment

The contractor shall submit a complete erection scheme for the approval of the Engineer showing the equipment that he would be a method and procedure of erection, compatible with details of fabrication. As time is of the very essence, the means to achieve fast and accurate work shall be employed. The approval of the Engineer shall not relieve the contractor of his responsibility for the safety of his method or equipment or from carrying out the work fully in accordance with the drawings of the specifications.

A detailed scheme must be prepared showing stage-wise activities, with complete drawings and phase-wise working instructions. This should be based on detailed stage-wise calculation and take into account specifications and capacity of erection machinery, tools, tackles to be used and temporary working loads as per Code provisions. Temporary work where used shall be supported by detailing and calculations.

The scheme should be based on site conditions, erection machinery employed, available working space, length and weight of members to be handled. The accent of the scheme shall be safe working and avoidance of any risk of accident.

The scheme should indicate precisely the type of temporary fasteners to be used as also the minimum percentage of permanent fasteners to be fitted during the stage erection. The working drawings should give clearly the temporary, fixtures, clamps, spacer supports, etc.

The contractor shall supply and erect all necessary false work and staging and shall supply all labour, tools, erection plant and other materials necessary to carry out the work complete in all aspects.

The contractor shall supply all types, bolts, nuts, washers, etc. required to complete erection at site with allowance for wastage, etc., of 10% of the net number of field bolts, washers required, or a minimum of five number of each item.

Service bolts and nuts, ordinary plate washers and drifts for use in the erection of works shall be supplied at 25% of the number of the permanent bolts in the work.

Prior to actual commencement of erection all equipment, machinery, tools, tackles, ropes, etc. need to be tested to ensure their safe and efficient working. Frequent visual inspection is essential in vulnerable areas to detect displacements, distress etc.

For welded structure, welders' qualifications and skill are to be checked as per standard norms.

Safety requirements should conform to IS: 7205, IS: 7273 and IS: 7269 as applicable. Safety shall be the paramount consideration in erection work.

Erection work should start with complete resources mobilised as per latest approved drawings and after a thorough survey of foundations and other related structural work. The structure should be divided into erectable modules as per the scheme. This should be pre-assembled in a suitable yard/platform and its matching with members of the adjacent module checked by trial assembly before erection.

The structure shall be set out to the required lines and levels. The steelwork should be erected, adjusted and completed in the required position to the specified line and level s with sufficient drifts and bolts. Packing materials are to be available to maintain this condition. Organised "Quality Surveillance" checks need to be exercised frequently.

During the progress of work, the Contractor shall have a competent Engineer and a skilled Foreman in charge of the work, who shall be adequately experienced in steel erection and acceptable to the Engineer.

C. Handling and storing Materials

Suitable area for storage of structures and components shall be located near the site of work. The access road should be free from water logging during the working period and the storage area should be on levelled and firm ground.

The store should be provided with adequate handling equipments e.g. road mobile crane, gantries, derricks, chain pulley blocks, winch of capacity as required. Stacking area should be planned and have racks, stands sleeper, access tracks, etc., and properly lighted.

Storage should be planned to suit work sequence and avoid damage or distortion. Rusted, bent or damaged steel shall be rejected. Methods of storage and handling steel, whether fabricated or not shall be subject to the approval of Engineer and should be accessible to handling equipment.

Small fitting hand tools are to be kept in containers in covered stores.

All materials, consumables, including raw steel or fabricated material shall be stored specification-wise and size-wise above the ground upon platforms, skids or other supports. It shall be kept free from dirt and other foreign matter and shall be protected as far as possible from corrosion and distortion. The electrodes shall be stored specification-wise and shall be kept in dry warm condition in properly designed racks. The bolts, nuts, washers and other fasteners shall be stored on racks above the ground with protective oil coating in gunny bags and suitably marked. It is essential to ensure that bolts of different strengths / sizes are not mixed up. The paint shall be stored under cover in airtight containers.

IS: 7293 and IS: 7969 dealing with handling of materials and equipments for safe working should be followed. Safety nuts and bolts as directed are to be used while working. The Contractor shall be held responsible for loss or damage to any material paid for by the Department while in his care or for any damage to such material resulting from his work.

D. Straightening Bent Material

The straightening of plates, angles and other shapes shall be done with prior approval of the Engineer by methods not likely to produce fracture or any injury. The metal shall not be heated unless permitted by the Engineer for special cases, when the heating shall not be to a temperature higher than that producing a dark "cherry red" colour, followed by as slow cooling as possible.

Following the straightening of a bend or buckle the surface shall be carefully investigated for evidence of fracture. Sharp kinks and bends may be the cause for rejection of material.

E. Assembling Steel

The parts shall be accurately assembled as shown on the drawings and match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged.

Hammering which will injure or distort the members shall not be done. Bearing surface or surfaces to be in permanent contact shall be cleaned, given a coat of contact paint before the members are assembled.

All joint surfaces for bolted connections including bolts, nuts, washers shall be free from scale, dirt, burrs, other foreign materials and defects that would prevent solid seating of parts. The slope of surface of bolted parts in contact with bolt head and nut shall not exceed 1 in 20, plane normal to bolt axis, otherwise suitable tapered washer shall be used.

All fasteners shall have a washer under nut or bolt head whichever is turned in tightening.

Any connection to be bolted shall be secured in close contact with service bolts or before the connections are finally bolted. Joints shall normally be made by filling not less than 50 percent of holes with service bolts and barrel drifts in the ratio 4:1. The service bolts are to be fully tightened up as soon as the joint is assembled. Connections to be made by close tolerance or barrel bolts shall be completed as soon as practicable after assembly.

Any Connection to be site welded shall be securely held in position by approved methods to ensure accurate alignment, camber and elevation before welding is commenced.

The field welding, bolted and pin connection shall conform to the Code requirements.

The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents proper assembling and fitting up of parts by moderate use of drifts or by a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Engineer and his approval of the method of correction obtained. The correction shall be made in the presence of the Engineer.

F. Erection tolerance

The unloaded steel structure, as erected shall satisfy the criteria specified in the following table within specified tolerance limits. Each criterion given in the table shall be considered as a separate requirement, to be satisfied independently of any other tolerance criterion. The erection tolerances specified in the table apply to the following reference points:

For a column, the actual centre point of the column at each floor level and at the base, excluding any base-plate or cap-plate. The level of the base plate on pedestal shall be so as to avoid contact with the soil and corrosion environment.

For a beam the actual centre point of the top surface at each end of the beam, excluding any end plate.

Permissible tolerances after erection

Criterion	Permitted deviation
Deviation of distance between adjacent columns	+/- 5 mm
Inclination of a column in a multi-storey building between adjacent floor levels	0.002 h where h is the storey height
Deviation of location of a column in a multi-storey building at any floor level from a vertical line through the intended location of the column base	$.0035 \sum h / n^{0.5}$ where $\sum h$ is the total height from the base to the floor level concerned and n is the number of storeys from the base to the floor level concerned
Inclination of a column in a single storey building, (not supporting a crane gantry) other than a portal frame	0.0035 h where h is the height of the column
Inclination of the column of a portal frame (not supporting a crane gantry)	Mean 0.002 h Individual 0.010 h Where h is the height of the column

A tension member shall not deviate from its correct position relative to the members to which it is connected by more than 3 mm along any setting axis.

G. Setting Column bases and grouting

Column bases shall be set so that the column load is uniformly transmitted to the foundation with column centre line aligned with the foundation as shown in the drawings. The location and layout of anchor bolts are to be correctly set to ensure that the structures are erected as shown in the drawings.

The Contractor shall be responsible for the correct alignment and levelling of all steelwork at site to ensure that the columns are plumb.

Before erection of columns on foundations, the top surface of the base concrete shall be thoroughly cleaned with wire brushes and by chipping to remove all laitance and loose material. The Contractor shall be responsible to provide all packing and shim plates that may be required for the proper erection and bedding of the columns with base plates. No steel structure shall be erected on the foundation unless the foundation has been certified fit for erection of steel, by the Engineer. Adequate number of air releases and inspection holes shall be provided in the base plate.

After the column is erected and alignment is checked and accepted, the column with base shall be held firmly in position by shims and pickings. The space between the column base and the base concrete shall be grouted with approved non-shrink grout.

The substrate surface must be free of contaminants and all dirt and dust blown clean. The surface shall be thoroughly cleaned with water and all free

water removed after cleaning. A containing formwork or other arrangement shall be made to hold the grout without leaks.

The (grout) powder shall be mixed with recommended quantity of water and stirred till a grout of smooth consistency is obtained. It shall be poured as soon as possible in order that the expanding properties are fully availed of. Where a thicker section is encountered, 10 mm chips may be added to the grout. This may slightly affect the flow properties of the grout and additional powder may be needed to restore the same. Bolt holes shall be filled in first and then the gap between the column base and base concrete grouted. It is essential that the grout flow is continuous. For larger grouts suitable pumps shall be employed. The air must escape and shall not be trapped inside. Grouting shall not be done in extreme hot or cold weather.

12. FIELD INSPECTION

All materials, equipment and work of erection shall be subject to the inspection of the Engineer who shall be provided with all facilities including labour and tools required at all reasonable times. Any work found defective is liable to be rejected.

No protective treatment shall be applied to the work until the appropriate inspection and testing has been carried out. The stage inspection shall be carried out for all operations so as to ensure the correctness of fabrication and good quality. Girder dimensions and camber shall not be finally checked until all welding and heating operations are completed and the member has cooled to a uniform temperature.

13. TESTING OF MATERIALS

All the material shall be tested as per specification, all pipes/plates hollow sections shall be tested as per following frequency.

- a) Pipes/Plates/hollow section /nuts and bolts/foundation/anchor bolts – one test per dia. / thickness subject to minimum one test per 250 MT per size as per relevant IS code. However, if quantity of any size is less than 5 MT, the test may be waived of at the discretion of EIC.
- b) Manufacturers test certificate shall be supplied along with each batch of material irrespective of quantity.

A. Bolted connections:

Bolts and bolted connection joints with high strength bolts shall be inspected and tested according to IS: 4000.

The firmness of joint shall be checked by 0.2 mm filler gauge, which shall not go inside under the bolt head by more than 3 mm. The alignment of plates at all bolted splice joints and welded butt joints shall be checked for compliance with Code requirements.

Testing of flame cut and sheared edges is to be done, where the hardness criteria given in the code are adopted. Hardness testing shall be carried out on six specimens.

B. Welding and welding consumables:

Welding procedure, welded connection and testing shall be in compliance with Code requirements.

All facilities necessary for stage inspection during welding and on completion shall be provided to the Engineer or their inspecting Authority by manufacturer.

Adequate means of identification either by identification mark or other record shall be provided to enable each weld to be traced to the welder(s) by whom it was carried out.

All metal arc welding shall be in compliance with IS: 9595 provisions.

The method of inspection shall be in accordance with IS: 822 and extent of inspection and testing shall be in accordance with the relevant standards or in the absence of such a standard, as agreed with the Engineer.

Procedure tests -The Destructive and Non-Destructive test of weld shall be carried out according to IS: 7307 (Part I).

C. Non-Destructive Testing of Welds

One or more of the following methods may be applied for inspection or testing of weld:

- i) Visual Inspection: All welds shall be visually inspected, which should cover all defects of weld such as size, porosity, crack in the weld or in the HAZ (Heat Affected Zone) etc. Suitable magnifying glass may be used for visual inspection. A weld shall be acceptable by visual inspection if it shows that:
 - a) The weld has no cracks.
 - b) Through fusion exists between weld and base metal and between adjacent layers of weld metal.
 - c) Weld profiles are in accordance with requisite clauses of IS: 9595 or as agreed with the Engineer.
 - d) The weld shall be of full cross section, except for the ends of intermittent fillet welds outside their effective length.

- e) When weld is transverse to the primary stress, undercut shall not be more than 0.8 mm deep when the weld is parallel to the primary stress in the part that is undercut.
 - f) The fillet weld in any single continuous weld shall be permitted to under run the nominal fillet weld size specified by 1.6 mm without correction provided that undersize portion of the weld does not exceed 10 percent of the length of the weld. On the web-to-flange welds on girders, no under run is permitted at the ends for a length equal to twice the width of the flange.
 - g) The piping porosity in fillet welds shall not exceed one in each 100 mm of weld length and the maximum diameter shall not exceed 2.4 mm, except for fillet welds connecting stiffeners to web where the sum of diameters of piping porosity shall not exceed 9.5 mm in any 25 mm length of weld and shall not exceed 19 mm in any 300 mm length of weld.
 - h) The full penetration groove weld in butt joints transverse to the direction of computed tensile stress shall have no piping porosity. For all other groove welds, the piping porosity shall not exceed one in 100 mm of length and the maximum diameter shall not exceed 2.4 mm.
- (ii) Dye Penetration Test (DPT):
This shall be carried out for all important fillet welds and groove welds for both statically and dynamically loaded structures to check the following
- i) Surface cracks
 - ii) Surface porosities
- Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E-166
- (iii) Magnetic Particle Inspection:
Welds that are subject to magnetic particle testing in addition to visual inspection shall have no crack.
- Magnetic particle test shall be carried out for detection of crack and other discontinuity in the weld according to IS: 5334.
- Acceptance Criteria:
- The weld shall be unacceptable if magnetic particle testing shows any of the type of discontinuities indicated in the code.
- (iv) Ultrasonic Inspection:
The Ultrasonic testing in addition to visual inspection shall be carried out for detection of internal flaws in the weld such as cracks, piping porosity inclusion, lack of fusion, incomplete penetration, etc.

Acceptance criteria shall be as per IS: 4260 or any other relevant IS Specification and as agreed to by the Engineer.

The non-destructive testing of following welds be carried out using one of the method or methods described at (ii) and (iii) above, as may be agreed to by the Engineer.

- a) All transverse butt welds in tension flange.
- b) 10 percent of the length of longitudinal and transverse butt welds in tension flanges.
- c) 5 percent of the length of longitudinal and transverse butt welds in compression flanges.
- d) All transverse butt welds in webs adjacent to tension flanges as specified by the Engineer.

The particular length of welds in webs to be tested shall be agreed with the Engineer, in case of (b) or (c).

Where specified by the Engineer, bearing stiffeners or bearing diaphragms adjacent to welds, plates in box girder construction adjacent to plates at cruciform welds, plates in box girder construction adjacent to corner welds or other details shall be ultrasonically tested after fabrication.

Any lamination, lamellar tearing or other defect found shall be recorded and reported to Engineer for his decision.

D. Testing of welding for Cast Steel:

The testing of weld for cast steel shall be carried out as may be agreed to by the Engineer-In-Charge.

E. Stud Shear Connectors (where applicable)

Stud shear connectors shall be subjected to the following tests:

- a) The fixing of studs after being welded in position shall be tested by striking the side of the head of the stud with a 2 kg hammer to the satisfaction of the Engineer.
- b) The selected stud head stroked with 6 kg hammer shall be capable of lateral displacement of approximately 0.25 the height of the stud from its original position. The stud weld shall not show any sign of crack or lack of fusion.

The studs whose welds have failed the tests given in (a) and (b) shall be replaced.

F. Inspection requirement

The fabricated member/component made out of rolled and built-up section shall be checked for compliance of the tolerances given in Table-2. Inspection of member/components for compliance with tolerances, and the check for deviations shall be made over the full length.

During checking, the inspection requirement shall be placed in such a manner that local surface irregularities do not influence the results.

For plate, out-of-plane deviation shall be checked at right angle to the surface over the full area of plate.

The relative cross frame deviation shall be checked over the middle third of length of the girder or frame between each pair of webs and for cantilever at the end of member.

The web of rolled beam or channel section shall be checked for out-of-plane deviation in longitudinal direction equal to the depth of the section.

During inspection, the component/member shall not have any load or external restraint

G. Inspection Stages

The inspection to be carried out for compliance of tolerances shall include but not be limited to the following stages:

- a) For completed parts, component/members on completion of fabrication and before any subsequent operation such as surface preparation, painting, transportation, and erection.
- b) For webs of plate and box girder, longitudinal compression flange stiffeners in box girders and orthotropic decks and all web stiffeners at site joints, on completion of site joint.
- c) For girders and frames, cantilevers and other parts in which deviations have apparently increased on completion of site assembly.

Where, on checking member/component for the deviations in respect of out-of-plane or out-of-straightness at right angles to the plate surface, and any other instances, exceed tolerance, the maximum deviation shall be measured and recorded. The recorded measurements shall be submitted to the Engineer who will determine whether the component/member may be accepted without rectification, with rectification or rejected.

14. Surface Preparation for Painting

The steel surface which is to be painted will be cleaned of dirt and grease and the heavier layer of rust shall be removed by chipping prior to actual surface preparation to a specified grade. Prior to paint application all surfaces should

be assessed and treated in accordance with ISO 8504:1992. Oil or grease should be removed in accordance with SSPC-SP1 solvent cleaning. All steel members shall be prepared by blast cleaning to preparation grade Sa 2^{1/2} before painting(ISO 8501-1:1988). Surface defects revealed by the blast cleaning process, should be ground, filled, or treated in the appropriate manner.

15. Painting of Structural Steel

a) Paint system:

i) Primer Coat:

A two component Epoxy zinc phosphate Primer with minimum volume solids of 70% having VOC less than 250 gm/ltr of approved make.(Red or grey in colour)
Total DFT – Min. 75 microns

ii) Intermediate Coat:

A two component Epoxy Micaceous Iron Oxide Intermediate with minimum volume solids of 80% having VOC less than 250gms/ltr of approved make. (Colour as approved by E-I-C)
Total DFT – Min. 75 microns

iii) Finish Coat:

To be applied in two coats: Two component High Gloss Acrylic Polyurethane. Finish Paint with approximate Volume solids of 70-77%, having VOC < 250 gm/ltr, with gloss retention of minimum 80% after 2000 hours exposure to UV A Fluorescent lamp as per ASTM D523 of approved make. (Colour as approved by E-I-C)

Total DFT of two coats – Min. 100 microns

DFT Measurement should be in accordance with SSPC PA 2.

The entire paint system shall be of same manufacturers.

b) Application of Paint

All Paints delivered to the shop shall be ready mixed in original sealed containers, as packed by the paint manufacturers.

Painting shall not be carried out when the temperature is below 4 degrees C, or above 50 degrees C, Less than 3 degrees C above the dew point, or when the relative humidity is above 80%.

Paint shall be applied in accordance with manufacturer's recommendation, as supplemented by these specifications. The work shall be generally follow IS:

1477 – (part-II). Prior approval of Engineer shall be taken in respect of all primer or paints, before their use in works.

For Brush Application: Proper brush shall be selected for a specific work piece. Round or oval brush which confirms to IS: 487 are better suited for irregular surfaces, whereas flat brushes which confirm to IS: 384 are convenient for large flat areas.

For Spray Application: The spraying equipment shall be compatible with the paint material and provided with necessary gauges and controls. The equipment shall be cleaned of dirt, dried paint, foreign matter and solvent before use.

16. Fire Retardant Painting System to Steel works

a) General

Fire Retardant coating shall be carried out for Structural steel elements for location as specified in NBC 2016. The thickness of intumescent coating shall be determined in accordance with the factor H_p/A section given by the paint manufacturer.

b) Paint System

Surface Preparation	Preparing the structural steel surfaces to ensure complete removal of mill scale by blast cleaning confirming to SA 2.5 Swedish Standard. Surface should be free of all visible oil, grease, dust, dirt, mill scale, rust, oxides, corrosion products and other foreign matters.
Priming Coat	Two component solvent-based Polyamide cured Epoxy Zinc Phosphate Primer with volume solids of $64 \pm 2\%$. The DFT shall be minimum 100 microns (50 microns per coat of application). The mass density shall be minimum 1.4 Kg / Ltr.
Intumescent coating	Solvent (non-water) based Intumescent Paint with approximate volume solids $75 \pm 3\%$, confirming to BS 476 / EN 13381 with UL / Certified / BRE test Certification for four side exposure. The coating shall provide minimum 120 minutes protection from cellulosic fire. The thickness of intumescent coating shall be determined in accordance with the factor H_p/A section given by the paint manufacturer. The mass density shall be minimum 1.34 Kg / Ltr

Top Protective Coat (Finish)	Two component aliphatic acrylic polyurethane top finishing coat with approximate volume solids of 55 ± 2%. The product should have gloss retention of 80% following 3000 hours exposure to QUVA as per ASTM G 53. The DFT shall be minimum 100 microns (50 microns per coat of application).
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Dry Film Thickness (DFT) should be in accordance with Society for Protective Coatings (SSPC) PA 2. The entire paint system shall be of same manufacturers.

c) **APPLICATION OF PAINT**

All Paints delivered to the site shall be ready mixed in original sealed containers, as packed by the paint manufacturers.

Painting shall not be carried out when the steelwork temperature is below 4 degrees C, above 50 degrees C, less than 3 degrees C above the dew point, or when the relative humidity is above 80%.

Paint shall be applied in accordance with manufacturer's recommendation and as supplemented by these specifications. The work shall be generally follow IS: 1477 – (part-II). Prior approval of Engineer-In-Charge shall be taken in respect of all primer or paints, before their use in works.

Paint shall not be applied when the ambient temperature is 10 deg C and below.

Brush Application:

Proper brush shall be selected for a specific work piece. Round or oval brush which confirms to IS: 487 are better suited for irregular surfaces, whereas flat brushes which confirm to IS: 384 are convenient for large flat areas.

Spray Application:

The spraying equipment shall be compatible with the paint material and provided with necessary gauges and controls. The equipment shall be cleaned of dirt, dried paint, foreign matter and solvent before use.

d) **Precautions**

All fixtures, glazing, floors etc. shall be protected by suitable covering. All stains, smears, splashing if any shall be removed and any damage done shall be made good by the contractor on his cost.

III. VITRIFIED TILE FLOORING / SKIRTING / DADO / RISERS OF STEPS

Size & Type as per Finishing Schedule Matrix or as per direction of Engineering in Charge

1. General

Double charge heavy duty Vitrified tiles of required thickness (with applicable tolerances) (Polish / satin Finish/ anti-skid/ Matt finish) having water absorption less than 0.05% and confirming to IS:15622, of approved make, in all colours and shades laid in approved design and pattern over duly cured and dried 15 mm (average) thick correction layer base of cement mortar 1:4 (1 cement: 4 coarse sand) followed by laying and fixing with high polymer modified quick set adhesive Type II, IS: 15477, with average 6 mm thickness keeping 3mm wide joints between tiles including grouting of the joints using epoxy grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg), including filling / grouting and finishing as per direction of Engineer-In-Charge.

2. Reference Standards

Code/Parameters	Description
I.S. 383 - 1970	Specification for coarse and fine aggregates
I.S. 2250 : 1981	Tests for mortar
I.S. 2386 - 1963	Method of test of aggregates in concrete
I.S. 4082 : 1996	Recommendation on stacking and storage of construction materials at site.
I.S. 8042 - 1989	Specification for white port land cement
I.S. 8112 - 1989	Ordinary portland cement 43 grade
I.S. 456 & I.S. 3025	Water
IS : 15622	Pressed Ceramic Tiles – Specification (Vitrified tiles shall confirm to Table-12 of IS : 15622)
Antiskid Vitrified Tiles	Shall conform to EN - 176 Group B1a and ISO 13006 stds.
Deviation in length	Method of testing shall be as per EN 98
Deviation in thickness	Method of testing shall be as per EN 98
Straightness of sides	Method of testing shall be as per EN 98
Rectangularity	Method of testing shall be as per EN 98
Surface flatness	Method of testing shall be as per EN 98
Water absorption	Shall not be greater than 0.05 % (Method of testing shall be as per EN 99)
Moh's hardness	Shall not be less than 6 (Method of testing shall be as per EN 101)
Flexural strength	Shall not be less than 27 N / sqmm. (Method of testing shall be as per EN 100)
Abrasion resistance	(Method of testing shall be as per EN 102)
Skid resistance (coefficient of friction)	0.6 (Method of testing shall be as per ASTM C-1028)
Breaking strength	Shall not be less than 2500 N (Method of testing shall be as per ASTM C-678)

Code/Parameters	Description
Density	Shall not be less than 2 gm / cm ³ (Method of testing shall be as per DIN - 51082)
Frost resistance	Shall be frost proof (Method of testing shall be as per EN - 202)
Chemical resistance	Shall be resistant to chemicals (Method of testing shall be as per EN - 106)
Thermal shock resistance	Shall be resistant to thermal shocks (Method of testing shall be as per EN - 104)
Colour resistance	No damage (Method of testing shall be as per DIN - 51094)
Thermal expansion	Shall not be more than 9×10^{-6} (Method of testing shall be as per EN - 103)
Stain resistance	Shall be stain resistant (Method of testing shall be as per ISO 10545 -14)
Glossiness	Desired reflection effect as required by architect (Method of testing shall be with the use of glossometer)

3. Material

The tiles shall be unchamfered, double charged, (Polish / satin Finish/ anti-skid/ Matt finish) tiles of nominal size of premium quality. The tiles shall be of approved make and confirming to the standards. The size and thickness of tiles shall be as per the architectural requirements. They shall be flat, and true to shape and free from blisters, crazing, welts, crawling, warps or other imperfection detracting from their appearance. The tiles shall be tested as per standard acceptance criteria mentioned.

The size of the tiles shall be as per architectural drawings/finish matrix, the thickness of tiles shall be as per architectural requirement/manufacturer's specification as approved by the Engineer-In-Charge.

The underside of the tiles shall not have any finish in order that the tiles may adhere properly to the base. The edges of the tiles shall be preferably free from shine or polish. However, any finish, if unavoidable shall be permissible on only upto to 50 percent of the surface area of the edges.

4. Preparation of Surface and Laying of Floors

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of bedding shall be 15mm. Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over this mortar bedding **laying and fixing with high polymer modified quick set adhesive Type II, as per IS: 15477, with average 6 mm thickness.** Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be 3mm thick and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2m long, so as to obtain a true surface with the required slope. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles, which are fixed in the floor adjoining the wall, shall enter not less than 10mm under the plaster, skirting or dado. After tiles have been laid, the surplus adhesive shall be cleaned off.

5. Dado, Skirting, Risers of Steps

RCC column / wall on which the tiles are to be laid shall be cleaned, wetted and mopped. The backing mortar for the tiles shall be with cement mortar 1:3 (1 cement: 3 coarse sand). The average thickness of backing mortar shall be 12mm thick plaster of cement mortar 1:3 shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals. Over this backing mortar, dado / skirting shall be **fixed using average 6 mm thick high polymer modified quick set adhesive of Type II, as per IS: 15477.** Tiles shall be soaked in water washed clean and shall be fixed with the tile adhesive. The tiles shall be tamped and corrected to proper plane & lines. The tiles shall be set in a required pattern and jointed. The joints shall be 3mm thick. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/ cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size & their edges rubbed smooth.

Skirting/ dado shall not project from the finished "surface" or "wall" by more than the tile thickness, undulations if any shall be adjusted in wall.

6. Pointing and Finishing

The joint shall be cleaned off the surplus adhesive with wire/coir brush or trowel and all dust and loose mortar removed. The joint shall be grouted using epoxy grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg) of approved make.

If required, the finished surface shall be kept protected by laying Plaster of Paris @ 2kg / Sqm over 200mm micron polyethylene sheet till commissioning after laying of tiles.

The finished floor shall not sound hollow when tapped.

7. Testing:

Tile of each size shall be tested as below:
One test per 1000 Sqm or part thereof

~~IV. METAL DECK SHEET~~

~~1. General~~

~~Supply of approved manufacture Structural decking sheet of designed thickness 0.7 to 1.2 mm as per design BMT (Base Metal Thickness), Hi-Strength steel with minimum 550 MPa yield strength, galvanized steel with Z275 (minimum 275g/m² zinc coating) conforming to AS1397 standards. The structural decking panel shall have profile as specified here or as per approved manufacturer profile, nominal 960mm effective cover width, nominal 51 mm deep ribs with nominal 316mm centre to centre pitch with the embossments (shear groove) on top and side of ribs for better mechanical interlock between steel and concrete. In the assembled state, the profile shall comprise of intermediate male and female ribs for every interlocking side lap joint.~~

~~The decking sheets shall be Installed/laid continuously over each slab span without any intermediate splicing or jointing. The sheets are to be supported on structural steel with minimum bearing of 100mm at the intermediate supports and 50mm minimum at the end supports. The sheets shall be laid with the ribs aligned in the direction of the designed spans. The side laps shall be crimped for the proper engagement of laps. The decking sheets shall be fastened to the structural steel at every support, temporary and permanent, with Hex head min. 25 µm Zinc Tin alloy coated, self-drilling screw of approved make. The shear studs or connector of size as per the design of approved make to be welded on the structural steel.~~

~~2. Accessories~~

~~Shear Connectors~~

- ~~• Provide shear transfer~~
- ~~• Prevent vertical separation of concrete~~

~~Edge Forms~~

- ~~• Proper concrete retention~~
- ~~• Provide Smooth top edge~~

~~End caps~~

- ~~• Prevent concrete flow through profile troughs mainly at intermediate beams~~

~~Thickness tolerance +/- 0.05mm.~~

V. WATERPROOFING SYSTEM FOR RAFT & WALLS (ON THE EXTERNAL SIDES)

1. RAFT/FOOTING SLAB

Supplying and installing ≥ 1.2 mm thick self-adhesive HDPE membrane, having puncture resistance of 1000N as per ASTM E 154, Tensile strength of 25 Mpa as per ASTM D412, Elongation of 400% as per ASTM D 412, Resistance to hydrostatic head > 60 M as per ASTM D 5385, Peel adhesion to concrete 1500N/m as per ASTM D903, 28 Days UV Exposure test-Pass and conforming to IS 16471:2017 requirements of UG waterproofing structures, as per manufacturer's recommendation.

Preformed HDPE fully bonded membrane bonds to the wet concrete cast on the membrane. After the membrane bonds with the concrete it forms an integral seal which prevents lateral water migration and makes it unaffected by any substrate settlement below the slabs. Reinforcement can be directly laid on top of the membrane and it does not require screed protection. The system should be fully bonded to the RCC and consists of Virgin HDPE layer, a pressure sensitive -adhesive layer which is covered by a weather proof protective layer. The membrane shall have minimum of 75 mm side and end laps which shall be hot welded to ensure seamless joints. The size of the membrane should not be less than 2 Mtr. x 20 Mtr, to minimize the joints. No Protection Required for Fully Bonded HDPE Membrane allowing Faster Construction. HDPE membrane shall be virgin HDPE and not recycled. Thickness of bare HDPE shall not be less than 0.8mm.

The waterproofing system should be applied directly by the manufacturer with 15 years of complete system guarantee against leakage.

The fully bonded HDPE waterproofing membrane shall have following technical properties:

Property	Typical Value	Test Method
Colour	White	
Roll Size	2 Mtr x 20 Mtr	
Thickness	≥ 1.2 mm	ASTM D 3767
Tensile Strength, Film	25 Mpa	ASTM D 412 Modified
Elongation	400%	ASTM D 412 Modified
Low Temperature Flexibility	-25°C Pass	ASTM D 1970
Resistance to Hydrostatic Head	> 60 M	ASTM D 5385 Modified

Joint Strength at overlaps(lap adhesion)	>2500 N/m	ASTM D 6392:2012
Crack Cycling	Pass	ASTM D 836/ ASTM C 1305 Modified
Peel Adhesion to Concrete	>1500 N/m	ASTM D 903 Modified
Puncture Resistance	1000 N (± 5 to 10%)	ASTM E 154
UV resistance Test	No Change	28 Days Pass

2. METHOD OF APPLICATION

- The entire area shall be taken up for through surface preparation and mechanical removal of Debris, laitance and protrusions.
- Place the membrane HDPE film side to the substrate with the adhesive /coated side up facing towards the concrete pour and it shall be extended inside the shuttering on the vertical surface before casting the raft slab. End laps should be staggered to avoid a build-up of layers.
- Ensure the underside of the succeeding sheet is clean, dry & free from contamination.
- The HDPE membrane shall be welded together by HOT AIR welding with double seam welding machine.
- In case of minor damages in the said HDPE membrane, the area shall be marked & sealed with another patch of membrane using single seam hand welding machine.

3. CONSTRUCTION JOINT TREATMENT

Providing and fixing Swellable water stop 20 X 5 mm at construction joint at junction of raft and retaining wall. The swellable water stop should have min. tensile strength of 1MPa, min. elongation of 450% (as per ASTM D 412), Shore A Hardness of 40-50 (as per ASTM D 2240) and with Expansion Volume rate of 200-300%. The procedure involves spot bonding the water bar between the reinforcement with requisite adhesive per manufacturer's methodology.

Property	Typical Value	Test Method
Tensile Strength, Film	1 Mpa	ASTM D 412
Elongation	450%	ASTM D 412
Shore A Hardness	45-50	ASTM D 2240

4. RETAINING WALL

Providing and laying of 1.5 mm thick SBS based self-adhesive waterproofing membrane topped with hdpe cross laminated film with the following technical properties-Softening point of 105 (OC) as per ASTM D36, Tensile Strength (L/T)- 3.5 N/sq.mm as per ASTM D412, Elongation (L/T) L- 180 %, T-180 % as per ASTM D 412, Tear Resistance 125 N as per ASTM D 4073, Puncture

Resistance- 200 N as per ASTM E 154, Hydrostatic pressure > 60 m (6BAR)
No leakage as per DIN 1048, including cleaning the surface, priming the surface with cold applied bituminous primer@4-6 sqmtr/litre, properly sealing the joints & maintaining 75 mm overlap between the membrane selvedge & 100 mm overlap on the end joints of the membrane over the slab etc. complete.

The system shall be a SBS modified self-adhesive cold applied waterproofing membrane based on a tropical grade of polymer modified bitumen. The bitumen compound is laminated onto an impervious, non-perforated, HDPE film. The membrane is protected on the self-adhesive side with a silicone coated release film.

Termination: Supplying and applying aluminium strip flashing with fasteners at the top and sealing the joints with PU sealant.

The laid membrane shall be covered with protection board - spot bonded on retaining wall before backfilling -8mm thick dimple board of compressive strength not less than 200kN/m². The SBS Self-adhesive membrane shall have following technical properties

Product	Test Standard	Results
Top surface		Cross laminated HDPE
Softening point (oC)	ASTM D36	105
Tensile Strength (L/T) N/sq.mm(compound membrane)	ASTM D 412-06	3.5
Elongation (L/T), (%) (compound membrane)	ASTM D 412 -06	180
Tear Resistance (N) (compound membrane)	ASTM D 4073	125
Puncture Resistance, (N)	ASTM E 154	200
Adhesion to self-lap adhesion N/mm	ASTM D 1000	2.4
Hydrostatic pressure	DIN 1048	> 60 m (6 BAR) No leakage
Crack Bridging Ability, (mm)	ASTM C 836	1.3

5. METHOD OF APPLICATION:

- The substrate must be free of all dirt, oil grease and loosely adhering particles and made dry. Honeycomb and spalled concrete is to be repaired and all nail

heads and protrusions that are likely to puncture the membranes must be removed. All tie rod holes to be packed.

- Injection grouting (cementitious grouting) at all construction joints & weaker sections @ 1m C/C through the PVC nipples with 40PSI grout pump using cement slurry mixed with expansive plasticizing admixture @225gms per bag of cement
- Laying of angle fillets (50mm x 50mm) at the junction of slab & vertical walls prepared with cement sand mortar 1:4 admixed with integral waterproofing compound @ 200 ml per 50 kg bag of cement.
- All concrete surfaces will then be primed with a solvent based Bitumen Primer.
- Unroll only the required length of the membrane and cut the pieces to the desired length and shape.
- Place the membrane pieces on the area to be covered and check whether the pieces match with the profile of the marked substrate.
- Re-roll the membrane for about half the length without changing its orientation. Then slowly unroll the membrane, peel off the release film and carefully place the membrane on the surface.
- Smoothen out any entrapped air by pressing from the center to the sides.
- The subsequent rolls are to be laid in such a fashion that there is a 75 mm side overlap on sides and 100mm end overlap.
- The applied membrane is then to be protected from damage by installing 8 mm thick HDPE dimple board spot bonded on retaining wall before backfilling.

6. TOILETS/SUNKEN PORTIONS WATER PROOFING

- i. Cleaning the internal surface areas thoroughly so that they are free of all contaminants like dirt and laitance & to remove all the loose materials by various mechanical means.
- ii. Removal of all surface Imperfections, protrusions, loose concrete & filling of cracks using SBR latex Polymer Modified Mortar in the ratio Cement: Sand (1:4) and 5% by weight of Removal of all surface Imperfections, protrusions, loose concrete & filling of cracks using SBR latex Polymer Modified Mortar in the ratio Cement: Sand (1:4) and 5% by weight of cement.
- iii. Providing and making fillets at the junction of the walls and the slabs using cement mortar of 1:4 mix admixed with 5 % of SBR latex by weight of cement
- iv. Applying two coats of 2 component acrylic cementitious coating with elongation > 40%, @ 0.6-0.7 sq mtr per kg in two coats all over the sunken slab including over angular fillet, vertically right up to minimum 300 mm over finished floor level, achieving a uniform thickness of 1.0mm. Laying protection plaster 15mm, 1:4 admixed with Integral waterproofing compound @ 200 ml per bag of cement.

v. Sealing of Pipe cut outs

Supplying & sealing the Sanitary pipe inserts, provided in the floor & walls with double sided bituminous tape and supplying & grouting the gaps around the pipe inserts with non-shrink free flow grout.

vi. Technical Properties of Acrylic cementitious coating

Technical Features

Product	Test Standard	Results
Mixing Ratio		1: 2

7. Injection method waterproofing treatment

- i. **Horizontal Surface:** After the excavation and PCC levelling course, water proofing course shall be laid consisting of cement mortar 1:3 (1 cement:3 sand) and mixed with Acrylic water proofing chemicals and embedding aggregate by hand pack at random in two layers each of 25mm thick thus the total water proofing course shall be about 50mm thick. After the necessary curing, and fixing raft reinforce cement in partition provide 20 mm pipe sleeves at 1.2 m c/c on both ways by tying it with reinforcement in such a manner to ensure that the bottom end of the pipe remain free from getting choked and the length of the pipes shall be that of total thickness of the raft plus 25 mm above to protrude from the surface of the raft.

After concreting the raft, grouting Acrylic based waterproofing chemical mixed with neat cement slurry through the pipe sleeves shall be carried and for the required period. The projected pipe ends shall be cut after grouting the mouths. The same procedure shall be adopted for all joints around the column wall joints.

- ii. **Vertical Surfaces:** The vertical surfaces shall be treated by making holes on the surface at 1.20 m centre to centre on both ways and also at 0.75 m along construction joints, corners and fixing nozzles of 20 mm dia pipe and inject Acrylic based chemicals mixed with neat cement slurry as explained above. After grouting the pipe, nozzles shall be removed and the packets shall be made good. The external surface of the walls shall be neatly plastered with cement mortar (1:3) admixed with Acrylic Chemicals of 12 to 15 mm thick

Injection grouting is a process of filling the cracks, open joints, voids, or honeycombs, in concrete or masonry structural members, under pressure with a material that cures in place to produce the desired results like strengthening a structure and prevent water movement.

Grout is a flowable plastic material and should have negligible shrinkage to fill the gap or voids completely and should remain stable without cracking, delamination or crumbling. There are different types of grouts such as cement grout, polymer-cement slurry, epoxy, urethane, and high-molecular-weight methacrylate (HMWM).

These grout materials are selected for particular type of concrete or masonry repair work based on the compatibility of the grout with the original material.

If Proper grouting material is not selected, the desired objectives of the grouting process would not be achieved.

iii. Grouting Material Preparation

Only that quantity of epoxy is mixed which can be used before gelling of the material, otherwise pressure injection becomes considerably difficult. During the batch mixing process, the components of the epoxy are mixed in a fixed quantity using a mechanical stirrer, such as a paint mixing paddle.

In the more advanced continuous mixing system, the two liquid adhesive components are passed through an automatic mixing head after the pumping just before leaving the gun.

This system allows the use of fast setting adhesives that have a short working life. After the injected epoxy has cured, the projected part of surface seal is removed by grinding or other appropriate means.

iv. Grouting Procedures

a) Drill Ports

Drill short holes, which is also known as ports, into the cracks/ openings in order to be used as entry and venting terminals. Minimum diameter and depth of ports are 2.5cm and 5cm, respectively.

Spacing between holes is 150 mm c/c for finer cracks to 300 mm c/c for others. The spacing of ports is usually kept greater than the desired depth of grout penetration, but it may be adjusted based on judgment and requirements for a particular project.



Fig. 1: Drill Ports

b) Seal Cracks Between Ports

The crack /opening surfaces between ports are sealed by applying epoxy, polyester, strippable plastic surface sealer for low injection pressures, or cementitious seals if surface appearance is important to the surface of the crack.

Time required for hardening of seal depends upon the type of material used. To stiffen the surface seal, the cracks are usually routed 6 mm in width and 13 mm in depth.

Sometimes, the crack can be cut out to a depth of 13 mm and width of about 20 mm in a V-shape, which is then filled with an epoxy to get a flush surface. If cracks pass through the structure, such as a wall, the surface seals and ports are applied on both sides.

Openings may be sealed by plugging with cloth or fabric that allows passing of water or air but retaining of solids. Paper and other materials that remain plastic are not suitable for this purpose.



Fig. 2: Sealing Cracks between Ports

c) Cleaning Ports and Cracks

Before grouting, flushing is done with clean water to obtain the following objectives:

- To wet the interior surfaces for better grout flow and penetration.
- To check the effectiveness of the surface sealing and port system.
- To gather information on grout flow patterns and details of interconnections of voids / discontinuities in the mass.
- To familiarize the grouting crew with the situation.

Full crack cleaning may not be possible in practical situations and judgment must be used to decide the extent of this cleaning.

d) Make Grouting Hose Connections

When the ports are drilled after sealing the openings and the grout pressure is up to 350 kPa, a hand-held, cone-shaped fitting on the grout hose is sufficient.

For larger grout pressures, short pipe nipples are connected in to the holes to obtain grout hose connections. The method of installing entry and vent ports in case of V-grooving of the cracks is to drill holes 20 mm in diameter

and 13 to 25 mm deep below the groove at the required spacing. A pipe nipple or tire valve stem is usually bonded with an epoxy adhesive.

The method commonly used in case of rectangular grooves is to use a flush fitting has an opening at the top for the adhesive to enter and a flange at the bottom that is bonded to the concrete face.

Third method is to use special gasket devices which can be directly fitted on to the discontinuities / openings in the surface seals.



Fig. 3: Hose Connections

e) Grouting Process

Grouting is started at one end of a horizontal opening or at the bottom of a vertical opening. It is continued until grout appears at the next port or the surface seals of cracks bulge out, after which the grouting operation is shifted to the next port.

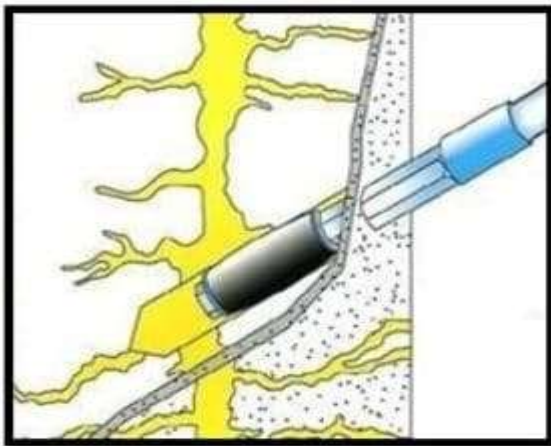


Fig. 4: Schematic Presentation of Injection Grouting

The port valves from where the grout is coming out are plugged before moving to the next injection location. Grouting is usually started with a relatively thin grout, thickened as quickly as possible to the heaviest consistency that can be pumped without blockage.

Extreme caution must be exercised when injecting cracks that are not visible on all surfaces. For injection of the epoxy, hydraulic pumps, paint pressure pots, or air-actuated caulking guns are generally used.

The pressure used for injection must be selected carefully and it must not be excessive. For vertical or inclined cracks, the injection process must begin by pumping epoxy at the lowest level until the epoxy level reaches the entry port above. The lower injection port is then capped, and the process is repeated until the crack has been completely filled.



Fig. 5: Pressure Injection Grouting

f) End of Grouting Process

An indication of full filling of the crack is that the pressure does not drop. Epoxy injection requires a high degree of skill for satisfactory application of the technique. The atmospheric temperature at the repair site is also an important consideration.

Injection Grouting of Massive Structures

For massive structures, the procedure consists of drilling a series of holes, 20 to 100-mm diameter, at a spacing of 1.5 m along the crack. In a recently developed method, a bag is wrapped all along the member and the liquid adhesive is introduced at the bottom and is sucked by a vacuum pump at

the top, or epoxy is injected in the cracks from one side and pulled from the other side.

VI. STP TANK/Septic tank WATERPROOFING (ON THE INTERNAL SIDE)

1. Scope

The scope of work covers supply, application, testing and guarantee waterproofing system for STP tank (On Internal Side)

2. General

A. Quality assurance

All products shall meet the key performance properties listed below against each and shall be sourced from a manufacturer with a certified QA system such as, ISO 9001 or an established and proven QA system that has ensured consistent products.

B. Approved sources:

All products in the specified system shall be sourced from a single manufacturer, from amongst the list of approved products and sources for each.

C. Installation:

All the products/systems shall be installed by a Specialist Applicator approved by the manufacturer strictly in accordance to the written application guide by the manufacturer and as approved by the Engineer-In-Charge.

D. Multiple sources and compatibility:

Should the Specialist Applicator or the Contractor want products from different sources, they shall submit proof of compatibility between the products of different sources.

E. Alternate equivalents:

Should the Specialist Applicator or Contractor prefer to use alternative equivalent product(s) to the approved list, it can only be after obtaining a written approval by the Engineer-In-Charge.

F. Substrate preparation:

Before starting to install the specified waterproofing system, the substrate shall jointly be inspected by the Contractor and the Specialist Applicator for soundness; any defects shall first be repaired utilising products and systems compatible with the specified waterproofing system.

G. Submittals

- i) Product Data: Include manufacturer's written instructions for evaluating, preparing and treating substrate, technical data and tested physical and performance properties of waterproofing.

- ii) Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing and other termination conditions.
 - a) Include setting drawings showing layout, sizes, sections, profiles, and joint details.
- iii) Samples: For the following products:
 - a) 300 x 300 mm square of waterproofing including all material components
- iv) Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
- v) Qualification Data: For Installer
- vi) Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- vii) Warranties: Special warranties / guarantees specified in this Section.

H. Delivery, Storage and Handling

- a) Deliver materials to Project site in original packages with seals unbroken labelled with manufacturer's name, product brand name and type, date of manufacture and directions for storing and mixing with other components.
- b) Store rolls according to manufacturer's written instructions.
- c) Protect stored materials from weather conditions

3. The Waterproofing System

The specified waterproofing system for the STP Tank for vertical & horizontal surface; each generic product specified shall meet the key performance properties mentioned below:

a. Waterproofing system for Horizontal and Vertical Surface

Apply 3 coats of two component acrylic modified cementitious coating applied by brush, roller or trowel to waterproof and resurface concrete, surface.

b. Pitch Epoxy Coating

The high – build pitch epoxy coating shall be of a two component, solvent free, pitch extended epoxy resin system to provide a high build coating that protects concrete and metal substrates from a wide range of aggressive chemicals. It shall be applied using short nap roller, shorthaired brushes or by airless spray on Concrete substrate

The High build, pitch extended epoxy coating shall be **100% solids**, solvent free, tough abrasion resistant protective coating. The product shall exhibit excellent bond strength with the substrate at least exceeding 2.5 MPa, when tested as per ASTM D4541. The product shall be formulated to have high build thickness exceeding 150 microns per coat on average and shall be applied to achieve overall thickness of 300 microns in two coats. The product shall be formulated to resist exposure to accelerated weathering test as per ASTM D4587 and shall not exhibit any flaking or blistering.

4. Key performance properties of the specified products

A. Waterproofing System for Horizontal & Vertical Surface

All exposed concrete surfaces shall be prepared and are to be coated with two component reactive polymer composite. The product shall be applied in minimum two coats @ **3.9 Kg/m²** to achieve total DFT of **2mm**.

Sr No	Properties	Results
1	Mixed Density	1940 kg/m ³
2	Mixing Ratio , by weight	3:1 (powder: Liquid)
3	VOC Content	0.5 g/L (HK prod code P10-17)
4	Elongation %	> 5% (Unbonded)
5	Water penetration (DIN 1048)	7 bars - no leakage (at 2mm DFT)

The horizontal protection over the waterproofing coating shall be minimum **50 mm thick** screed mixed with approved Waterproofing Compound.

The vertical protection over the waterproofing coating shall be with **15 mm thick** plaster mixed with approved Waterproofing Compound.

5. Treatment for Cut Outs

The Cut-Out Treatment shall be done by applying one layers of swelling polymeric paste on the external periphery of the PVC sleeve and sealing the cut out with ready to use approved Dual shrinkage compensated micro concrete or with approved Dual Shrinkage Compensated Mortar.

The properties of Swellable polymeric paste that shall be applied on external periphery of PVC sleeve are as below:-

Sr No	Properties	Results
1	Base	Hydro swelling polymeric paste
2	Mix Density	1.5 Kg/ Litre
3	Re-swelling capacity	> 80% in potable water
4	Setting time	3 – 6 Hours

The sealing of cut out shall be done using Dual Shrinkage Compensated free flow Micro Concrete having the following Physical Properties

Sr No	Properties	Test Method	Values
1	Fresh Wet Density		2250 Kg/m ³
2	Compressive Strength	ASTM C 109, 7mm cube	15 MPa at 1 Day 25 MPa at 3 Days 35 MPa at 7 Days 40 MPa at 28 Days
3	Water/Powder Ratio by Weight		0.14

6. Treatment for crack & joints

Cracks and construction joint shall be treated with special re-swellable resin through non – returnable. The property of metha-acrylate re-swellable resin used for injecting for treating construction joints and cracks as below: -

Sr No	Properties	Values
1	Chemical Base	Acrylate Polymer
2	Mixed Density	1.065 Kg/Ltr
3	Viscosity	< 40 CPS @ 20° C
4	Setting time	1-2 Hours

7. Potable Grade Epoxy Lining

The potable grade epoxy coating shall have the following physical properties.

Sr No	Properties	Values
1	Base	Water Base
2	Volume Solids	65 ± 3%
3	Density	1.25 Kg/ Ltr
4	Pot Life	50 min at 20°C 25 min at 40°C

VII. WATERPROOFING OF UNDER GROUND WATER STORAGE TANKS ON THE INTERNAL SIDE

1. Scope

This specification covers the waterproofing system for underground water tank (On Internal Side)

2. General

A. Quality assurance

All products shall meet the key performance properties listed below against each and shall be sourced from a manufacturer with a certified QA system such as, ISO 9001 or an established and proven QA system that has ensured consistent products.

B. Approved sources:

All products in the specified system shall be sourced from a single manufacturer, from amongst the list of approved products and sources for each.

C. Installation:

All the products/systems shall be installed by a Specialist Applicator approved by the manufacturer strictly in accordance to the written application guide by the manufacturer and as approved by the Engineer-In-Charge.

D. Multiple sources and compatibility:

Should the Specialist Applicator or the Contractor want products from different sources, they shall submit proof of compatibility between the products of different sources.

E. Alternate equivalents:

Should the Specialist Applicator or Contractor prefer to use alternative equivalent product(s) to the approved list, it can only be after obtaining a written approval by the Engineer-In-Charge.

F. Substrate preparation:

Before starting to install the specified waterproofing system, the substrate shall jointly be inspected by the Contractor and the Specialist Applicator for soundness; any defects shall first be repaired utilising products and systems compatible with the specified waterproofing system.

G. Submittals

- i. Product Data: Include manufacturer's written instructions for evaluating, preparing and treating substrate, technical data and tested physical and performance properties of waterproofing.
- ii. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing and other termination conditions.
 - a) Include setting drawings showing layout, sizes, sections, profiles, and joint details.
- iii. Samples: For the following products:
 - b) 300 x 300 mm square of waterproofing including all material components
- iv. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

- v. Qualification Data: For Installer
- vi. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- vii. Warranties: Special warranties / guarantees specified in this Section.

H. Delivery, Storage and Handling

- a) Deliver materials to Project site in original packages with seals unbroken labelled with manufacturer's name, product brand name and type, date of manufacture and directions for storing and mixing with other components.
- b) Store rolls according to manufacturer's written instructions.
- c) Protect stored materials from weather conditions

3. The Waterproofing System

The specified waterproofing system for the underground water tank for vertical & horizontal surface; each generic product specified shall meet the key performance properties mentioned below:

c. Waterproofing system for Horizontal and Vertical Surface

Apply 3 coats of two component acrylic modified cementitious coating applied by brush, roller or trowel to waterproof and resurface concrete, surface.

d. Pitch Epoxy Coating

The high-build, water based epoxy coating of two-component, water dispersed epoxy formulation. The product shall be of high-solids, not less than 65% by volume. The product shall be applied at 150 microns dry film thickness in two-three coats. The product shall exhibit adhesive bond strength to concrete of 1.5 Mpa minimum, when tested to ASTM D4541 test method.

It provides a protective coating which is impermeable to liquids, abrasion resistant, prevent growth of bacteria and fungus and easy to clean.

4. Key performance properties of the specified products

A. Waterproofing System for Horizontal & Vertical Surface

All exposed concrete surfaces shall be prepared and are to be coated with two component reactive polymer composite. The product shall be applied in minimum two coats @ **3.9 Kg/m²** to achieve total DFT of **2mm**.

Sr No	Properties	Results
1	Mixed Density	1940 kg/m ³
2	Mixing Ratio, by weight	3:1 (powder: Liquid)
3	VOC Content	0.5 g/L (HK prod code P10-17)
4	Elongation %	> 5% (Unbonded)

5	Water penetration (DIN 1048)	7 bars - no leakage (at 2mm DFT)
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The horizontal protection over the waterproofing coating shall be minimum **50 mm thick** screed mixed with approved Waterproofing Compound.

The vertical protection over the waterproofing coating shall be with **15 mm thick** plaster mixed with approved Waterproofing Compound.

5. Treatment for Cut Outs

The Cut-Out Treatment shall be done by applying one layers of swelling polymeric paste on the external periphery of the PVC sleeve and sealing the cut out with ready to use approved Dual shrinkage compensated micro concrete or with approved Dual Shrinkage Compensated Mortar.

The properties of Swellable polymeric paste that shall be applied on external periphery of PVC sleeve are as below: -

Sr No	Properties	Results
1	Base	Hydro swelling polymeric paste
2	Mix Density	1.5 Kg/ Litre
3	Re-swelling capacity	> 80% in potable water
4	Setting time	3 – 6 Hours

The sealing of cut out shall be done using Dual Shrinkage Compensated free flow Micro Concrete having the following Physical Properties

Sr No	Properties	Test Method	Values
1	Fresh Wet Density		2250 Kg/m ³
2	Compressive Strength	ASTM C 109, 7mm cube	15 MPa at 1 Day 25 MPa at 3 Days 35 MPa at 7 Days 40 MPa at 28 Days
3	Water/Powder Ratio by Weight		0.14

6. Treatment for crack & joints

Cracks and construction joint shall be treated with special re-swellable resin through non – returnable. The property of metha-acrylate re-swellable resin used for injecting for treating construction joints and cracks as below: -

Sr No	Properties	Values
1	Chemical Base	Acrylate Polymer
2	Mixed Density	1.065 Kg/Ltr
3	Viscosity	< 40 CPS @ 20° C

4	Setting time	1-2 Hours
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7. Potable Grade Epoxy Lining

The potable grade epoxy coating shall have the following physical properties.

Sr No	Properties	Values
1	Base	Water Base
2	Volume Solids	65 ± 3%
3	Density	1.25 Kg/ Ltr
4	Pot Life	50 min at 20°C 25 min at 40°C

VIII. PERFORATED METAL CEILING

1. General

300mm wide Perforated + NWT - Providing & Fixing of 300mm wide perforated 2.0 mm diameter 5mm c/c pasted with NWT corrosion resistant Aluminium Magnesium Alloy metal ceiling consisting of panel 300mm wide x 30 mm deep x 0.7 mm thick with bevel edge having panel length up to 6 mtrs. coil coated on a continuous paint line, Double baked and roll formed for higher straight and good roll forming characteristics with 21% perforation in approved Colour. The panel ends are raised up to 29 mm. The panel about each other with a narrow V groove. Panel shall be clipped to a backed enamelled Aluminium panel carrier of 41.5 mm wide x 62 mm deep x 0.95 mm thick in standard length of 5 mtrs. made of double baked enamelled Aluminium magnesium alloy AA5052 black with cut outs to hold panels module of 300 mm and at distance of 2.4 mtrs. the carrier shall be suspended by means of GI suspension rod 4mm diameter and suspension clip at 1.3 mtr. distance. The coils to go through 4 stages of pre-treatment, three times oven baked through conversion coating, priming and finish coat ensuring superior adhesion, high corrosion resistance and good colour stability. The coils to be painted on both sides after degreasing. Inside surface to have a primer of 5 microns and a coat of natural colour of 5 microns, exposed surface to have a primer of 5 microns, binder of 5 microns and topcoat of approved colour of 15 microns. If any MS Sub structure is required.

Paint finish: Aluminium panels shall be chromatised for maximum bond between metal and paint, enamelled twice under high temperature one side with full primer and Luxacote finish, the other side (Inner side) with a primer coat and skin coat on a Continuous paint line.

2. Material

300mm wide perforated 2.0 mm diameter 5mm c/c pasted with NWT corrosion resistant Aluminium Magnesium Alloy metal ceiling consisting of panel 300mm wide x 30 mm deep x 0.7 mm thick with bevel edge having panel length up to 6 mtrs. coil coated on a continuous paint line, Double baked and roll formed for higher straight and good roll forming characteristics with 21% perforation in approved Colour.

3. Approved System

Providing & Fixing of 300mm wide perforated 2.0 mm diameter 5mm c/c pasted with NWT corrosion resistant Aluminium Magnesium Alloy metal ceiling consisting of panel 300m wide x 30 mm deep x 0.7 mm thick with bevel edge having panel length up to 6 mtrs. coil coated on a continuous paint line, Double baked and roll formed for higher straight and good roll forming characteristics with 21% perforation in wooden finish Colour. The panel ends are raised up to 29 mm. The panel about each other with a narrow V groove. Panel shall be clipped to a backed enamelled Aluminium panel carrier of 41.5 mm wide x 62 mm deep x 0.95 mm thick in standard length of 5 mtrs. made of double baked enamelled Aluminium magnesium alloy AA5052 black with cut outs to hold panels module of 300 mm and at distance of 2.4 mtrs, the metal ceiling panel should be serviceability advantage by having 100% removable without tools.

4. Access

All the metal ceiling panel should be serviceability advantage by having 100% removable without tools.

5. Level

All the panels should be fitted to ensure accurate positioning & level of the ceiling system as per the site/architectural requirements.

6. General Suspension System

The panel ends are raised up to 29 mm. The panel about each other with a narrow V groove. Panel shall be clipped to a backed enamelled Aluminium panel carrier of 41.5 mm wide x 62 mm deep x 0.95 mm thick in standard length of 5 mtrs. made of double baked enamelled Aluminium magnesium alloy AA5052 black with cut outs to hold panels module of 300 mm and at distance of 2.4 mtrs. the carrier shall be suspended by means of GI suspension rod 4mm diameter and suspension clip at 1.3 mtr. distance.

7. Finish

Aluminium panels shall be chromatised for maximum bond between metal and paint, enamelled twice under high temperature one side with full primer finish, the other side (Inner side) with a primer coat and skin coat on a Continuous paint line. The coils to go through 4 stages of pre-treatment, three times oven baked through conversion coating, priming and finish coat ensuring superior adhesion, high corrosion resistance and good colour stability. The coils to be painted on both sides after degreasing. Inside surface to have a primer of 5 microns and a coat of natural colour of 5 microns, exposed surface to have a primer of 5 microns, binder of 5 microns and topcoat of approved colour of 15 microns.

8. Fire Performance

A fire-resistant ceiling can be constructed utilizing steel panels and steel carriers. The 300C ceiling has been tested on fire resistance in accordance to British standard, BS476:part 23: 1987: clause 5, resulting in a fire resistance of 132, minutes and to the German DIN 4102, part 2 rating F30 AB.

9. Provisions For Light and Other Fittings

The panels will be cut on site for the provision of light fixtures and other fittings as per the directions of the Engineer-In-Charge

10. Manufacturing Tolerances

All the metal ceiling elements and the corresponding substructure should be manufactured in accordance with ceiling standards accessed by German DIN 4102.

11. Green Building

For LEED certification by Indian Green Building Council (IGBC) and ISO 9001: 2015 Quality Management System Certification.

12. Quality Assurance

- BSI ISO 9001:2015 for quality management system
- CII – Green Products and Services Council.
- German DIN 4102for ceiling standard
- BS476:part 23: 1987: clause 5.

13. Acoustic Performance

The 2mm perforated panels with NWT (Non-Woven Textile) with a plenum height of 400mm enhances the acoustic performance up to 0.7NRC

14. Warranty Certificate

Manufacturer should submit the warranty certificate for the minimum 10 years.

IX. UNPERFORATED METAL CEILING EXTERNAL (NON-AC AREA)

1. General

Supply and Installation of 300mm wide un-perforated Exterior Aluminium panel ceiling of Exterior white finish colour consisting of panel 300mm wide x 30 mm deep x 0.7mm thick with bevel edge, panel length up to 6 mtr, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium alloy AA 3005 (Al. Mg) for higher strength and good roll forming characteristics. The Panels shall about each other with a narrow V groove. Panel shall be clipped to a baked enamelled Aluminium panel carrier of 41.5mm wide x 62mm deep x 0.95mm thick in standard length of 5 mtr made of doubled baked black enamelled Aluminium alloy AA 5052 (Al. Mg) with cut outs to hold the panels in a module of 300mm closed at a distance 935mm-1000mm. The coils to go through 4 stages of pre-treatment, three times oven baked through conversion coating, priming

and finish coat ensuring superior adhesion, high corrosion resistance and good colour stability. The coils to be painted on both sides after degreasing. Inside surface to have a primer of 5 microns and a coat of natural colour of 5 microns, exposed surface to have a primer of 5 microns, binder of 5 microns and topcoat of approved colour of 15 microns. If any MS Sub structure is required.

Paint Finish: Aluminium panels shall be chromitized for maximum bond between metal and paint, enameled twice under high temperature, one side with a full primer and finish coat the other side (inner side) with a primer coating and Skin Coat on a Continuous Paint Line.

Green-pro certification: For LEED certification by Indian Green Building Council (IGBC) and ISO 9001: 2015 Quality Management System Certification.

2. Material

300C un-perforated Exterior Aluminium panel ceiling of Exterior white finish colour consisting of panel 300mm wide x 30 mm deep x 0.7mm thick with bevel edge, panel length up to 6 mtr.

3. Approved System

Supply and Installation of 300mm wide un-perforated Exterior Aluminium panel of Exterior white finish colour consisting of panel 300mm wide x 30 mm deep x 0.7mm thick with bevel edge, panel length up to 6 mtr, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium alloy AA 3005 (Al. Mg) for higher strength and good roll forming characteristics. The Panels shall abut each other with a narrow V groove. Panel shall be clipped to a baked enamelled Aluminium panel carrier of 41.5mm wide x 62mm deep x 0.95mm thick in standard length of 5 mtr made of double baked black enamelled Aluminium alloy AA 5052 (Al. Mg) with cut outs to hold the panels in a module of 300mm closed at a distance 935mm-1000mm, the metal ceiling panel should be have serviceability advantage by having 100% removable without tools.

Access

All the metal cladding panel should be serviceability advantage by having 100% removable only with tools.

Level

All the panels should be fitted to ensure accurate positioning & level of the ceiling system as per the site/architectural requirements.

General Suspension System

The panel ends are raised up to 29 mm. The panel abut each other with a narrow V groove. Panel shall be clipped to a baked enamelled Aluminium panel carrier of 41.5 mm wide x 62 mm deep x 0.95 mm thick in standard length of 5 mtrs. made of double baked enamelled Aluminium magnesium alloy AA5052 black with cut outs to hold panels module of 300 mm and at

distance of 2.4 mtrs. the carrier shall be suspended by means of GI suspension rod 4mm diameter and suspension clip at 1.3 mtr. Distance

Finish

Surface of the panel finish for exterior application, the exterior ceiling system should be with additional lockable hold on clip to avoid removal due to heavy wind loads, edge design square. Aluminium panels shall be chromatised for maximum bond between metal and paint, enamelled twice under high temperature one side with full primer finish, the other side (Inner side) with a primer coat and skin coat on a Continuous paint line. The coils to go through 4 stages of pre-treatment, three times oven baked through conversion coating, priming and finish coat ensuring superior adhesion, high corrosion resistance and good colour stability. The coils to be painted on both sides after degreasing. Inside surface to have a primer of 5 microns and a coat of natural colour of 5 microns, exposed surface to have a primer of 5 microns, binder of 5 microns and topcoat of approved colour of 15 microns.

Fire Performance

A fire-resistant ceiling can be constructed utilizing steel panels and steel carriers. The 300C ceiling has been tested on fire resistance in accordance to British standard, BS476:part 23: 1987: clause 5, resulting in a fire resistance of 132, minutes and to the German DIN 4102, part 2 rating F30 AB.

Provisions for Light And Other Fittings

The panels will be cut on site for the provision of light fixtures and other fittings as per the directions of the Engineer-In-Charge.

Manufacturing Tolerances

All the metal ceiling elements and the corresponding substructure should be manufactured in accordance with ceiling standards accessed by German DIN 4102.

Green Building

For LEED certification by Indian Green Building Council (IGBC) and ISO 9001: 2015 Quality Management System Certification.

Quality Assurance

- BSI ISO 9001:2015 for quality management system
- CII – Green Products and Services Council.
- German DIN 4102for ceiling standard
- BS476:part 23: 1987: clause 5.

4. Warranty Certificate

Manufacturer should submit the warranty certificate for the minimum 10 years.

X. METAL CEILING LINING (FASCIA)

1. General

Supply of torsion spring Tile Ceiling System, comprising of customized Tile of 300mm to 600mm wide and customized length 600mm to 1200mm manufactured out of 0.7mm thick Aluminium. The metal ceiling panels shall be downward accessible with a minimum of four (4) torsion springs per panel. The Tile will be manufactured on advanced CAD/CAM equipment that includes several levelling stages in the manufacturing process in grey Colour. Torsion Spring panel with two side legs die formed and two end legs die formed and punched to receive torsion springs (min two springs each end or side) for secure engagement into Tee Grid main runners which are factory punched to receive torsion springs. Tiles will be square edged. The metal ceiling panels shall be downward accessible with a minimum of four (4) torsion springs per panel. The Tile shall be Polyester powder coated in white colour. The panel will be installed on a rigid MS Substructure.

2. MATERIAL

Torsion spring Tile Ceiling System, comprising of customized Tile of 300mm to 600mm wide and customized length 600mm to 1200mm manufactured out of 0.7mm thick Aluminium. The metal ceiling panels shall be downward accessible with a minimum of four (4) torsion springs per panel. The Tile will be manufactured on advanced CAD/CAM equipment that includes several levelling stages in the manufacturing process in grey Colour.

3. APPROVED SYSTEM

Main Runners: 24mm deep, inverted "Tee" sections, 3.6m long, with factory punched flanges to receive torsion spring assembly. Main Tee on center spacing to match panel length.

Cross Runners: 24 mm deep, inverted "Tee" sections designed to interlock in to web of main tee section on designated spacing. Cross tee length to match panel length. Cross tees are spaced spacing 1200mm on center maximum.

ACCESS

All the metal cladding panel should be serviceability advantage by having 100% removable only with tools.

LEVEL

All the panels should be fitted to ensure accurate positioning & level of the ceiling system as per the site/architectural requirements.

GENERAL SUSPENSION SYSTEM

Torsion Spring panel with two side legs die formed and two end legs die formed and punched to receive torsion springs (min two springs each end or

side) for secure engagement into Tee Grid main runners which are factory punched to receive torsion springs. Tiles will be square edged. The metal ceiling panels shall be downward accessible with a minimum of four (4) torsion springs per panel.

FINISH

The panels will be pretreated in latest nano technology process and electro statically powder coated with automatic Carona system and cured with gas catalytic technology.

FIRE PERFORMANCE

A fire-resistant ceiling can be constructed utilizing Aluminium panels and carriers. The torsion ceiling has been tested on fire resistance in accordance to Class A1 according EN 13501-1.

PROVISION FOR LIGHT AND OTHER FITTINGS

The panels will be cut on site for the provision of light fixtures and other fittings as per the directions of the Engineer-In-Charge.

MANUFACTURING TOLERANCE

All the metal ceiling elements and the corresponding substructure should be manufactured in accordance with Manufacturers ceiling standard.

GREEN BUILDING

For LEED certification by Indian Green Building Council (IGBC) and ISO 9001: 2015 Quality Management System Certification.

QUALITY ASSURANCE

- BSI ISO 9001:2015 for quality management system
- CII – Green Products and Services Council.
- Class A1 according EN 13501-1

4. WARRANTY CERTIFICATE

Manufacturer should submit the warranty certificate for the minimum 10 years.

XI. FIXED GLASS PANEL PARTITIONS

1. GENERAL

Summary

Section includes fixed, framed glass panel partitions with sliding / openable glass doors.

Reference Standards

- American Architectural Manufacturers Association (AAMA):
AAMA 611 Voluntary Specification for Anodized Architectural Aluminium
- American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structure
- ASTM International (ASTM):
 - ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar
 - ASTM B221/ASTM B221M Standard Specification for Aluminium and Aluminium-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 - ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
 - ASTM C1172 Standard Specification for Laminated Architectural Flat Glass
 - ASTM E84 Test Method for Surface Burning Characteristics of Building Materials
 - ASTM E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
 - ASTM E413 Classification for Rating Sound Insulation
 - ASTM E557 Guide for the Installation of Operable Partitions
 - Code of Federal Regulations
 - 16 CFR 1201 Safety Standard for Architectural Glazing Materials
- International Code Council (ICC):
ICC A117.1 Accessible and Usable Buildings and Facilities (ANSI)
- U.S. Architectural & Transportation Barriers Compliance Board:
Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities.

Administrative Requirements

A Coordination:

- Coordinate installation of glass panel partitions with installation of floor, wall, and ceiling construction to comply with substrate tolerance requirements of partition manufacturer.
- Coordinate installation of anchors and secondary structural members indicated on approved glass panel partition shop drawings and specified in other sections.
- Pre-installation Conference: Conduct conference at Project Site.

Action Submittals

Product Data: For each glass panel partition and door component specified, including:

Glass panels.

Frame and sill tracks.

Door hardware and accessories.

- Shop Drawings: For fixed glass panel partitions.
Include plans, elevations, sections, and details. Provide numbered panel installation sequence.
Show locations and requirements for tracks, bracing, blocking, and attachments to other work.
Samples for Verification: For each exposed component including hardware, for each Colour and finish selected, of size indicated below:
Glass: Units 300 mm square.
Exposed Frame, Track, and Sill Members: Not less than 150 mm long.
Hardware: One of each type of exposed door hardware items.

Informational Submittals

- A Qualification Data: For qualified installer.
- B Warranty: Sample of unexecuted manufacturer warranty.

Quality Assurance

- A Installer Qualifications: Experienced Installer equipped and trained for installation of glass panel partitions required for this Project with record of successful completion of not less than five projects of similar scope.
- B Single Source Responsibility: Provide glass panel partitions and associated hardware by a single manufacturer through a single source.
- C Mockups: Provide mockup consisting of initial sections of tracks, frames, and glass panels with operating doors and hardware, in location as directed by PMC. Proceed with work upon approval of mockup by PMC.

2. PRODUCTS

Manufacturers

Basis-of-Design Product: Subject to compliance with requirement, provide the fixed glass panel partition systems of approved manufacturers.

Glass Panel Partitions

- A Fixed Glass Panel Partitions: Framed glass panel partition with sliding / openable doors, with perimeter channel frames, butt-glazed dry joint and framed joints between panels.
- B Fully Tempered Clear Float Glass / Fully Tempered Ultraclear (Low-Iron) Float Glass / Fully Tempered Tinted Float Glass shall conform to ASTN C.1048
- C Laminated Fully Tempered Clear Float Glass conforming to ASTM C1172; consisting of two plies of 8mm and 6 mm respectively. thick glass with interlayer of 1.52mm thick clear polybutyral; unit thickness 15.52mm.

Glass Panels and Doors

- A Glass Panels, General: Provide glass panels that comply with 16 CFR 1201, Category II requirements for safety glazing. Permanently mark glazing with certification label of the SGCC.

- I. Glass and Door Panel Thickness: Thickness required for size of panel based upon manufacturer's written recommendations, but not less than 12 mm.
- B Fully Tempered Clear Float Glass / Fully Tempered Ultraclear (Low-Iron) Float Glass / Fully Tempered Tinted Float Glass shall conform to ASTN C.1048
- C Laminated Fully Tempered Clear Float Glass conforming to ASTM C1172; consisting of two plies of 8mm and 6 mm respectively. thick glass with interlayer of 1.52mm thick clear polybutyral; unit thickness 15.52mm.

Doors

- A Accessibility Standard: Comply with applicable provisions in ADA-ABA Accessibility Guidelines for Buildings and Facilities.
- B Doors: Glass panel matching partition panel material and thickness, of size indicated on Drawings.
- C Sliding Door Track: Extruded Aluminium track integral with partition frame, configured to pocket door edge in brush-lined channel, designed for operation, size, and weight of glass panel door, with factory-finished head closure trim and seals as required for acoustical performance indicated.
- D Door Panel Carriers: Trolley system designed for operation, size, and weight of glass panel door, with ball-bearing wheels.

Materials

- A Aluminium: ASTM B221M with strength and durability characteristics of not less than Alloy 6063-T5.
- B Stainless Steel: ASTM A666, Type 304.

Finishes

- A Aluminium Finish:
 - 1. Clear anodic finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 - 2. Powder Coat: Manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm), in Colour selected by PMC from manufacturer's full range.
- B Stainless Steel Finishes: As approved by the Engineer-In-Charge.

Door Hardware and Fittings

- A Door Hardware, General: All-glass door hardware units in types, sizes, quantities, and mounting locations recommended by manufacturer for glass door types, sizes, and operation. For exposed components, match metal and finish of exposed partition fittings unless otherwise noted.
- B Locking Ladder Pull: Pair of tubular lockable pull handles with thumb turns, Grade 316L stainless steel, accommodating key cylinder, with [floor-recessed deadbolt] [and] [head-mounted deadbolt].
 - 1. System basis: As per manufacturer.
- C Pulls and Handles: Back-to-back, minimum 32mm diameter.

1. System basis: As selected by EIC.

3. EXECUTION

Examination

- A Examine partition substrates to determine if work is within glass panel partition manufacturer's required tolerances and ready to receive work. Proceed with installation of partitions once conditions affecting installation and performance of partitions meet manufacturer's requirements.
- B Verify that partition construction adjacent to acoustically-rated glass panel partitions complies with requirements of ASTM E557.

Partition Installation

General: Comply with glass panel partition manufacturer's written installation instructions and approved shop drawings.

Install glass panel partitions after other finishing operations have been completed.

Set units level, plumb, and true to line, with uniform joints.

Fasten glass panel partition framing to building structure and supports as indicated on approved shop drawings, utilizing approved fasteners and spacing.

Set framing in continuous bed of sealant or in positive contact with preformed gasket where indicated.

Set, seal, and grout floor closer cases.

Adjusting

- Adjust doors and hardware to produce smooth operation and tight, uniform fit.
- Adjust door closers to required timing and force.
- Adjust latches and locks for smooth operation.
- Test and adjust hardware linked to access control system.
- Replace damaged panels and accessories.

Cleaning

Clean glass panels in accordance with glass manufacturer's written instructions. Do not use cleaning agents or methods not approved by glass manufacturer.

Clean exposed metal surfaces to factory new appearance.

XII. ALUMINIUM COMPOSITE PANEL IN DRY CLADDING SYSTEM

1. GENERAL

- i. All Aluminium composite panels shall have a minimum thickness of 4.00mm.
- ii. The composite cladding panels shall be of cassette type, framed with an

- extruded Aluminium profile.
- iii. All fasteners shall be concealed within the panel joints. All fixing and joint details shall be designed to provide for the expected thermal expansion and contraction. The fixing of these panels shall accommodate the expected structural movements in the building.
 - iv. With a gloss of 30% according to Gardner Scale, the installed composite panel surface shall not have irregularities such as oil canning, waves, buckles, and other irregularities when viewed at any position not less than 15 degrees to the true plane of the panel.
 - v. All fasteners, anchors, brackets and similar attachments used for the fixing and erection of these panels shall be of Aluminium, non-magnetic stainless steel, or hot dip galvanized steel.

2. SCOPE

Providing and fixing 4mm thick Aluminium Composite Panels {ACP}/ Aluminium Composite Material {ACM) of grade 5005 alloy 8t fire retardant {FR) grade mineral filled inorganic core of compliance to A2-s1,d0 for cladding of columns, walls, jambs, sills, projected area/ fascia, ceiling, decorative cladding on any surface to any profile and shape (pan shape) using stainless steel screws, nuts, bolts, washers, cleats, weather silicone sealant, backer rods etc. at horizontally/ vertically/ sloped/ curved/ circular etc. for all heights and levels as per drawings and specifications. Base frame work for ACP I ACM cladding is payable under the relevant Aluminium items.

Provide necessary Aluminium frame work for fixing ACP panel in position.

Gaps up to 10 mm between the peripheral ACP panels and masonry / R.C.C. / Stone shall be sealed by inserting adequate size of backer rod and non-staining weather silicon. Wherever the gaps are expected to be more than 10 mm, shall be sealed by providing and fixing of 2mm thick Aluminium sheet flashings bent to required profile as per site, Aluminium flashing sheet shall be super durable polyester powder coated to 60-80 Microns thickness in approved shade / colour or as per instruction of Engineer-In-Charge. Detailed drawing of the flashings to be submitted by the contractor as per the site conditions for the approval of Engineer-in Charge.

Guarantee of weather silicones used for ACP cladding works shall be submitted by the contractor.

3. MATERIAL:

Aluminium Composite Panel (ACP) cladding in pan shape in metallic colour of approved shade, made of Aluminium Composite Material (ACM), made out of 4 mm thick Aluminium composite panel consisting of 3 mm thick fire retardant (FR) grade mineral filled inorganic core of compliance to class A2-s1,d0 as per EN13501-1, sandwiched between two thin coil coated Aluminium sheets (Top i.e. face # 1& rear i.e. face # 2) of alloy, **Grade 5005** (ALMg1) and H-22/ H24 temper and minimum thickness of 0.5 mm each. The ACPs are used

for the external cladding surface like column, wall, jambs, sills, projected area, ceiling, decorative cladding on any surface to any profile and shape (panshape) at horizontally/ vertically/ sloped/ curved/ circular etc. (linear as well as curvilinear shape).

The ACP/ACM fire retardant core of A2-s1,d0 grade contain 90% of Non-Combustible Inorganic compound & 10% of virgin LOPE. The main ingredient of the non-combustible compound is Aluminium Trihydrate/ Magnesium Hydroxide.

The ACP/ACM top face (exposed surface) coil should have Kynar 500 PVDF (Polyvinylidene fluoride)/ FEVE Lumiflon based fluoropolymer resin (high surface energy) coating of approved colour and shade of 25 - 30 microns to ensure corrosion resistance and weather proof and thus shall confirm to relevant ASTM or EN or BIS or AAMA 2605 code. The back face (rear side) of the cladding panel surface facing to the wall shall have polyester based wash (service) coating of 7 microns preferably grey in colour to protect against possible corrosion problems. The finished surface (Top face) shall be protected with a self-adhesive peel off film with two layers of white & black tested to withstand local weather conditions without losing the original peel off characteristic or causing stains or other damages.

The weight of the ACP/ACM should not be less than 8.10 Kg/Sqm. The ACP shall confirm to ASTM E84/ EN13501-1/ NFPA 285/ BS 8414 resulting in fire resistant properties. The ACP/ACM manufacturer must have Certificate of Conformity in confirmation of the authenticity of the above FR tests.

The complete system shall be designed to withstand the design wind pressure as per relevant IS code or international code (Test pressure shall be 1.5 times of the design wind pressure).

Necessary pull out test of anchor fastener shall be carried out on the masonry wall /RCC structure to check the load carrying capacity of the bolt designed under suction pressure for designing the supporting and anchoring system.

4. Movement:

System shall be designed to accommodate movement due to any force including the movement resulting from the exterior skin temperature ranging from 15°C to 85°C and also to accommodate the horizontal building movement of 10 mm per panel & vertical movement of 20 mm between floors on the Aluminium framing system with support brackets, glass, gaskets and fastening devices. System shall be designed to accommodate the size and shape of the Laminated sandwiched composite panel as per the approved drawings including approved modifications as may be required during execution as well as all other incidental forces and stresses likely to be experienced under service conditions, i.e. Lateral force, Dead weight and Thermal expansion due to building movement both vertical and horizontal

etc. Grooves shall be designed in such a way to accommodate weather silicon sealant/ Non staining sealant of approved make.

5. Testing:

The mechanical properties of 4mm thick ACP/ACM with core and Aluminium coil/sheet shall confirm to the requirement as given in table below.

Specification for ACP I ACM

S.No.	Description	Specification for 4mm	Acceptable
A	Physical Tests for ACP / ACM	Standard Test	Value / Results
1	Overall thickness of ACP / ACM	Measurement	4mm (Tolerance + 0.2mm)
2	Aluminium Skin thickness (each side)	Measurement	.50mm (Tolerance +/- .02mm)
3	Panel Weight (ACM)	Measurement	Min. 8.10 Kg/m ²
B	Mechanical Properties of ACP / ACM		
1	Peel off Strength (Drum Peel Test)	ASTM D1781	Min. 4 N/mm
2	Tensile Strength	ASTM E8	Min. 45 N/mm ²
3	Yield Strength	ASTM E8	Min. 40 N/mm ²
4	Elongation	ASTM E8	Min. 4%
5	Flexure Strength	ASTM D1781	Min. 120 N/mm ²
6	Shear Strength with punch shear test	ASTM D732	Min. 18 N/mm ²
C	Properties of Aluminium Skin		
1	Tensile Strength (Rm)	ASTM E8	Min. 150 N/mm ²
2	Modulus of Elasticity	ASTM E8	Min. 70000 N/mm ²
3	Elongation	ASTM E8	Min. 3%
4	0.2% proof stress	ASTM E8	Min. 110 N/mm ²
5	Yield Strength	ASTM E8	Min. 124 N/mm ²
6	Sound Transmission Loss	ASTM E413	Min. 26 dB
D	Surface		
1	Lacquering		P.V.D.F. coating (Kynar 500) / FEVE- Lumiflon
2	Hardness (pencil hardness)		H2 or H3
3	Temperature resistance		-50 °C to +80°C
4	UV stability		Very Good

6. Performance Certificate:

Requisite performance certificate from the manufacturer of ACP/ACM stating compliance with ACP/ACM technical specification as per above table shall be submitted by the contractor to the Engineer-In-Charge before fixing at site of work. It should be backed by ACP/ACM manufacturer Certificate of Conformity of product and installation procedure.

The manufacturer shall visit the site of project site along with the executing agency and ensure that fabrication & installation is being carried out as per industry practice/ manufacturer's recommendation.

The contractor shall provide curtain wall with Aluminium composite panel cladding, having all the performance characteristics all complete as per the Architectural drawings, as per items description, as specified, as per the approved shop drawings and as directed by the Engineer-In-Charge.

7. Marking:

The ACP/ACM sheet should have a following laser marking and should be at Repeated interval at the rear face of ACP/ACM sheet.

1. Total thickness with coil and core materials.
2. Size of ACP/ACM sheet.
3. Fire Retardant (FR) grade.
4. Date and time of manufacturing.
5. Batch number.
6. Make of manufacturer.

8. Installation:

The installation system of ACP/ACM as external cladding with tray type (rout and return) panels and sealing joint is one of the most common method and it is available for a wide range of new buildings and renovation projects. The ACP/ACM sheet under this system is first fixed on the substructure i.e. of steel members/ RCC structures/ brick walls with the help of base Aluminium member frame work using necessary clamps, brackets, anchor fasteners, stainless screws, nuts and bolts, weather silicon sealant backer rods etc. as per approved design & drawing at all height and elevation which include all labours, materials, equipment's, handling, transportation, workmanship, design & preparation of working drawings, staging, scaffolding etc. all complete as per specification, drawings an instructions of the Engineer-In-Charge.

Composite panels are cut to size, routed, corners notched and bend as per the dimensions specified. After the panels are bend Aluminium cleats of size 16mm x 16mm by 25mm length are fixed to the edge of the panels by using Aluminium pop rivets. The panels are fixed to the framework by using stainless steel screws. The gap of 12mm or 16mm between the panels (both vertical and horizontal) are filled with backer rod of size 12mm x 20mm or 16mm x 20mm, weather proof silicon sealant shall be used to filled the grooves.

9. Frames:

Providing and fixing Aluminium extruded members (Box Tube) designed to with stand design wind pressure and movement as specified as continuous member for cladding the Aluminium Composite Panel. Aluminium member shall be fixed into masonry wall/ RCC member/ steel structures with brackets/ clamps and it shall be of chromicised finish Aluminium. All fastening straps, nuts & bolts, rivets, washers/other fastening materials shall be of nonmagnetic stainless steel and Aluminium brackets shall be considered for ACP/ACM cladding with standard dimension and after the site survey if any undulation is observed intern that doesn't allow to fix the Aluminium bracket only in these areas the additional support with locally fabricated hot dip galvanized bracket can be considered. The bidder shall include the provision for these brackets also with in the quoted rate for ACP/ACM cladding works. Aluminium shim shall be used for level adjustment of bracket but more than 20 mm is not acceptable. If more than 20 mm, bracket shall be designed according to site condition.

The fastening brackets of Aluminium alloy 6005 TS I MS with Hot Dip Galvanized with serrations and serrated washers to arrest the wind load movement, fasteners, SS 316 Pins and anchor bolts of approved make in SS 316, Nylon separators to prevent bimetallic contacts all complete required to perform as per specification and drawing.

Aluminium brackets/ clamps shall be fixed with chemical injection technique threaded anchor rods of approved make to the base structure in the case of masonry wall 1 RCC members and SS anchor bolts in the case of steel structure. Extruded member shall be designed to accommodate laminated sandwiched composite panel as per the approved shop drawings and extruded Aluminium member shall be 6063 T6 or 63400 (H9) grade conforming to BS 1467 or IS 8147, finished with transparent electrolytic colour anodic coating AC15 grade conforming to IS 1868.

10. Composite Panel:

Aluminium composite panel cladding of approved make to be fixed on the framing system described above. Lamination process of Aluminium panel shall only be glue technology and the source of complete composite panel shall only be accepted. The Laminated sandwiched composite panel suitably stiffened internally on the back side for preventing deformation due to design wind pressure beyond permissible limits by using Aluminium flat 25 mm wide, 4 mm thick gloved with double adhesive tape in order to maintain panel flatness and to avoid permanent deformation over a period. Stiffener shall be provided at 600 mm c/c behind ACP/ACM panel irrespective of structural check of the panel against stability and deflection. Aluminium flat of size 25 mm wide and 3 mm thick shall be provided to a length 100 mm bent to shape, wherever the inner skin is cut to bend the ACP/ACM at the corners and as per approved shop drawing.

Methodology of fixing the stiffener/ flat in the corner panel shall be established in the drawing or to be glued to ACP/ACM on the backside of the panel in such a way the fixing mechanism of stiffener/ flat shall not be visible on the elevation of the panel/ outside.

11. Sealing:

After fixing the ACP/ACM on the sub structure, then a suitable sealing materials i.e. Non-structural FR grade weather silicon sealant/Non staining sealant filled to the joints of panel with baker rod of approved make to ensure water tightness to the panel. Sealing shall be carried out with Non-structural FR grade weather silicon sealant/ Non staining sealant with PE baker rods, wherever the system is interfacing with glazing, cladding groove and any other groove.

Non-Staining FR grade Weather silicon sealant should have minimum tearing strength 4.0N/mm, shore a hardness 24 (ISO 868)1 joint movement capability +30% (As per ASTM C-920)1 one part natural cure. The FR grade silicon weather sealant is designed for sealing expansion and contraction joints.

12. Flashing:

Fixing flashing at terrace level as part of the system made to profile as shown in the approved shop drawings and the profile shall be made out of hot dip galvanized sheet 1.2 mm thick and galvanizing coating thickness shall be in accordance with IS 2629 & 4759. In general1 the flashing shall be provided to the entire length of cladding horizontally at terrace level with necessary anchoring system with SS fastening devices of approved make. Also1 the flashing shall be provided at parapet top below the coping to drain the water during any seepage through the sealant joints \with overlap of 100 to 125 mm in plan with sealant at joints to make sure that no water leakage through coping/ flashing joints.

13. Field Test:

Conduct field test e.g. weight1 thickness/ FR grade identification marking etc. at site as per the criteria set out in specification in the presence of Engineer-inCharge. If field test fails1 the material of the entire lot/ batch shall be rejected and replaced with fresh material confirming to particular specifications.

14. General Guideline:

System design in total, including Aluminium extruded member, type & thickness of Aluminium composite panel, Aluminium sleeves at connections, inserts, Sealant, supporting system/bracket including fastening and anchoring system & materials specified in the schedule and the system details as shown in the tender drawing are only tentative and is meant to set out a general outline of the proprietary system. Since the cladding system in terms

of design, materials, all fixing details, methodology of execution are proprietary in nature, the onus of the design and performance requirements, shop drawing, execution etc. satisfying the design intent, particular specification and site conditions lies solely with the Contractor.

15. Precautions:

- i. Do unpacking and repacking of ACP/ACM sheet work in a clean place.
- ii. Remove dust and chips from ACP/ACM sheet and the packing paper.
- iii. Handle ACP/ACM sheet on a worktable. Do not handle it on the floor.
- iv. ACP/ACM sheets should always be handled by two people with external face upward to avoid possible rubbing of the ACP/ACM surface during handling.
- v. Prior to fabrication, clean off the worktable, temporary stand and both side of ACP I ACM sheet.
- vi. Ensure that cutting chips generated from saws, routers and drills are completely removed from the interface between ACP I ACM sheet and tools.
- vii. The arrow should be followed as marked on the rear (back) face coil/ sheet to avoid the variation in colour.
- viii. Protective film of 75 microns should be removed within 45 days after the installation.
- ix. Do not use adhesive tapes made of PVC (Polyvinyl Chloride) on the surface of protective film or any time during storage, fabrication or installation.
- x. ACP/ACM manufacturer shall provide warranty of ten years for any manufacturing defects.
- xi. Do's & Don'ts as prescribed by the manufacturer shall be strictly adhered to during stacking, fabrication, installation & final finishing of the executed surface.

- 16.** The cost of all mockups at site, testing charges, cost of all sample of the individual components for testing in an approved laboratory, field test on the assembled working curtain wall with Aluminium composite panels claddings, cleaning and protection of the curtain wall with Aluminium composite panel claddings till the handing over of the building for occupation. Base Aluminium members frame work for ACP/ACM cladding is payable under the relevant Aluminium items.

XIII. STEEL DOORS, WINDOWS, VENTILATORS & COMPOSITE UNITS (FIRE & NON-FIRE RATED DOORS)

1. SCOPE INCLUDES

- A. Architectural hollow metal doors and frames as shown on the Drawings and as specified herein.
 1. Flush Steel Doors
 2. Flush Steel Fire rated doors as per Indian & British standard

- a. Insulated doors
- B. Un-insulated doors
 - 1. Steel frames

2. References

A. Indian Standard

IS 277	Standard specification for steel sheet, Zinc Coated (Galvanized)
IS 3614 Part 1	Specifications for fire check doors
IS 3614 Part 2	Metallic and non-metallic fire check doors – Resistance test and performance criteria
IS 513	Standard Specification for Steel Sheet, carbon, Cold rolled Commercial Quality.

B. International Standard

ISO 834-1	International standard for fire resistance tests – Elements of building construction – Part1
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C. British Standard

BS 476 Part 22:1987	Standard methods of test of fire door assemblies
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3. Submittals

- A. Product Data: Submit manufacturer's specifications for fabrication and installation, including data substantiation that products comply with requirements.
- B. Certificates:
 - 1. Manufacturers Certification that products comply with referenced standards.
 - 2. Evidence of certificates as listed.
- C. Shop Drawings: Submit for fabrication and installation of metal doors and frames. Include details of each frame type, elevations of door detailing types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and details of joints and connections. Indicate door elevation, internal reinforcement, closure method, and cut-outs for glass lights and louvers. Show anchorage and accessory items. Provide schedule of doors and frames using same reference numbers for details and openings as shown on Drawings.
- D. Samples: Submit 300 mm x 300 mm cut away sample door with provisions for lockset, hinge and corner section of the frame.

4. Transportation, Handling and Storage

- A Deliver, store and handle hollow metal work in a manner to prevent damage and deterioration.
- B Provide packaging such as cardboard or other containers, separators, banding, spreaders and paper wrappings to protect hollow metal items.
- C Store doors and frames upright, in a protected dry covered area, at least 100 mm or more above ground or floor and at least 6 mm between individual pieces.
- D Doors and frames are to have a metal tag with the door number thereon.
- E Should door wrapper become wet, remove immediately.

5. Quality Assurance

- A. General: Unless otherwise specified, provide doors and frames complying with the Indian standard and the British standard for stability, integrity and insulation
- B. Fire-Rated Door Assemblies: Provide Fire Doors and Frames tested at approved national and international laboratory
 - 1. Labelled Fire doors and frames in accordance with IS 3614 for stability and integrity Fire tests of Door Assemblies.
 - 2. Where insulation is the criteria supply labelled Fire doors and frames in accordance with IS 3614 for stability, integrity and Insulation Fire tests of Door Assemblies
 - 3. Complying with ISO 834-1 or BS476 part 22: 1987 and which are labelled and listed by national or internationally accredited laboratory.
 - 4. Manufacture doors and frames under the third-party inspection program and in strict compliance to standards and provide the degree of fire protection, heat transmission.
 - 5. Affix a physical label or approved marking to each fire door or fire door frames at any authorized facility as evidence of compliance and test conducted by approved agency.
 - 6. Conform to applicable codes for fire ratings. It is the intent of the specification that hardware and its application comply or far exceeds the standard for fire doors
- C. Manufacturer: Provide doors, frames and hardware from a single manufacturer approved by the Engineer.
- D. Installers: Minimum three years documented experience installing products of similar nature.

6. Manufacturer

- A. Any acceptable manufacturer who has the manufacturing capability and can supply the complete door set as an assembly, tested and certified.
- B. ISO 9001:2015 certified company

- C. Has the ability to prepare door and hardware schedule with proper detailing and certifications.

7. Materials

- A. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with IS 513
- B. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with IS 277 zinc-coating, mill phosphatized.
- C. Supports and Anchors: Fabricated of 1.25 mm thick, galvanized sheet steel.
- D. Inserts, Bolts and Fasteners: Manufacturer's standard units, except hot-dip galvanize items to be built into exterior walls
- E. Shop Applied Paint: Rust-inhibitive self-etching primer and polyurethane paint as per manufacturer specification and coating.
- F. Grain tech sheets to be used for doors with surface wood finish. Minimum sheet thickness shall be 1.6mm

8. Fabrication – General

- A. Fabricate metal door and frame units to be rigid, neat in appearance and free from defects (warp or buckle). Wherever practicable, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at project site.
- B. Fabricate exposed faces of doors and panels, including stiles and rails of non-flush units, from only Galvanized steel.
- C. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and mouldings from Galvanized steel.
- D. Fabricate exterior doors, panels, and frames from galvanized sheet steel. Close top edges of all doors as an integral part of the door construction or by addition of inverted steel channel.
- E. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat heads for exposed screws and bolts.
- F. Finish Hardware Preparation
 - 1. Prepare doors and frames to receive mortised and concealed finish hardware in accordance with Hardware Schedule and templates provided by hardware supplier.
 - 2. Reinforce doors and frames to receive surface- applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.
 - 3. Locate finish hardware as shown on final shop drawings or, if not shown, in accordance with **Recommended Locations for Builder's Hardware**.
- G. Shop Painting – Primer
 - 1. Clean, treat, and paint exposed surfaces of steel door and frame units, including galvanized surfaces.
 - 2. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.

3. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint.

9. Pressed Metal Frames

- A. General: Provide continuous type pressed metal frames, including glazing stops and reinforcement, of various profiles to suit conditions detailed on the drawings and be constructed of new prime quality, Galvanized sheet steel. All frames shall be fabricated from zinc-coated sheet chemically treated after fabrication for optimum paint adhesion.
- B. Materials: Provide pressed metal frame of the following minimum thickness:
 1. Exterior / interior Frames: 1.6 / 1.2 mm thick sheet respectively. Sheets lesser than 1.2mm are not acceptable for frames.
 2. Wall Anchors: Same thickness and material as frame.
 3. Hinge Reinforcement: Manufacturer's Standard 5mm thick unless recommended otherwise by the door manufacturer.
 4. Strike Reinforcement: Manufacturer's Standard unless recommended otherwise by the manufacturer.
 5. Closer and Holder Reinforcement: 1.6 mm by the required length and width.
- C. Frames: Provide frames that have joints die-mitered with integral tabs for reinforcement and interlocking of the jambs to head. Frames shall be knockdown or equivalent, with self-aligning tabs and slots for securely locked corners. Single rebate or double rebate profile shall be provided based on application and manufacturer recommendation. Minimum depth of frame shall not be less than 85mm, and max shall be 350mm. Recommended profile shall be part of the tested assembly. For applications recommended frames shall be grooved to take appropriate seal for air leakages and dust control. (See frame drawings as detailed)
- D. Construction: The finished work shall be strong and of rigid construction neat in appearance and free from warp, wave and buckle. Molded members shall be clean cut, straight and true. Miters shall be well formed and in true alignment. Fastenings shall be concealed where practicable.
- E. Door Silencers: Except on weather stripped frames, drill stops to receive 3 rubber silencers on strike jamb of single-swing frames and 4 silencers on heads of double-swing frames.
- F. Anchors
 1. Unless otherwise indicated on drawings, anchor frame in concrete and masonry walls by means of galvanized expansion shields and flat-head machine screws. Screw heads shall be counter-sunk in soffit of jamb. Machine screws shall be approved type, 9 mm diameter by minimum 75 long of zinc plated or dichromated steel with 9 mm diameter by minimum 44 mm long malleable iron or steel expansion shield. Reinforce jamb at each expansion screw location with 5 mm by 38 mm wide steel fitting into inside of stop and welded to backbends. Anchors shall be located not more than 150 mm from top and bottom of each jamb with intermediate anchors spaced at a maximum of 650 mm on center.

2. Anchors for plaster partitions with truss stud framing shall be Z-clip type, to be secured to studs and welded to back of frames above each hinge reinforcement and just below the top hinge reinforcement. Anchors on the strike side shall occur directly opposite to those on the hinge side.
3. Provide at least 4 anchors for each jamb for frames up to 2.28 m in jamb height; 5 anchors up to 2.40 m; and one additional anchor for each 0.6 m fraction thereof over 2.4 m jamb height.

10. HOLLOW METAL DOOR SHUTTER (Door Leaf)

A. General:

Construct exterior or interior doors to the following details and gauges:
 Full flush -1.2mm or 0.8mm sheet thickness as approved
 Full flush/ Rail & Stile -1.2mm sheet thickness

1. **Interior Doors:** Fabricate interior hollow metal doors of 2 outer sheets, 0.8mm (22guage) thick galvanized sheet steel, free from rust, scale, pits and surface defects. Unless otherwise indicated on Drawings, hollow metal door thickness shall be minimum 46mm.
2. **Exterior Doors:** Fabricate exterior hollow metal doors of 2 outer sheets, 1.2mm (18guage) thick galvanized steel sheet. Unless otherwise indicated on Drawings, hollow metal door thickness shall be 46mm.
3. **Glass Lite on doors:** Fabricate glass lite of approved sizes and rating based on the door schedule. The material shall be 20 guage galvanized steel with face fixing countersunk screws.
4. **Louver on Doors:** Shall be manufacture's standard product fabricated of 20 gauge cold-rolled sheet metal, free from rust, scale, pits and surface defects. Door thickness shall be 46 mm. Stile channels, stiffener channels and other construction members shall be of sizes as recommended by the manufacturer. For fire doors the louvers are not applicable
5. **Service Heavy-Duty Doors:** Fabricate service doors using minimum 1.2mm (18Guage) same sheet facing thickness as that for exterior doors as per door location. Provide additional reinforcing stiffeners for the door construction.

B. Door Construction

a) Full Flush Doors (Non-fire rated)

1. Door leaf shall be constructed from minimum 0.8mm (22 guage) galvanized sheet pressed formed with interlock joints on stile edges.
2. Door leaf to have internal reinforcing channels or z-shaped members of 1.6 mm thick steel, on top and bottom. Door stiles to be interlocked on both sides with a bending radius of 1.4mm.

3. Hollow portions of doors shall be filled completely with expanded honeycomb core glued on either inside surface for stability and integrity. If it is mineral wool minimum 100kg density per sq.mt, shall be the infill material
4. Door thickness should be minimum 1-3/4" (46mm)
5. Vertical edge seams: Provide doors with continuous vertical edges and mechanical interlocking joints at lock and hinge edges.
6. Provide single swing doors with not more than 3 mm clearance at jambs and heads and not more than 6 mm clearance at meeting edges of pair of doors (3 mm on fire rated doors).
7. Where required as indicated on door type schedule drawing, provide doors with grills and vision glass panels of thickness indicated on drawings. Manufacturer's standard steel assembly, one side integral with door and the other side equipped with applied steel stops of minimum 20 gage steel, 1-piece lengths, secured within 76 mm of ends and maximum 306 mm centers between with cross-slotted flat-head countersunk screws.
8. Fire Rating: Supply door units bearing Labels for fire ratings indicated in Door Schedule for the locations indicated.

b) Rail & Stile Doors:

1. Door leaf shall be constructed from minimum 0.8mm (22 guage) galvanized sheet pressed formed with interlock joints on stile edges.
2. Door leaf to have internal reinforcing channels or z-shaped members of 1.6 mm thick steel, on top and bottom. Door stiles to be interlocked on both sides with a bending radius of 1.4mm.
3. Hinge stile and lock stile size of (Maximum 150 x 46mm) Plus 16mm for glass bead and stop.
4. Top Rail size shall be (Maximum 150 x 46mm) Plus 16mm for glass bead and stop.
5. Bottom Rail size should be (Maximum 250 x 46mm) Plus 16mm for glass bead and stop.
6. Intermediate Rails size should be (Maximum 150 x 46mm) Plus 16mm for glass bead and stop
7. Door thickness should be 1-3/4" (46mm)

8. Mechanical fastened hairline flush vertical joints on the inside and interlocking joints at lock and hinge edges.
9. Glazing bead should be 16mm high with countersunk screws.

c) Fire rated Doors: Insulated

1. All fire doors shall be manufactured as per the test certificate and the original product proto type for minimum of 60minutes and maximum of 120minutes as per NBC 2016 requirement
2. It should comply with the specification in terms of sheet thickness and frame details. Door frame and leaf sheet thickness can be on the higher side of the specification but not otherwise and shall be fully compliant in terms of construction details and finish. Minimum recommended sheet thickness for frame shall be 1.6mm (16guage) and shutter shall be 1.2mm (18guage)
3. All fire doors should be tested for stability, integrity and insulation. Doors shall be tested for 120minutes integrity and 30minutes insulation.
4. The infill material shall be high density insulation material tested for minimum 30minutes insulation. The internal construction of the door shall be rigid reinforcement for stability and integrity.
5. Fire doors shall be tested as a complete assembly including Frame, door leaf, vision lite and hardware.
6. Intumescent seal is mandatory for all insulated doors. This is independent of the addition smoke seal if required. Smoke seal cannot be used as an alternative for the intumescent seals.
7. Products tested and certified shall be from approved labs of national or international repute. Third party certified products under a labeling program shall be acceptable provided the test certificates are valid and in line with the door and hardware.
8. All fire doors supplied by the manufacturer shall also be acceptable to the Local authority or AHJ (Authority Having Jurisdiction)
9. Doors tested without vision panel shall not be used if it is not covered as a assembly in the related test certificate
10. The Maximum size of the glazing shall not exceed the overall glass sq.mt tested.
11. All hardware used shall be in line with minimum and maximum fire rating for which it is tested and approved. The hardware supplier shall provide

relevant certificates to the door manufacturer and agree in writing if the material is not tested along with the door.

12. Door manufacturer shall be fully responsible for manufacturing, supplying of material in compliance with the standard and certification. Any deviation there off shall be documented and approved by competent authority before the supplies are affected.

d) Fire rated Doors: Un-Insulated

1. All fire doors shall be manufactured as per the test certificate and the original product proto type for minimum of 60minutes and maximum of 120minutes as per NBC 2016 requirement.
2. It should comply with the specification in terms of sheet thickness and frame details. Door frame and leaf sheet thickness can be on the higher side of the specification but not otherwise and shall be fully compliant in terms of construction details and finish. Minimum recommended sheet thickness for frame shall be 1.6mm (16guage) and shutter shall be 1.2mm (18guage)
3. All fire doors should be tested for stability, and integrity. Doors shall be tested for 120minutes stability and integrity.
4. The infill material shall be resin bonded honeycomb craft paper of higher density. The internal construction of the door shall be rigid reinforcement for stability and integrity.
5. Fire doors shall be tested as a complete assembly including Frame, door leaf, vision lite and hardware.
6. Products tested and certified shall be from approved labs of national or International repute. Third party certified products under a labelling programme shall be acceptable provided the test certificates are valid and in line with the door and hardware.
7. All fire doors supplied by the manufacturer shall also be acceptable to the Local authority or AHJ (Authority Having Jurisdiction)
8. Doors tested without vision panel shall not be used if it is not covered as a assembly in the related test certificate
9. The Maximum size of the glazing shall not exceed the overall glass sq.mt tested.
10. All hardware used shall be in line with minimum and maximum fire rating for which it is tested and approved. The hardware supplier shall provide

relevant certificates to the door manufacturer and agree in writing if the material is not tested along with the door.

11. Door manufacturer shall be fully responsible for manufacturing, supplying of material in compliance with the standard and certification. Any deviation there off shall be documented and approved by competent authority before the supplies are affected.

e) Glazed Fire rated Doors: Insulated

1. All glazed fire doors shall be manufactured as per the test certificate and the original product proto type for maximum rating of 120minutes as per NBC 2016 requirement.
2. It should comply with the specification in terms of sheet thickness and frame details. Door frame and leaf sheet thickness can be on the higher side of the specification but not otherwise and shall be fully compliant in terms of construction details and finish. Minimum recommended sheet thickness for frame shall be 1.6mm (16guage) and shutter shall be 1.2mm (18guage)
3. All fire glazed doors should be tested for stability, integrity and insulation. Doors shall be tested for 120minutes integrity and 30minutes insulation.
4. The infill material shall be high density insulation material tested for minimum 30minutes insulation. The internal construction of the door shall be rigid reinforcement for stability and integrity.
5. Fire doors shall be tested as a complete assembly including Frame, door leaf, glazing glass with intumescent seal and hardware.
6. Intumescent seal is mandatory for all insulated doors. This is independent of the addition smoke seal if required. Smoke seal cannot be used as an alternative for the intumescent seals.
7. Products tested and certified shall be from approved labs of national or international repute. Third party certified products under a labeling program shall be acceptable provided the test certificates are valid and in line with the door and hardware.
8. For doors with side and top partitions, the certificate shall satisfy the requirement for maximum size of the partition and sq.mt area.
9. For continuous side partition, the detailing approval shall be based on valid assessment report indicating the maximum and minimum allowable glass in each panel. Manufacturer test certificate for specimen door may not be sufficient; it should be supported by valid assessment report from accredited lab for continuity of the system.

10. Glass manufacturer certificate may not be acceptable as they are just part of the assembly. Door manufacturer test certificate is mandatory.
11. NBC 2016, requires all
12. All fire doors supplied by the manufacturer shall also be acceptable to the Local authority or AHJ (Authority Having Jurisdiction)
13. Doors tested without vision panel shall not be used if it is not covered as a assembly in the related test certificate
14. The Maximum size of the glazing shall not exceed the overall glass sq.mt tested.
15. All hardware used shall be in line with minimum and maximum fire rating for which it is tested and approved. The hardware supplier shall provide relevant certificates to the door manufacturer and agree in writing if the material is not tested along with the door.
16. Door manufacturer shall be fully responsible for manufacturing, supplying of material in compliance with the standard and certification. Any deviation there off shall be documented and approved by competent authority before the supplies are affected.

11. Shop Finish

- A. Carry out shop finishing of metal doors and frames as follows:
 1. Chemically treat non galvanized, non bonderized metal surfaces with a phosphate compound to assure maximum paint adherence.
 2. Thoroughly clean all metal surfaces of all rust, scale, grease, rough spots and other foreign matter which may prevent proper paint adhesion.
 3. Apply spray powder coat of rust-inhibitive self-etching powder on all surfaces of frames and on exposed surfaces of doors and panels. Doorset shall be baked on in accordance with manufacturer's recommendations for developing maximum hardness and resistance to abrasion; paint dry film thickness not less than 50 microns.
 4. In case of primed surfaces shall be smooth and suitable to receive the finish coats.

12. Final Finish

- A. Painted Doors: All doors and frames can either to painted at site with suitable aliphatic grade paint polyurethane base. Powder coated frames and shutters are also acceptable if specified in the item description. Provide a final painted doors and

frames of approved shade. Paint surface shall be tested for minimum 250 hours of salt spray test.

- B. Wood grain finish: Provide wood finish on the grain tech surface of the door and frame. Doors to be hand finished and stained with approved wood finishes.

13. Hardware Preparation

- A. General: Hollow metal doors and pressed metal frames shall be prepared at the manufacturer's plant for all hardware in accordance with templates furnished and shall be drilled and tapped to receive hardware as indicated on the hardware templates.
- B. Mortised and concealed hardware: Mortise, reinforce, drill and tap for mortised and concealed hardware.
- C. Locations: Locate hardware as shown on the drawings and conform to standards established by the door hardware manufacturers.

14. Inspection

- A. Examine the substrates and the conditions under which hollow metal doors and frames shall be installed and correct any unsatisfactory conditions.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

15. Installation

- A. General: Install metal doors, frames, and accessories in accordance with final shop drawings and manufacturer's data, and as specified in this section.
- B. Placing Frames: Shall comply with provisions Recommended Erection Instructions for Steel Frames, unless otherwise indicated.
- C. Door Installation: Fit hollow metal doors accurately in frames, within clearances specified.
- D. Finish Hardware: Conform to recommended hardware installation manual.
- E. Anchors for installation shall be recommended by manufacturer based on kind of construction and fire rating
- F. Grouting of frames shall be done once the doors are fully aligned with approved grouting material.

16. Adjust and Clean

- A. Prime Coat Touch-Up: Immediately after erection, sand smooth any damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- B. Protection Removal: Immediately prior to final inspection, remove protective plastic wrappings from prefinished doors.
- C. Final Adjustments: Check and readjust operating finish hardware items leaving steel doors and frames undamaged and in complete and proper operating condition.

17. Fire Rated Hardware

- A. Door closer shall be SS 316 grade & confirming to CE & EN 1154 and B.S. – 476, Part-22, two hours fire rated of Approved make.
- B. Panic Exit Device – Single / Double leaf shall be SS 316 grade & confirming to CE & EN 1154 and B.S. – 476, Part- 22, two hours fire rated of Approved make
- C. Mortice Lock with lever handle shall be SS 316 grade & confirming to CE & EN 122090/DIN 18251 and B.S.-476, Part-22 , two hours fire rated of Approved make
- D. Stainless steel ball bearing hinges 4 nos. on each side of Steel Fire door shutters size 100 mm x 100 mm x 3 mm with screws etc. complete of Approved make
- E. Vision panel: Minimum 5 mm thick Fire Rated Clear Non-Wired Glass of 120 minutes rating one on each leaf of size 300 x 300mm.

18. Testing

The fire doors shall be tested by CBRI/ National Test House (Govt. of India) in accordance with BS 476 part 22. Galvanized steel to be used conforming to IS 277 (2003). The supply should be made along with valid test report from CBRI/NTH. One number door shutter along with frame and fittings of each type shall be tested from CBRI Roorkee/NTH for fire rating as per required standards and nothing extra for additional door shutter and testing charges shall be paid on this account.

XIV. FRAMELESS GLASS DOOR:

Providing, supplying and fixing of Frameless Single/D leaf Swing Glass Door of approved make with glazing using 12mm thick toughened glass of approved

make with die cast patch fitting with stainless steel cover including fixing of patch fittings, floor springs, locks, handles etc. using the hardware items as detailed, complete in all respects as per detailed drawings, specifications and as per the direction of Engineer-In-Charge. Single Leaf Door with Hardware's as specified:- Swing Glass Door which includes each of Top Pivot, Bottom Patch, Top Patch, Floor Lock, Strike Plate , Floor Spring, or any other L patch as per site requirement or any other patch pair, SS Pull Handle 25 mm dia. x 450 mm long and other accessories for self-closing feature (if required) as per detailed drawings and approval of Engineer-In-charge.

A) The Single door with side panels consists of the following:

- a) 1 Set Glass door over/side panel fitting, with pivot and satin SS covers.
- b) 1 Set Top patch fitting with pivot bearing location, with satin SS covers.
- c) 1 Set Bottom patch fitting with pivot bearing for floor spring, with satin SS covers.
- d) 1 Set Floors lock with strike plate and Euro Profile cylinder as per approved make.
- e) 1 Set Floor Spring as per approve make.
- f) 1 Set Back-to-Back SS Pull Handle 450mm x 25mm diameter.

B) Double door with side and upper panels

- a) 2 Set Glass door over/side panel fitting, with pivot and satin SS covers.
- b) 2 Set Top patch fitting with pivot bearing location, with satin SS covers.
- c) 2 Set Bottom patch fitting with pivot bearing for floor spring, with satin SS covers.
- d) 2 Set Floors lock – as per approved make with strike plate and Euro Profile cylinder.
- e) 2 Set Floor Spring as per approved make.
- f) 2 Set Back-to-Back SS Pull Handle 450mm x 25mm diameter.

Note: SS material used to be minimum 304 grade

1. Glass

The glass panes shall be of the type and thickness specified in the item. Their sizes shall be as shown in the drawings. The glass panes shall be of approved

quality and make. They shall have properly squared corners and straight edges. Damaged or defective glass shall be replaced with new glass. Each piece of glass shall be delivered with factory labels intact, indicating glass type, quality and thickness. Labels shall not be removed until installation has been accepted.

Glass is to be protected from breakage immediately upon installation by applying suitable warning markings.

Sealants of high quality, silicone, as specified by the manufacturers shall be used.

Toughened Glass

Toughened glass is 4 to 5 times stronger than its thickness of normal annealed float of sheet glass. It offers great resistance to sudden temperature changes and sudden impacts.

Float glass on international quality conforming to BS 952 Part – I for clear and tinted glass and of the thickness specified in the item shall be used for manufacturing toughened glass. Toughening, which shall be carried out horizontally (without tong-marks), shall conform to ASTM 1048.

All works such as cutting, grounding, drilling etc. On glass shall be carried out prior to toughening. Once tempering is done, no work will be allowed on the glass.

2. Handling & Storage

Glass shall be securely and safely rated for delivery, handling and storage. Cushions shall be provided at edges of glass to prevent damage. Glass faces shall be protected from scratches and abrasions. It shall be stored in a dry, well-ventilated location, carefully always protected from soiling, atmospheric.

3. Replacement of glass

In case of glass breakage after installation, the glass will have to be replaced by deglazing the glass at site & the re-glazing of the new glass will have to be done at site.

4. Structural Sealant

Structural sealant should have minimum tearing strength 6.0N/mm, shore A hardness 44 (ISO:868), tensile strength (ISO :8339-A) 1.06 N/Sqmm and one part. Joint movement capability + 25% (As per ASTM C-920).

5. Weather Sealant

The Silicon weather proofing sealant is designed for sealing expansion and control joints, pre-cast concrete panel joint, non-structural curtain wall mullion joints, stress cracks and joints in parapet wall. The sealant forms durable, flexible, water tight bonds with most building materials in any combination, in particular, ceramics, stone, masonry, wood, steel, anodized.

Weather sealant should have minimum tearing strength 4.0N/mm, Shore A hardness 20 (ISO 868), joint movement capability +15% (as per ASTM C-920).

6. Final Cleaning

Protective coating and warning markings shall remain undisturbed until final acceptance. Immediately prior to final inspection, temporary protective covering or coating shall be removed and surfaces shall be washed with a suitable thinner and left in a finished condition having approved uniform appearance and free from all marks and blemishes. Both faces of the glass shall be washed and polished.

XV. CHECK IN COUNTERS, INFORMATION/BOARDING GATE COUNTERS, INSPECTION TABLE, STAMPING TABLE AND OTHER ACCESSORIES:

1. GENERAL

Designing, Providing and placing counters etc. as per the design requirements.

2. MATERIAL

a) Solid Acrylic Surfaces

12 mm thick Solid acrylic of approved make should have the following parameters

Sl No.	Parameter	Unit	Requirement
1	Specific gravity		1.65-1.75
2	Rockwell hardness(HRM) /surface	HRM/Mohs Index)	Min88(HRM)/2-

	hardness(mohs index)		3(mohs index)
3	Tensile strength	Mpa	> 40
4	Flexural strength	Mpa	57 -74
5	Colour stability/Appearance		No change
6	Heat water resistance		No effect
7	Flexure modulus	Mpa	Min 6085
8	Flammability		Class A/ Class 1
9	Fungi and bacterial growth		No growth

b) 19 mm thick (BWP) block board

All frame work to be made with 19 mm thick block board of approved make and should be of boiling water proof (BWP grade) conforming of IS 1659 as per approved drawing. It should conform to the following parameters:

Sl. No	Parameters	Unit	Requirement
1	Dimensional	a) Length b) Width c) Thickness	+6mm +3mm +/-5%
2	Moisture content		5-15%
	Dimensional Changes		No de-lamination in the extreme ranges of
			Dimensional changes to be not more than +/- 1.00mm in local planeness
3	Resistance to water		After 72 hrs boiling Min. pass standard
4	Adhesion of plies		Min. pass standard
5	Mycological Test		No appreciable signs of separation at edges
6	Modules of Elasticity (N/mm ²)		Average 5000 Min. individual 4200 N/mm ²
7	Modules of Rupture (N/mm ²)		Average 50 Min. individual 42

c) 1 mm thick decorative laminate

The laminate shall be of approved make, in suede or gloss finish, the Colour and pattern to be approved before execution.

d) 18-gauge Stainless steel cladding

The grade of steel sheet to be used for bottom portion of table is of 304. Inclusive of pasting and fixing with SS screws or approved method as decided by Engineer-In-Charge.

Any other minor accessories like Teflon beading (if required for exposed surface of frame work) bottom supports, wire managers etc also included in the scope of work.

e) 18 mm thick pre polished granite

Top of the table is finished with 18-20 mm thick dark grey granite (sample to be approved before procurement) supported on teak batten of size 50 x 50mm at suitable spacing for firm support as per approved drawing. The exposed edges of the granite stone slab shall be chamfered and polished as directed.

f) 1.5 mm thick PVC flooring

Bottom floor of counter wherever required shall be provided with 1.5 mm thick PVC flooring of approved make, duly pasted on floor with smooth finish. The Colour and pattern of the floor is to be approved by Engineer-In-Charge before execution.

g) Accessories

Accessories (like telescopic channel for drawer, locks, hinges, handles should be of best quality as approved by the Engineer-In-Charge)

Any other minor accessories like Teflon beading (if required for exposed surface of frame work) bottom supports, wire managers etc also included in the scope of work.

3. FABRICATION /EXECUTION:

All the frame work to be prepared with approved material as mentioned above along with all accessories like stainless steel screws etc and application of solid acrylic surface to be done strictly as per manufacture's specification. Necessary molding of solid acrylic surface etc also included in the scope.

4. TEST & FREQUENCIES

All the material shall be tested as per specification with following frequency:

- a) Solid Acrylic Surface, 19mm thick BWP block board & laminate (as applicable) – one test per 100 Sqm of material..
- b) Manufacturers test certificate shall be supplied along with each batch of material irrespective of quantity.

XVI. WASH BASIN COUNTER TOP/VANITY COUNTER

1. Material

a) Solid acrylic surface

12 mm thick Solid acrylic of approved make should have following parameters:

Sl. no	Parameter	Unit	Requirement
1	Specific gravity		1.65-1.75
2	Rockwell hardness (HRM) / surface Hardness (mohs index)	HRM/Mohs Index)	Min88 (HRM) / 2-3 (mohs-index)
3	Tensile strength	Mpa	> 40
4	Flexural strength	Mpa	57-74
5	Colour stability/Appearance		No change
6	Heat water resistance		No effect
7	Flexure modulus	Mpa	Min-6085
8	Flammability		Class A/ Class 1
9	Fungi and bacterial growth		No growth

b) 19 mm thick (BWP) block board

All framework to be made with 19 mm thick block board of approved make should be of boiling water proof (BWP grade) conforming of IS-1659 as per approved drawing should conform following parameters:

Sl. No	Parameters		Requirement
1	Dimensional	a) Length b) Width c) Thickness	+6mm +3mm +/- 5%
2	Moisture content		5-15%
	Dimensional Changes caused by humidity		No de lamination in the extreme ranges of humidity Dimensional changes to be not more than +/- 1.00mm in local plainness
3	Resistance to water		After 72 hrs boiling Min. pass standard
4	Adhesion of plies		Min. pass standard
5	Mycological Test		No appreciable signs of separation at edges
6	Modules of Elasticity (N/mm ²)		Average 5000 Min. individual 4200 N/mm ²

7	Modules of Rupture (N/mm ²)		Average 50 Min. individual 42
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Final pattern of solid acrylic surface finish shall be approved by Engineer In-Charge.

2. FABRICATION /EXECUTION:

The Washbasin/vanity counter tops to be prepared with solid acrylic surface as per approved drawing and design to be fixed over 19mm thick BWP block board over MS powder coated frame supports or any other surface including all moulded wash basins, finishing of joints, silicon sealants etc to give joint less smooth surface complete as per satisfaction of Engineer In-Charge. Any additional requirement for fixing is to be arranged by contractor without extra payment. Necessary moulding of solid acrylic surface etc also included in the scope.

3. TEST & FREQUENCIES

All the material shall be tested as per specification with following frequency:

- a) Solid Acrylic Surface, 19mm thick BWP block board & laminate (as applicable) — one test per 100 Sqm of material.
- b) Manufacturers test certificate shall be supplied along with each batch of material irrespective of quantity.

XVII. LOOKING MIRROR:

Mirrors shall be fabricated from float glass of at least 6 mm thickness of approved make shall match the International Standards. The edges of mirrors shall be polished and beveled and mitered as per IS 3438:1994, The edges shall be beveled as indicated in drawings and shall be done at approved source. The glass sheet used for mirrors shall comply with the requirements prescribed for AA and A qualities of IS 2835: 1987. Silvering shall be a coating of deposited silver. It shall be free from defects or blemishes in the reflecting surface such as lifting or separation of the silver from the glass, sulphide or other spots, haze or any other visible defects. The amount of silver deposit shall not be less than 0.8 g/m² when determined with the method prescribed in IS 3438:1994.

XVIII. TOILET CUBICLES

1. MATERIAL

The Toilet cubical shall be of approved size and shape as per design and drawings, erected at locations enclosed by corner masonry walls. Division, frontal and nib panels shall be of 18 mm thick compact general purpose flame retardant (CGF) category board, Decorative Thermosetting Synthetic Resin

Bonded Compact Laminated Sheets conforming to IS 2046. Hardware and fittings shall be of grade 304 stainless steel conforming to relevant IS codes.

All the material supplied and installed shall be as per the description and specifications in the item. The following information shall be submitted by the contractor for obtaining approval of the Engineer-In-Charge before start of work.

Product data	:	Manufacturer's data sheets on each product to be used, including preparation instructions and recommendations. Storage and handling requirements and recommendations. Details of construction and fabrication. Installation methods.
Shop Drawings	:	Detailed plans and elevations, details of framing members, anchoring methods, clearances, hardware, and accessories clearly shown.
Name of fabricator / installer	:	Approved by the manufacturer, specializing in performing work of this section with minimum two years' experience.
Manufacturer's warranty	:	Components of the toilet cubical for 10(ten) years against breakage, corrosion, and defects in factory workmanship.

2. DELIVERY, STORAGE, AND HANDLING

L-shaped Toilet cubical material and hardware shall be delivered and stored in manufacturer's unopened packaging until ready for fabrication and installation. It shall be protected from damage.

3. FABRICATION

The substrates shall be prepared including but not limited to blocking and supports in walls and ceilings at points of attachment using methods recommended by the manufacturer for achieving the best result. Area shall be inspected to receive toilet cubicles for correct dimensions, verticality of walls, and soundness of surfaces that would affect installation of mounting brackets.

Spacing of plumbing fixtures shall also be verified to assure compatibility with installation of compartment. Installations shall not be preceded until substrates have been properly prepared with blocking and supports in walls and ceilings at points of attachment and deviations from manufacturer's recommended tolerances are corrected. All the fabrication work shall be carried out as per approved shop drawings.

4. INSTALLATION

All installation shall be carried out by the fabricator/installer approved by the Engineer-In-Charge. Installation shall be in accordance with manufacturer's written instructions approved by the Engineer-In-Charge.

Blocking and supports in walls and ceilings shall be verified that they have been installed properly at points of attachment. Location should not interfere with door swings or use of fixtures. Installation of cubical units should be rigid, straight, true to plumb, and level. Evidences of drilling, cutting, and fitting to room finish shall be concealed by capping / shoe box plate etc. U-channels and noise deafening tapes shall be provided as per drawing. All the units shall be tested for proper operation. The following SS 304 grade/Polyster powder coated fittings shall be provided in each toilet cubical as approved by Engineer-In charge.

1. Gravity hinge – 3 Nos.
2. Coat hook cum Door stopper – 1 No.
3. Door knob cum vacant / engaged position showing device – 1 No.
4. Lock set – 1 No.
5. Shoe Box
6. Chanel

5. ADJUSTING, CLEANING AND PROTECTION

Adjustment of hardware for proper operation after installation may be permitted provided it does not damage the unit either structurally or aesthetically. Hinge cam may be set on in-swinging doors to hold doors open when unlatched and on out-swinging doors to hold unlatched doors in closed position.

Touch-up, repair or replacement of damaged products shall be done with prior approval of the Engineer-In-Charge, whose decision shall be final and binding.

Exposed surfaces of compartments, hardware, and fittings shall be cleaned thoroughly.

6. TEST & FREQUENCIES

- a) CGF category board (compact general purpose flame retardant) Decorative Thermosetting Synthetic Resin Bonded Compact Laminated Sheets shall be tested for every 100 nos. or part thereof.
- b) Manufacturers test certificate shall be supplied alongwith each batch of material irrespective of quantity.

XIX. URINAL PARTITIONS/MODESTY PANEL

1. Material

Wall Hung Screen / urinal partitions using 8mm thick toughened and satin frosted glass panels, hung from the wall using two SS 304 grade pivoted clamps. The urinal partition shall have minimum standard dimension of 1200 mm Height x 450 to 500 mm Width. The edges of the glass panels shall be grinded & polished smooth with architectural profile

Product data	Manufacturer's data sheets on each product to be used, including preparation instructions and recommendations. Storage and handling requirements and recommendations. Details of construction and fabrication. Installation methods.
Shop Drawings	Detailed plans and elevations, details of framing members, anchoring methods, clearances, hardware, and accessories clearly shown.
Glass partition	Glass shall be toughened in accordance with BSEN 12150, BSEN 12600 All edges of the glass shall be polished The corners of the glass shall have 5mm radius unless otherwise specified Frosted toughened glass can be drilled, shaped, notched as required.

2. Delivery, Storage, and Handling

Urinal partition material shall be delivered and stored in manufacturer's unopened packaging until ready for fabrication and installation. It shall be protected from damage.

3. Fabrication

The substrates shall be prepared including but not limited to blocking and supports in walls and ceilings at points of attachment using methods recommended by the manufacturer for achieving the best result.

4. Installation

All installation shall be carried out by the fabricator/installer approved by the Engineer-In-Charge. Installation shall be in accordance with manufacturer's written instructions approved by the Engineer-In-Charge.

5. Adjusting, Cleaning and Protection

Adjustment of hardware for proper operation after installation may be permitted provided it does not damage the unit either structurally or aesthetically.
Exposed surfaces of compartments, hardware, and fittings shall be cleaned thoroughly.

XX. MODULAR STAINLESS-STEEL RAILING (ALL TYPES)

1. SCOPE

This section refers to the design, supplying, fabrication and installing in position composite hand railing for staircase, open area, balcony / terrace, corridor, cafeteria etc. at different floors, levels and locations.

2. CODES AND STANDARDS

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

Specification	Description
IS: 800	Code of Practice for Use of Structural Steel in General Building Construction.
IS: 875	Code of Practice for Design Loads of Buildings and Structures
IS: 813	Scheme of symbols for welding.
IS: 814	Covered electrodes for manual metal arc welding of Carbon and carbon-manganese steel.
IS: 816	Code of practice for use of metal arc welding in general mild steel construction.
IS: 817	Code of practice for training and testing of metal arc welders.
IS: 818	Code of Practice for safety and health requirements in electric and gas welding and cutting operations
IS: 822	Code of procedure for inspection of welds
IS: 823	Code of procedure for manual metal arc welding of mild steel
IS: 1161	Steel tub Steel tubes for structural purposes
IS: 1181	Qualifying tests for metal arc welders
IS: 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS: 3696	Safety codes for scaffolds and ladders
IS: 4923	Hollow steel sections for structural use
IS: 7205	Safety code for erection of structural steelwork
ASTM A276 -06	Standard Specifications for Stainless Steel Bar and shapes
ASTM A479/ A 479 M - 06a	
ASTM E 1086 - 94	Standard Test Method for Optical Emission Vacuum Spectrometric Analysis of Stainless Steel
ASTM B-117	Standard practice for operating Salt Spray (fog) apparatus.
ASTM A 484	Standard Specifications for general requirement for Stainless Steel bars, Billets and Forgings.
ASTM A554 - 11	Standard Specification for Welded Stainless Steel Mechanical Tubing
Material Testing & Inspection <ul style="list-style-type: none"> • Test Method: ASTM. (American Society for Testing and Materials). • Material confirms to ASTM A-276-06, ASTM A479/A479M-06a • Chemical Analysis Test Method ASTM E 1086-94, ASTM B 117 • Dimensional tolerance as per ASTM A484/AA484M-06b • Specification used: AISI.(American Iron and Steel Institute) 	

Specification	Description
<ul style="list-style-type: none"> • All the materials testing are done through the NABL Certified Laboratory only. 	

3. MATERIALS

i. Stainless Steel railing / hand railing

Pipes used in all Railing shall be Stainless Steel as per SS 304 Grade with minimum tube thickness of 1.5 mm having tolerance level as per ASTM A554. All components in railing including baluster, pipes, caps etc. shall be in brush finish or as approved by Engineer-In-Charge.

Balusters

- The balusters to have a standard height of approximate 1050 mm or as specified in the drawings.
- All components used in the baluster to be manufactured using SS 304 grade material turned and finished on CNC and other automatic Machines.
- The base plate of the Baluster to be solid Stainless Steel of size 115 mm dia and 8 mm in thickness or as specified in the drawings.
- All connectors to be fixed to the Baluster using Allen Bolts. The baluster to have Zero welding except on the bottom plate.
- Balusters to be fixed using Stainless Steel M8 Fasteners with SS 304 grade Stainless Steel Caps
- The Baluster neck to be modular and can be tilted as per the handrail. The neck plate shall be minimum 2 mm thick in Stainless Steel 304 grade.
- Handrails shall be connected to the neck plate using Stainless Steel CSK M5x10 mm Screw only
- Balusters shall be installed with a centre-to-centre distance of 1 mtr. or as indicated in the drawing.

ii. Glass

- Laminated toughened glass panels comprising of multiple panels of 5mm thick clear toughened glasses + 1.52 PVB film + 5mm thick clear toughened glasses and fixed to the vertical balusters with glass clamping discs.
- Glass railing shall be of equal panels in each flight or as shown in the drawing and all visible edges of the glass shall be machine polished.

iii. Aluminium Frame

Aluminium channel - T-6065 grade of specified size shall be used for holding the glass from the bottom with wedges, gaskets and fixed to the structure with anchor fasteners at 300 mm c/c including cutting the floor, grouting the joints using non-shrink grout.

iv. Samples /Mock-up

Before taking up fabrication and erection on mass scale, the sample of railing materials being used etc. including mock-up of the system shall be got approved by the Engineer-In-Charge.

v. Manufacturing Tolerances

- a) A high degree of accuracy should be employed in the fabrication of the Hand rails, skirt rails and their support structure.
- b) Deviations in section length, width and diagonal dimension tolerances should not exceed $\pm 2\text{mm}$.
- c) The twist and warping should not cause any point of the element to be more than 1mm out of plane.

4. FABRICATION, ASSEMBLY AND INSTALLATION

i. General

- a) Use no materials, equipment or practices that may adversely affect functioning, appearance and durability of completed items specified herein and related construction. Items shall comply with specified criteria without buckling, opening of joints, undue stress on fasteners, sealants and gaskets opening of welds, cracking of glass, leakage, noises, or other harmful effects.
- b) Conform strictly to materials, finishes, and shapes, sizes, thicknesses, and joint locations required by drawings and specifications.
- c) Match all materials to produce continuity of line, texture, and colour.
- d) To fullest extent practicable, fabrication and assembly shall be executed in shop. Work not shop assembled shall be shop-fitted.
- e) All components exposed in finished work shall be acceptably free from warping, oil canning effects, and telegraphing of welds, studs, and other fasteners.
- f) Pipes used in the work shall be seamless type.

ii. No site welding of SS pipes will be allowed and longitudinal joints shall be made by arrangement of internal SS sleeves, in vertical pipes no joints are permitted.

iii. Glass

- a) Glazing shall be performed without springing or forcing of glass.
- b) Install glass under the conditions recommended by respective product manufacturers.

iv. Protection, Cleaning and Acceptance

- a) Protect the Work of this Section from any materials, equipment or practices that may impair function appearance or durability of the work.
- b) Remove and replace or repair with approval of Engineer-In-Charge any portion of work including glass damaged prior to date of acceptance.

- c) Acceptance of completed work requires installation be sound, free from defects in materials and workmanship and clean. Clean is defined as free of any substance that cannot be removed by a normal cleaning with detergent and water.

5. METHODOLOGY & WORKMANSHIP

i. General

- b) Fit exposed connections together to form tight, hairline joints. Perform cutting, drilling, and fitting required to install handrails, skirt rails.
- c) Set handrails and railings accurately in location, alignment and elevation; measured from established lines and levels and free from rack.
- d) Adjust handrails and railings before anchoring to ensure matching alignment at abutting joints.
- e) Space posts at interval indicated, but not less than that required by structural loads.
- f) Fastening to In situ Construction. Use anchorage devices and fasteners where necessary for securing handrails and railings and for property transferring loads to in situ construction.
- g) The hand railing shall follow the inclination of stair in case of stair-case and shall be perfectly in line, level and plumb for all other railings.
- h) Any damage caused to treads/risers while fixing of balusters, posts, railings etc., the damaged tread and riser shall be removed and replaced by new ones at no extra cost to the Employer.

ii. Anchoring Railing Ends

Anchor railing ends into concrete and masonry with round flanges connected to railing ends and anchored into wall construction with post installed anchors and bolts. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces. Connect flanges to railing ends using non welded connections.

iii. Attaching Handrails to Walls

- a) Attach handrails to wall with wall brackets. Provide brackets with at least 50 mm clearance from inside face of handrail and finished wall surface.
- b) Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- c) Secure wall brackets to building construction as follows:
 - i) For concrete and solid masonry anchorage, use drilled in expansion anchors
 - ii) For steel framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs.

iv. Installation Tolerances

- a) The hand railing, skirt railing shall be erected in proper alignment in relation to established lines and grids shown on the Shop Drawings.
- b) The width of any joint should not deviate from the nominal width by more than $\pm 1\text{mm}$. Any variation should be equally distributed with no sudden changes.

c) Set posts plumb within a tolerance of 2 mm in 1 m.

6. TEMPORARY STORAGE & HANDLING

- a) The material shall deliver and store packed materials in original packing with seals unbroken and labels intact till the same are intended to be used.
- b) The Contractor shall take necessary precautions during storage to prevent damage or contamination to the materials by water, foreign matter or other causes.
- c) Store materials in a dry, well ventilated, weather tight place, and protect from damage.

7. CLEANING & PROTECTION

i. Cleaning

- a) Remove temporary coverings and protection of adjacent work areas.
- b) Clean installed products in accordance with manufacturer's instructions before acceptance by the Engineer. Do not use chlorine-based or abrasive cleaners.
- c) Remove from project site and legally dispose of all construction debris associated with this work.

ii. Protection

Protect installed product from damage during subsequent construction activities.

XXI. MODULAR TROLLEY-FENDER SYSTEM

1. GENERAL

Design, supply, fabricating, fixing and installing in position 240 grit satin polished stainless steel AISI 316 modular trolley-fender system with height of 200 mm of approved make having tube dia 60.0 mm wall thickness 1.5 mm modular and component-based system connected with modular attachments between tube rail 54X12 mm flat members at max c/c distance of 1500 mm or as per approved drawing with all necessary bends and joints. No welding of SS pipes will be allowed and work shall be done by a specialized agency on modular and component basis as directed by Engineer-In-Charge. The contractor shall supply all materials, labour, tools, ladders, scaffolding and other equipment necessary for the completion and protection of all stainless-steel work.

2. MATERIAL

All stainless-steel pipes and plates shall confirm to ASTM 316 in 18/8 composition 18 will be chromium and Nickel and carbon content will be 0.03 maximum and the relevant clauses associated with this grade of steel to be followed as per criteria / properties mentioned below:

a) Material Composition

Material Composition of Inox, Stainless Steel Balls (Round or Spherical) etc are as specified herein below:

Element %	316 Grade	Implications
Carbon	.08	Increase in percentage decreases the corrosion resistance.
Silicon	1	-
Manganese	2	Affects the magnetic Characteristic and hardness of Iron
Phosphorus	.045	-
Sulphur	.03	-
Chromium	16 to 18	Addition of 12% forms stainless steel from ordinary steel. Removes the corrosive effect of carbon. Forms a passive film which prevents oxidation & consequent corrosion.
Molybdenum (MOLY)	2 to 3	Molybdenum increases the corrosion resistance. It has a superior tensile strength at high temperature as compared to 304 Grade Steel. This element can resist major chemical reaction and thus being a very
Nickel	10.0 to 14.0	Nickel provides corrosion resistance, increases strength in both high & low temperature, increases toughness in low temperature and lowers the effects of work hardening. Thus, higher percentage makes the steel superior in quality.

b) Corrosion Resistance

Nickel: Improves corrosion resistance, formability and weld ability, higher percentage makes Steel more corrosion resistance & superior in quality. Thus, as given in table with 10 to 14 % of Nickel AISI 316 is highly non corrosive.

c) Surface Finish

Surface finish of all the stainless-steel materials will be in 240 grit satin finish/ matt finish

d) Accessories

Fixing will be done by stainless steel expansion bolts of approved size and make as per direction of Engineer-in Charge and welding to be done by using organ welding rods and surface being duly finished and cleaned by K2 passivation, which is nitric acid plus florid acid solution treatment by which chances of corrosion will be eliminated and any burn out marks on the metal will also be eliminated.

e) Coating Mass

All Stainless-steel material will have to be coated by solution of Inox to avoid finger imprints and avoidance of settlement of environment/atmosphere dust. The coating thickness will be 2 to 4 microns.

XXII. STAINLESS STEEL Q-MANAGEMENT SYSTEMS

Stainless Steel Q-Management systems with retractable tape head Mechanism (four-way tape head connectivity (3 receiving and 1 extension) consisting of Polyester tape of desired colour of minimum 45 mm width, with minimum 2.75 metre retractable length, with desired AAI logo and name in desired colour, with pole 1000mm total height, 63 mm dia. with thickness 1.5 mm of Stainless-Steel Grade -304. Stainless Steel pole fixed to circular MS base (300 mm dia & 19 mm thick) with SS cover of thickness 0.60 mm and bottom with rubberized cover etc. Approx. weight should be 10 Kgs. (Note: A sample is to be submitted to AAI before taking mass production).

~~XXIII. STAINLESS STEEL BOLLARD~~

~~Providing and fixing of Stainless Steel Bollard made of SS: 304 grade having 750 mm projected height & 100mm dia with 3mm thickness having truncated top at 45 degree as per drawing. The base plate shall be of size 250 x 250 x 4 mm thick of stainless steel: 304 grades covered with stainless steel sheet 1.2 mm thick flushing with ground. The upper part (truncated portion) of Bollard shall be covered with 3mm thick SS: 304 grade sheets. The complete Bollard should be fixed with suitable fasteners for fixing at ground including welding, polishing, buffering complete with necessary holes etc. The bollard should have 2 Nos. of reflecting Band of size 125mmx700mm micro prismatic retro-reflective sheeting grade type VIII as per ASTM D 4956-07, be pasted on the Bollard for better visibility at night all complete as per direction of Engineer In Charge.~~

XXIV. DUSTBINS

- i. Dustbins made of 18-gauge SS-202 grade stainless steel hairline finish of 400 mm external dia. 750 mm height with 300 mm dia round opening at top with PU coating including 125 mm high AAI Blue colour Logo, colour coded waste description sticker and neoprene gasket ring at bottom. The dustbin should have removable cover, provision of clipping poly bag complete as per design drawing No: PLG/A9/STD/DB/01 and directions of Engineer-In-Charge. The dustbin shall display sticker indicating type of garbage and the top shall be finished with approved shade of PU Coating as per the instructions of Engineer-In-Charge. [One make-up sample to be supplied at the site according to the drawings and directions of EIC and approval shall be taken from EIC for further fabrication and supply of balance Dustbins].
- ii. Dustbins made of 18 gauge SS-202 grade stainless steel hairline finish of 400 mm external dia. 750 mm height with 2 nos 300 mm dia round opening at

top with PU coating including 125 mm high AAI Blue colour Logo, colour coded waste description sticker and neoprene gasket ring at bottom. The dustbin should have removable cover, provision of clipping poly bags complete as per design drawing No: PLG/A9/STD/DB/02 and directions of Engineer-In-Charge. The dustbin shall display sticker indicating type of garbage and the top shall be finished with approved shade of PU Coating as per the instructions of Engineer-In-Charge. [One make-up sample to be supplied at the site according to the drawings and directions of EIC and approval shall be taken from EIC for further fabrication and supply of balance Dustbins].

- iii. Dustbins made of 18-gauge SS-202 grade stainless steel hairline finish of 400 mm external dia. 750 mm height with 3 nos. 300 mm dia round opening at top with PU coating including 125 mm high AAI Blue colour Logo, colour coded waste description sticker and neoprene gasket ring at bottom. The dustbin should have removable cover, provision of clipping poly bags complete as per design drawing No: PLG/A9/STD/DB/03 and directions of Engineer-In-Charge. The dustbin shall display sticker indicating type of garbage and the top shall be finished with approved shade of PU Coating as per the instructions of Engineer-In-Charge. [One make-up sample to be supplied at the site according to the drawings and directions of EIC and approval shall be taken from EIC for further fabrication and supply of balance Dustbins].

XXV. TOUGHENED LACQUERED GLASS

1. General

Providing and fixing 6mm Thick Toughened Lacquered Glass of superior quality confirming to BS EN 16477-1:2016 in cladding, wall lining etc. of approved shade, edge polished complete pasted to 12millimeter thick ply backing with the help of silicone (GE WINSEL-20/Dow Corning-786). 12mm thick plywood shall be fixed to Aluminium base frame work using 50 mm x 25 x 2.41 mm sized Hollow Aluminium section members @ 450mm c/c both ways i.e. horizontally & vertically of approved shade fixed to brick wall/RCC wall with necessary flat headed screws/ fasteners at all level as per shop drawings complete, design, as per drawing including drilling, cutting, screws and washers, cleats, adhesive, sealant, all accessories, cleaning etc. The glass should bevelled edged at the corners /junctions to avoid any sharp edge in the glass.

2. Fabrication /Execution:

The 6mm thick toughened lacquered glass to be pasted on 12 mm thick Plywood. 12mm thick plywood shall be fixed to Aluminium base frame work using 50 mm x 25 x 2.41 mm sized Hollow Aluminium section members @ 450mm c/c both ways i.e. horizontally & vertically of approved shade fixed to brick wall/RCC wall with necessary flat headed screws/ fasteners at all level as per shop drawings in absolute plumb .The flat headed screws /

mechanical fastener/ rawl plugs of sufficient length to be used for fixing ply with wall so that holding can be ensured from brick wall /RCC wall (not limited to plaster), and projection of flat headed screws /Mechanical fasteners / rawl plugs should be completely flush with level of plywood .The No of fasteners should be sufficient to ensure its alignment and durability be used be approved by Engineer-In-Charge before execution .All the edged of lacquered glass should be bevelled as per site requirement to avoid any sharp edge in cladding. The glass and plywood should have provision of cut out, if any, required as per site condition.

XXVI. LOUVERS AND VENTS

1. SECTION INCLUDES

This section includes requirements of fixed, external extruded-Aluminium louvers.

2. DEFINITIONS

- a) Louver terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this section unless otherwise defined in this section or in referenced standards.
- b) Horizontal louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.
- c) Drainable-blade louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- c) Storm-resistant louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

3. SUBMITTALS

- a) Product data:
Product data shall be submitted for each type of product indicated.
For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA certified ratings seals.
- b) Shop drawings: Shop drawings shall be submitted for louvers and accessories which include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, spacing and shall comprises of: Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

Show mullion profiles and locations.

Wiring diagrams: For power, signal, and control wiring for motorized adjustable louvers.
- c) Samples for initial selection shall be submitted for units with factory-applied colour finishes.

- d) Samples for verification shall be submitted for each type of metal finish required.
- e) Provide delegated-design submittal for louvers complying with structural and seismic performance requirements and design criteria, including analysis data.
- f) Informational submittals
 Product test reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by an accredited testing agency or by manufacturer and witnessed by an accredited testing agency, for each type of louver and showing compliance with performance requirements specified.

4. MATERIALS

- a) Aluminium extrusions shall conform to ASTM B 221, Alloy 6063-T5, T-52, or T6.
- b) Aluminium sheet shall conform to ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- c) Fasteners: Use fasteners of types and sizes to suit unit installation conditions as detailed below:
 - i) Use hex-head or pan-head screws for exposed fasteners unless otherwise indicated.
 - ii) For fastening Aluminium, use Aluminium or 300 series stainless-steel fasteners.
 - iii) For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
 - iv) For fastening stainless steel, use 300 series stainless-steel fasteners.
 - v) For colour-finished louvers, use fasteners with heads that match colour of louvers.
- d) Post-installed fasteners for concrete and masonry: Provide Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by an accredited testing agency.

- e) Bituminous paint shall be cold-applied asphalt emulsion complying with ASTM D 1187.

5. FABRICATION

- a) Louvers shall be assembled in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- b) Vertical Assemblies: Wherever height of louver units exceeds fabrication and handling limitations, units shall be fabricated to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
- c) Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- d) Frames shall be fabricated including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- d) Include supports, anchorages, and accessories required for complete assembly.
- e) Provide vertical mullions of type and at spacing's indicated, but not more than recommended by manufacturer, or 1830mm centre to centre whichever is less.
- f) Provide extended sills for recessed louvers.
- g) Join frame members to each other and to fixed louver blades with fillet as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

6. FIXED, EXTRUDED-ALUMINIUM LOUVERS

Horizontal storm-resistant louver:

- i) Louver
- ii) Double banked weatherproof
- iii) Louver depth: 100mm.
- iv) Frame and blade nominal thickness: Not less than 1.5mm for blades and 2.0mm for frames.
- v) Louver performance ratings:

- Free area: Not less than 50% perforation or as approved by the Engineer-In-Charge.
 - Air performance shall not be lower than 0.3 airflow coefficient.
 - Wind-driven rain performance shall not be less than 80 percent effectiveness when subjected to BSRIA or AMCA standard of testing.
- vi) AMCA seal: Mark units with AMCA certified ratings seal.

7. FINISHES

Comply with NAAMM's "Metal finishes manual for architectural and metal products" for recommendations for applying and designating finishes.

8. ALUMINIUM FINISHES

- a) Finishes to louvers shall be carried out after the assembly of the system.
- b) Colour anodic finish shall conform to AAMA 611, or thicker.
 - i) Colour shall be as selected by Engineer-In-Charge as per industry colours and colour densities.
- c) PVDF2 Fluorocarbon 3 coat paint system shall be prepared and applied in accordance with the following performance requirements and standards:
 - i) Meet or exceed the performance requirements of the AAMA605.2 "Specification for high performance organic coatings on Architectural extrusion and panels"
 - ii) Application of the finish shall be performed under specifications issued by the licensed formulator and by an applicator specifically approved by one (or more) of the formulators. Applicator shall provide written notification of approval by a formulator prior to application of the finish.
 - iii) The fluorocarbon 3 coat system shall consist of:
 - First coat: Inhibitive primer, with a dry film thickness averaging 5-7 microns.
 - iv) The total minimum dry film thickness of the fluorocarbon coating shall be 40 microns. This coating system shall be spray-applied and thermocured at 230-250 C or as specified by paint manufacturer. The micron thickness shall be measured in accordance with ASTM B 244-29.
- v) Batch testing of paint finish shall be carried out by supplier including:
 - Crosshatch adhesion list.
 - Bending test for cracking or flaking.
 - Impact testing to check for cracking or flaking.
 - Gauge testing to check micron thickness.
- vi) Colour and gloss shall be as selected by Engineer-In-Charge as per manufacturer's catalogue.

XXVII. PAINTING

1. General

Work of painting shall be one of the last items of work and shall not be taken up until all other internal works except fittings & fixtures have been completed and approved. No work under this section shall start without approval from EIC. The contractor shall ensure that approval has been obtained for all primer, paints, oils, varnishes, texture rendering materials for each location/area to be finished and in respect to shades brand, product literature, shade card with range of colours & manufacturer for such finishing materials, well in advance to commencement of work.

2. Working Specimen

A working specimen at the actual place of this detail for each type as instructed by the Engineer-In-Charge executed and the work shall be done up to the satisfaction of the EIC. The further work shall be carried out strictly as per the working specimen in terms of finish and Tolerance.

3. Materials

All material shall be the best of their kind and of approved manufacture for each item. Painting materials such as shellac, thinner, oils, driers, brushes, rollers etc. shall be of the best-approved quality and type. If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by EIC shall be used.

4. Colour

The Contractor shall procure paints and other finished matching colours as provided in the colour schedule. It shall be subject to approval by the EIC. The Contractor shall as far as possible use premixed manufacturer's colours and shall prepare paint samples of the colours selected and submit the same for approval by the EIC. However in case he has to produce paints/ other finishes of particular Colours / shades by blending / additions of strainers he shall do so at no extra cost to the Employer and in a manner approved by the EIC. No work is to proceed unless the EIC has given his approval of the colour samples.

If contractor proposes any alternative/ substitution after the sample approval, details of the same shall be submitted to EIC for their review and approval prior to use.

5. Primer

Primer for work / Iron & Steel / Plastered / Aluminium surfaces shall be as specified below:

Surfaces	Primer to be used
Wood work (hard and soft wood)	Pink conforming to IS 3536-1966
Resinous wood and ply wood	Aluminium primer
Iron & Steel, Aluminium and galvanized steel work:	Zinc chromate primer conforming to IS 104-1962
Plastered surfaces, cement brick work, Asbestos surfaces for oil bound distemper, Synthetic Enamel paint and Acrylic Emulsion Paint	Cement primer

The primer shall be ready mixed primer of approved brand and manufacture.

6. Sealed Containers

The Contractor shall bring paints, oils or varnishes of approved shade, brand & manufacturer to the site of work in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The empty containers shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from EIC.

7. Storage

All materials and equipment shall be stored in a neat and orderly fashion in one single clean space and such as no disturbance or obstruction is caused to works and workers of other trades. Care shall be taken to maintain this place as clean and dust-free as possible.

8. Specialized Workmen

The Contractor through specialized skilled workmen experienced in the trade shall do all work.

9. Work as per Manufacturer's Instructions

All work shall be done strictly as per this specification and manufacturer's printed instructions. In case these specifications differ in any way from manufacturer's instructions, the latter shall apply.

10. Samples

- i. Before commencement of work

Before starting work under this section large size samples of all types of coating including preparation of surface shall be made at the site and approval obtained from the EIC before proceeding with the finishing works. Only after specific approval has been given to the samples, work shall commence. The actual work shall be done as per the approved samples.

ii. After work completion

Contractor shall provide owner with extra quantity of all paint products with the mixing details. This is useful for further & any minor patchwork. All products shall be clearly labelled and provided in fully sealed containers.

11. Preparation

The plastered surfaces shall be allowed to dry out completely. All surfaces to be finished shall be thoroughly brushed and cleaned of mortar drops, dust, dirt, fungi, rust, mill-scale, efflorescence and all other extraneous material. All loose pieces and scales shall be removed by scrapping. Surfaces shall be thoroughly sand papered to a smooth finish. Further preparation work shall be done as specified under different types of finishes. Before starting painting work all floors shall be washed clean and wiped dry.

12. Finished Surface to EIC's Satisfaction

All finished surface shall be smooth and of even shade to the satisfaction of EIC.

13. Protection

All work done shall be thoroughly protected from damage at all times by suitable and appropriate methods to the satisfaction of EIC. All other adjacent areas which may not have received the finish at the same time shall also be thoroughly protected by suitable canvas, paper covering or by some other approved method.

The contractor shall remove and safely store or protect all hardware on painted or adjacent surfaces to prevent damage or discoloration from application of paint products.

14. Damages to be made good

Any and all damages or disfigurements of other works caused by the painting works shall be immediately made good. All paint and varnish spots and other stains shall be thoroughly and carefully removed from all floors, doors, windows, fittings, furniture, glass, hardware and all other surfaces required by approved paint removers and the places left clean, tidy and to its previous finish to the satisfaction of the Engineer-In-Charge without any additional cost.

15. Scaffolding

Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No bellies, bamboo or planks shall rest on or touch the surface, which is being painted.

Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

For painting of the ceiling, proper stage scaffolding shall be erected with proper protection of the floor preventing the scratch mark on floors. Also the scaffold should be operated to prevent any damage or discoloration of the surfaces.

Painting shall not be started until and unless the EIC has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work.

Painting, except priming coat, shall generally be taken in hand after all other builder's work, practically finished.

The rooms should be thoroughly swept out and the entire building cleaned up minimum one day in advance of the paintwork being started.

16. Spray painting

Spray painting with approval machines will be permitted only if written approval has been obtained from the Designer prior to painting. No spraying will be permitted neither in the case of priming coats nor where the soiling of adjacent surface is likely to occur. The nozzle and pressure to be so operated as to give an even coating throughout to the satisfaction of the Engineer-In-Charge. The paint used for spraying is to comply generally with the specification concerned is to be specially prepared by the manufacturer for spraying. Thinning of paint made for brushing will not be allowed.

17. White Wash

i. General

The work shall not be started without the approval of the EIC. The contractor shall submit the samples of all proposed white & colour wash finishes to the Engineer-In-Charge for their review and approval.

ii. Surface Preparation

The surface shall be thoroughly brushed free from mortar droppings and foreign matters. All plaster damages shall be made good by cement sand mortar and curing it sufficiently before the painting work is taken up.

iii. Material

The white wash shall be prepared from fresh shell lime to which shall be admixed with sufficient quantity of whiting zinc oxide in the ratio of 15:1 (1 part to lime and 15 parts of zinc) and gum. The lime and whiting shall be made into thin cream and screened through clean coarse cloth. 40 gms of gum dissolve in hot water shall be added to each 10 cu. Decimeter of the cream. Indigo up to 3 gms per kg. of lime dissolved in water shall then be added to the composition. Water at the rate of about 5 liters per kg. of lime shall be added to produce a milky solution.

iv. Application

In case of colour washing approved mineral colours not affected by lime shall be added to the white wash in required quantities instead of indigo.

The wash shall be applied with approved brushes in minimum 3 coats. Each coat shall be allowed to dry before applying the next. In case the surface does not present a smooth and uniform finish throughout to the satisfaction of EIC. If the finish is not as per the required standards and acceptability more coats shall be added as required at no extra cost till the acceptable finish is achieved.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

v. Colour Washing

In the case of colour washing, mineral colours, not affected by lime, shall be added to white wash with proper glue. No colour wash shall be done until a sample of the colour wash to the required tint or shade has been got approved from the EIC. The Colour shall be of even tint or shade over the whole surface.

If it is patchy or otherwise, badly applied, it shall be redone by the contractor, at no extra cost to the Department.

For new work the priming coat shall be of white wash lime or with whiting as specified in the description of the item. Two or three coats shall then be applied as specified on the entire surface till it represents a smooth and

uniform finish. Each coat after applying shall be got approved from the EIC.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

Other specifications as detailed for whitewashing with lime shall be applicable. Indigo (Neel / blue) shall however, not be added.

18. Acrylic emulsion Paint (for External application)

i. Preparation of Surface

The surface shall be thoroughly cleaned of all mortar dropping, loose pieces & scales, dirt, dust algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement paint shall be applied over patches after wetting them thoroughly. The surface shall be thoroughly wetted with clean water before the cement paint is applied.

ii. Preparation of mix

Acrylic paint of approved brands shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish.

Acrylic paint shall be mixed with water stirred thoroughly as per manufacturer's instructions to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed strictly.

The lids of acrylic emulsion paint drums shall be kept tightly closed when not in use in order to avoid thick layer formation at top.

iii. Application

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface, which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement paint shall be as per manufacturer's specification. The

The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

The surface shall be treated with three or more coats of waterproof acrylic paint as found necessary to get a uniform shade to the satisfaction EIC.

iv. Precaution

Water proof cement paint shall not be applied on plastered surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

19. Painting with Synthetic Enamel Paint

i. General

Synthetic enamel paint conforming to IS: 1932-1974 of approved brand and manufacturer and of the required colour shall be used for the top coat and undercoat of shade to match the top coat as recommended by the manufacturer shall be used.

ii. Painting on New Surface

Preparation of surface shall be as specified above or as the case may be.

iii. Preparation of Surface

A. Wood Work

The surface shall be cleaned and all unevenness shall be rubbed down smooth with sandpaper and cleaned removed as specified above. Knots if visible, shall be covered with a preparation of red lead mixed with strong glue sized and used to. Holes and indentations on the surface shall be filled in with glazier's putty or wood putty and rubbed smooth before painting is done. The surface should be thoroughly dry before priming coat is applied.

B. Plastered Surface

The surface shall not be painted until it has been dried completely. Before primer is applied, holes, undulations shall be filled up with plaster of paris and rubbed. The primer shall be applied with brushes, worked well into the surface and spread even and smooth.

C. Iron and Steel Work

All surfaces shall be washed with mineral spirits to remove any dirt or grease before applying paint. Where rust or scale is present, it shall be wire brushed and sand papered clean. All cleaned surfaces shall be given one coat of approved phosphate before prime coat in accordance with the manufacturer's instructions. Shop coats of paint

that have become marred shall be cleaned off, wire brushed and spot primed over the affected areas.

D. Galvanized

Galvanized metal shall be thoroughly cleaned with naphtha and treated with a solution consisting of 5 gallons of 36% acetic acid, 1.36 Kg. of blue vitriol and 1.36 Kg. of powdered alum dissolved in 225 liters of water, prepared in a wooden container and applied with a brush. Allow drying thoroughly and brushing off before applying paint.

iv. Application

The number of coats including the undercoat shall be as stipulated in the item.

A. Undercoat

One coat of the specified paint of shade suited to the shade of the topcoat shall, be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

B. Top Coat

The painting of approved brand and manufacturer shall be laid on evenly and smoothly by means of crossing and laying off which consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternately at right angles to the same. The full process of crossing and laying off will constitute one coat. The number of coats as specified in the item shall be applied and the painted surface shall present uniform appearance and finish, free from streaks blisters etc. to the satisfaction of the Engineer-In-Charge.

20. Oil Bound Distemper

i. Materials

Ready mixed paint of approved brand and manufacture and of required shades conforming to IS 428:1969 & other relevant IS specification shall be used. The primer shall be ready mixed cement primer preferably of the same brand and manufacturer. Ready mixed paint as received from manufacturers without any admixture shall be used and if for any reason thinning is necessary the brand of thinner shall be as per manufacturer's instruction.

ii. Preparation of Surface

The surface shall be prepared as specified hereinbefore. Any unevenness including pitting in plaster shall be made good by applying putty, made of plaster of paris mixed with turpentine/oil on the entire dry surface including filling up the undulation and then sand papering after it is dry.

A coat of the paint shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of paint is applied.

iii. Application of Priming Coat

The priming coat shall be applied with cement primer or distemper primer of approved quality depending on the condition of the wall surface as prepared. If the wall is completely dry to receive the priming coat, then distemper primer of same brand & manufacturer of distemper paint as approved, shall only be applied uniformly on the wall with proper brushes. If the wall surface has not dried completely, the priming coats shall be of cement primer of approved brand & manufacturer.

iv. Distemper Coat

After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the paint, taking care not to rub out the priming coat. All loose particles shall be dusted off rubbing. One coat of ready mixed distemper properly diluted with thinner shall be applied with brushes in horizontal strokes followed immediately by vertical ones, which together constitute one coat.

The subsequent coats shall be applied in the same way. Two or more coats of paint are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between consecutive coats to permit of the proper drying of the preceding coat.

15-cm double bristled paintbrushes shall be used. After each day's work, brushes shall be thoroughly washed.

A brush in which paint has dried up shall on no account be used for painting work. The containers when not on use shall be kept closed and free from air so that paint does not thicken and also shall be kept safe from dust.

21. Acrylic Emulsion Paint (Internal application)

The acrylic emulsion paint is not suitable for application on external wood and iron surface and surfaces, which are liable to heavy condensation and are to be used on internal surfaces except wood and steel which are liable for condensation. No priming coat is required for the later.

Acrylic emulsion paint This shall be polyvinyl based Acrylic / plastic emulsion paint of approved manufacture of the required shade conforming to IS 5411-1969.

i. Priming Coat

The primer to be used for the painting with acrylic emulsion on cement concrete surfaces, plastered surfaces, A.C. sheets, timber and metal surfaces, if necessary, shall be of approved base and as per recommendations of the manufacturers.

ii. Preparation of Surface

Plaster filler to be used for filling up (putting) uneven surfaces, small cracks and holes etc. shall be of approved compound and as per recommendations of the manufacturers. No oil-based putty shall be used. The putty should be made from a mixture of whiting and plastic emulsion paint or as per manufacturers recommendations.

iii. Application

The number of coats shall be a two or more coat to give a smooth required finish meeting the approval of the EIC. The paint shall be applied in the usual manner with brush or roller. The paint dried by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the undercoat, which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats shall be applied till the surface presents a uniform appearance with velvety smoothness.

iv. Precautions

Old brushes if they are to be used with emulsion paints, shall be completely dried of turpentine or oil paints by washing in warm soap water.

Brushes shall be quickly washed in water immediately after used and kept immersed in water during break periods to prevent the paint from hardening on the brush.

In the preparation of walls for acrylic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

Splashes on floors, etc. shall be cleaned out without delay, as they will be difficult to remove after hardening.

Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

22. Water Proofing Cement based paint

i. Material

Cement based paint (IS 5410-1969) of approved manufacture, quality, shade and colour only shall be used.

ii. Preparation of surfaces

The surface shall be thoroughly cleaned off all mortar dropping, dirt, dust, algae, grease and other foreign matter by brushing and washing the surfaces. The surface shall be thoroughly wetted with clean water before the water proof cement paint is applied. The Engineer-In-Charge shall be approved the prepared surface before painting is commenced.

The water proof cement paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish.

Water proof cement paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of water proof cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the water proof cement paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain liquid of workable

and uniform consistency. In all cases the manufacturers instruction shall be followed meticulously.

iii. Application

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. To avoid direct heat of the sun during painting, the cement-based paint shall be applied on the surface, which is on the shady side. Cement based paint shall not be applied on the surfaces already treated with white wash, colour wash, dry or oil bound distemper, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

23. Epoxy Painting

i. General

It is the intent of these specifications to protect the steelwork in Basement, super structure and other locations against atmospheric corrosion and other environmental attacks permanently with Epoxy Paint besides providing decorative appearance. These specifications cover the major aspects of the proposed treatment. It shall be the responsibility of the Contractor to ascertain and do everything necessary as recommended by the manufacturers / specialists.

ii. Epoxy Paint for Marking vehicle positions in Basement and as protective, decorative finish to steel members.

iii. Materials

They shall be of two components (Base and Accelerator) and shall be mixed and applied as recommended by the manufacturer. The paint shall be of the shade approved by the EIC.

iv. Primer

Primer coat for steelwork shall be Red Oxide / Zinc Chromate Primer manufactured by the firm whose finishing coat is used. Primer coat for floor making shall be appropriate primer as recommended by the manufacturers.

v. Surface Preparation

The Surface preparation shall be carried out strictly as recommended by the manufacturer. The surfaces shall be thoroughly cleaned of all rust, mill scale, dust, grease, moisture and other matter to ensure proper adhesion

of the paint coating. Compressed air shall be used as necessary and as instructed by the EIC.

vi. Primer Coat

Red Oxide / Zinc Chromate Primer as described above, shall be applied by brush after ensuring that surfaces are prepared as described. All steel members shall be primed immediately after assembly.

vii. Directions for Mixing and Application

Before stating actual painting with Epoxy compositions, the following directions should be followed:

Stir the individual constituents (base and hardener) separately before mixing.

It is absolutely essential that painting of an area be completed within 1 hour after mixing required quantity of base component and hardener.

A fresh mix must be used for every subsequent application.

Mix the base component and hardener together, stir thoroughly wait for 10-15 minutes and then start application.

The mix paint shall be suitable for application by brush, if it is absolutely necessary to thin the paint for brushing or spraying, only appropriate Epoxy thinner should be used. The thinning should be avoided or kept to the minimum and shall be as approved by the EIC.

The mixing ratio of paint to hardener shall be as specified by weight or by volume. Care should be taken that this ratio is strictly adhered to.

A second coat should be applied after 20-24 hours, only after rubbing down the first coat lightly with waterproof sandpaper so as to form a good key for the subsequent coat.

Painting shall not be carried out when the temperature falls below 10°C or relative humidity rises above 90% or during rain, fog or mist.

viii. Finishing Coats

Two finishing coats shall be applied by brush with an interval of minimum 24 hours and not more than 24 hours.

The paint system shall be allowed to be cured for minimum 7 (Seven) days for achieving the desired hardness and chemical resistant.

ix. Cleaning

All rubbish waste or surplus material shall be removed from time to time, and all wood work, hardware, floors, or other adjacent work shall be cleaned up to the satisfaction of the Engineer-In-Charge.

Hardware and other unpainted surfaces shall be cleaned using lacquer thinner or paint remover.

x. Consumption of paint for different Painting items:

Brief Description of painting work	Consumption per 10 sq.m. of net area
Oil Bound distemper on plastered surfaces:	
Cement primer (one coat)	0.91 liters
Two finishing coats	1.60 kg
Three finishing coats	2.40 kg
Flat oil paint to plastered surfaces:	
Cement primer (one coat)	0.91 liters
Cement primer (two coat)	1.82 liters
two finishing coats	1.72 liters
Acrylic Emulsion Paint:	
Cement primer (one coat)	0.91 liters
Two finishing coats	0.87 liters
Three finishing coats	1.30 liters
Cement Paint (New surfaces):	
Two coat on sand faced plastered surface	4.50 kg
Two coats on roughcast plastered surface	8.50 kg
Enamel Paint to wood / steel:	
Wood primer (one coat)	0.90 liters
Steel primer (one coat)	0.75 liters
Two finishing coats on wood	1.40 liters
Two finishing coats on steel	1.35 liters
Flat oil paint to wood / steel work:	
Wood primer (one coat)	0.90 liters
Steel primer (one coat)	0.75 liters
Two finishing coats on wood	1.70 liters

24. CEMENT CONCRETE FLOORING (IPS FLOORING)

Indian patent stone flooring shall be 40mm or of specified thickness and laid in two layers, bottom layer 28mm thick or as specified in 1 part of portland cement, 2 parts of coarse sand and 4 parts of crushed stone aggregate 12mm down well graded machine mixed with not more than 5.5 gallons of water for each bag of cement and top layer 6mm thick in one part of portland cement, 2.5 parts of selected crushed stone chips with just enough sand maximum part to make workable mix, machine mixed with not more than 5 gallons of water. Top layer to be laid before the bottom layer has hardened. Flooring shall be laid in squares or bays as directed and each layers shall be well compacted by ramming with heavy teak wood floats. The top shall be brought to a smooth and even surface free from blemishes and finished smooth with neat cement by steel trowelling. The flooring shall be kept wet for seven days for curing.

Ironite/hardonite topping in the bottom layer shall be 50mm thick and the top layer shall be 12mm thick mixed with ironite/hardonite as per manufacturers specification and finished fair.

25. VACCUM DEWATERED CONCRETING/TREMIX FLOORING

a) Preparation

- i. The surface to receive flooring shall be clean, free from dirt and free from foreign material.
- ii. Any undulations or mortar remaining on the floor shall be trimmed.
- iii. Base course shall be trimmed.
- iv. The base shall be cleaned and watered before laying the floor.
- v. Work includes at all depths and heights.
- vi. The finished surface shall be kept wet for a maximum period of one week.

b) CONCRETING

i. General

- Concreting shall have a concrete base of M20/M25 of specified thick.
- Flooring shall have hard top on the concrete base.
- Flooring shall be laid in strips, the size of which is mentioned on the drawings.

ii. Materials

Cement	-	Portland
Sand	-	River sand
Aggregate	-	Max. size 10 to 20mm
Water	-	Potable

Floor hardener (Optional) - @3kG/Sqm

c) Execution

- a. Mix cement, sand and aggregates as per grade M20 thoroughly with water to get an appropriate consistency.
- b. Prepared concrete shall be laid immediately after mixing.
- c. The base shall be free from water and other foreign materials, dust and dirt.
- d. A coat of cement slurry of the consistency of thick cream shall be brushed on the surface of the base course.
- e. The concrete shall then be spread over this base evenly and leveled carefully.
- f. Low areas shall be filled with concrete and humps removed. Devacumisation shall be done for removing the voids.
- g. The whole concrete surface shall be leveled, compacted by ramming and trowelling.
- h. Prepared surface shall be allowed to set.
- i. Hardner screed
 - Hard top to be prepared as per the specifications with Nito hardner and one part of dry cement.
 - The hard top shall be provided over concrete base immediately after it is set, compacted and leveled with a steel trowel.
 - The surface shall be trowelled to bring the hardener coat to a leveled surface.
 - Excessive trowelling shall be avoided.
 - After the initial set, further compaction shall be done by steel trowelling.
 - Final brushing shall be made before the floor top becomes too hard.

i. CURING

- a. Curing shall commence as soon as the surface is hard enough to receive the water.
- b. The surface shall be covered with sacks or sand and shall be kept continuously wet for a period of at least one week.

26. FALSE ACCESS FLOORING

450 mm Finished Floor Height (FFH)/ 600 mm Finished Floor Height (FFH) removable raised/false access flooring with system and its components of approved make for different plenum height with possible height adjustment upto 50 mm, comprising of modular load bearing floor panels supported on G.I. rectangular stinger frame work and G.I. Pedestal etc. all complete, as

per the architectural drawings, as specified and as directed by Engineer-in-charge consisting of:

(a) Providing at required spacing to form modular framework, pedestals made out of GI tube of thickness minimum 2 mm and 25 mm outer diameter, fully welded on to the G.I. Base plate of size 100mm x 100mm x 3mm at the bottom of the pedestal tube, G.I. pedestal head of size 75mmx75mmx3.5 mm welded with GI fully threaded stud 16mm outer diameter with two GI Check nuts screwed on the stud for level adjustment upto 50mm, locking and stabilizing the pedestal head in position at the required level. The pedestals shall be fixed to the subfloor (base) through base plate using epoxy-based adhesive of approved make or the machine screw with rawlplug.

(b) Stringers system in all steel construction hot dipped galvanized of rectangular size 570x20x30x0.80mm thick having holes at both ends for securing the stringers on to the pedestal head using fully threaded screws ensuring maximum lateral stability in all directions, the grid formed by the pedestal and stringer assembly shall receive the floor panel, this system shall provide adequate solid, rigid support for access floor panel, the system shall provide a minimum clear uninterrupted clearance between the bottom of the floor for electrical conduits and wiring etc. all complete as per the architectural drawings, as specified and as directed by the Engineer-in-charge.

(c) Providing and fixing Access Floor panel of 600x600x32 mm medium grade Filled Steel anti-static high-pressure Lamination of 800H grade (FS800H). Access Floor panel shall be steel welded construction with an enclosed bottom pan with uniform pattern of 64 hemispherical cones. The top and bottom plates of Steel Gauges: top 0.6 mm and bottom 0.7 mm fused spot welded together (minimum 64 welds in each dome and 20 welds along each flange). The panel should be Corroresist epoxy coated for lifetime rust protection and cavity formed by the top and bottom plate is filled with Pyrogrip non-combustible Portland cementitious core mixed with lightweight foaming compound. The access floor shall be factory finished with Anti-static High-Pressure laminate with non-warp technology upto 1mm thickness for superior adhesion and Surface flatness within 0.75mm. The panel is to withstand a Concentrated Load of 363 kgs applied on area 25mm x 25mm without collapse in the centre of the panel which is placed on four steel blocks. The panel will withstand and Uniformly Distributed Load (UDL) minimum 1250 kg/sqm and an impact load of 50kg all complete as per the approved manufacturers specification and as per the direction of Engineer-in-charge. All specification must be printed on the side of the panel to ensure the quality of the product.

27. SUPPLY & INSTALLATION OF PREFABRICATED SANDWICH PUF PANEL (as per below or as per Manufacturer specifications)

a) GENERAL

Supply & Installation of Prefabricated Sandwich Puf Panel for Wall comprising of two sides facing of Colour Coated Galvalume Steel Sheet (PPGL) and sandwiched between them CFC free close cell high Density rigid Polyurethane foam 40 ± 2 Kg/m³ having a thermal conductivity value of 0.023 w/mk. The outer & inner sheet shall be of any shade of color of Galvalume Steel Sheet (PPGL) of 0.5mm TCT steel min.550 Mpa having a coating Mass of min.120 gsm zinc coating total of both sides as per IS : 277 and finished with 20 microns colour coating of SMP polyester quality paint coat over a 5 micron primer on exposed side and back coat of 5 microns on inner side over a 5 microns- primer. The outer and inner sheet have a core of 60mm thick Polyurethane Foam Insulation. The PUF insulation have fire retardant and self-extinguishing properties as per IS 12436. The panels are manufactured according to the required length and in 1180 mm width with tongue and groove arrangement on the sides having hidden fastener jointing arrangement. Prefabricated Puf Panels are fixed to the support structure. The metal sheet conforms to IS: 277 & 14246. The polyurethane insulation conforms to IS: 12436. Make of Galvalume Steel sheet JSW/TATA/ESSAR. Make of Puff panel. Puf panels are to be fixed with necessary L & U channels (galvanized) with necessary fittings etc. complete as per specifications and directions of Engineer-in- charge.

b) SCOPE OF WORK

The above specification includes supplying, providing, fabricating, assembling, and erecting at site Prefabricated Puf Panels in external/ internal walls of where-ever required with necessary G.I. U-channels & L-angles, G.I. flashings match with colour & shade of Puf panels and other necessary supporting/fixing accessories for fixing of walls to the supporting MS structure complete.

c) MATERIALS I (For Walls)

Puf Panel for Wall comprising of two sides facing of Colour Coated Galvalume Steel Sheet (PPGL) and sandwiched between them CFC free close cell high Density Rigid Polyurethane foam $40+2$ Kg/m³ having a thermal conductivity value of 0.023 w/mk. The outer & inner sheet shall be of any shade of color of Galvalume Steel Sheet (PPGL) of 0.5mm TCT and min. 550 MPA strength. Sheet should have coating mass of min. 120 gsm zinc coating on both sides as per IS: 277 and finished with 20 microns colour coating of SMP polyester quality paint coat over a 5-micron primer on exposed side and back coat of 5 microns on inner side over a 5 microns primer. The outer and inner sheet shall have a core of 60 mm thick Polyurethane foam insulation. The PUF insulation shall have fire retardant and self-extinguishing properties as per IS 12436. The panels shall be manufactured according to the required length and in 1180 mm width with tongue and groove arrangement on the sides

having hidden fastener jointing arrangement. Prefabricated Puf Panels are to be fixed to the support structure with all necessary G.I. U-channels & L-angles, G.I. flashings match with colour & shade of Puf panels and other necessary supporting/fixing accessories for fixing of walls to the supporting MS structure complete. The metal sheet shall conform to IS: 277 & 14246. The polyurethane insulation shall conform to IS: 12436. Galvalume (PPGL) sheet shall be of approved makes.

d) MATERIALS II (Wall Partition)

Providing and Fixing Composite factory made continuous prefabricated sandwich Rockwool Panel for Wall/Partition comprising of two sides facing of colour coated galvalume (PPGL) steel sheet with core of high-density non-combustible grade Rockwool Insulation of density 120Kg/m³ and average thickness 100 mm conforming to IS: 8183.

The wall shall be constructed of 100mm thick ROCKWOOL insulated panels having 100+2 Kg/m³ density lined with pre-coated Galvalume sheet both side made by lamella Technology. The top and bottom sheet shall be Micro Ribbed/plain PPGL sheet.

These Panels are factory assembled in continuous manufacturing line into a complete unit to eliminate the necessity of field assembly of units prior to installation. The edges of the panels shall be shaped to provide a continuous engagement for the Full height of the wall / partition and permitting roll formed slip joint with unique Locking arrangement in the shape of tongue and groove individually from each side (Fascia) of the panels. The effective cover width of the panel shall be of 1170 mm and Length of the panels shall be to suit as per site or as per transportable length.

e) MATERIALS II (Roofing)

Providing and Fixing Composite factory made continuous prefabricated sandwich Rockwool Panel for Wall/Partition comprising of two sides facing of colour coated galvalume (PPGL) steel sheet with core of high-density non-combustible grade Rockwool Insulation of density 120Kg/m³ and average thickness 50 mm conforming to IS: 8183.

The Insulated Roofing shall be constructed of 50+30mm thick ROCKWOOL insulated panels having 100+2 Kg/m³ density lined with pre coated Galvalume sheet both side made by lamella Technology.

The top covering on roof panels will trapezoidal Pre-coated galvalume sheet with crest height 30±1mm, crest width 24±1mm and pitch 200±1mm & bottom covering on roof panels shall be micro ribbing Pre-coated galvalume sheet.

f) EXECUTION

Puf Panel shall be got executed by specialized agencies having requisite experience in execution of similar works of similar magnitude as approved by Engineer-in-Charge. The panels should be properly shaped, connected, and aligned to the required profile, i.e. work shall be executed as per drawing prepared by the agency and got approved by the Engineer-in-Charge. In front and rear wall panels shall be fixed as per profile necessary curved shape shall be prepared and properly sealed with necessary joints. Nothing extra shall be paid on this account.

Wherever opening is required it shall be provided with necessary beadings/flashings etc. complete in all respect. If any aluminium frame/ fixtures like sliding door, bolt tower bolt handles are to be provided wherever required.

g) TEST & FREQUENCIES

Material Test:

All the material shall be tested as per relevant IS specification for PPGL sheet and Polyurethane foam insulation shall be tested as per frequency (01 per 1200 sqm) for following physical properties.

- a) Compressive Strength Test.
- b) Tensile Strength test.
- c) Water Vapour Permeability Test.
- d) Bending Strength Test.
- e) Dimension Stability Test (At 100 C for 24 hrs.)
 - a. Change in dimension (%)
- f) Horizontal Burning Characteristic Burning rate (mm/minute)
- g) Apparent Density Test
- h) However, manufacturers test certificate shall be supplied along with each batch material.

28. Tensile Fabric Canopy

Fabricating, assembling and erection of Architectural Tensile Membrane structure in desired profile as per conceptual drawing, with Tensile fabric TYPE II having minimum Tensile strength (Warp/Weft] 4300/4200 N/50 mm & minimum tear strength (Warp/Weft) of 500 / 500 N, with Nano polymered fluorinated lacquer, Multi-composed PVDF-lacquer system on both sides,

antimicrobial, UV-protected, Titanium dioxide (TiO₂) front side primer and the fabric should be weldable without grinding having a minimum weight of 900gm/sqm and tested 100000 times for crack resistance. Burning behaviour BS 7837, California T19, DIN 4102: B1, NFPA 701 Test 2, D.M.26.06.84 (UNI 9177): CL. 2, NFP92507:M2 (Color is blanc), AS1530 part 2, AS 1530 part 3, EN 13501-1: B-s1-d0 with a minimum 20 years warranty of approved colour over steel structure frames (underneath steel structure shall be paid separately).

Roofing system

▪ SECTION - 2: ROOFING SYSTEM

~~I. DOUBLE SKINNED INSULATED STANDING SEAM ZINCALUME ROOFING SYSTEM:~~

~~1.0 ROOFING SYSTEM~~

~~Supply, Fabrication, Erection and installation of on-site single length 0.55mm bmt color coated Standing Seam Flex-Lok profile, double structural architectural insulated zip standing seam steel roofing system; of nominal 300-450mm effective cover width, 61-65mm rib height, three stiffener symmetrically spaced (100mm c/c) parallel to 61-65mm deep rib, fixed to every purlin by means of structural grade Aluminium clip with UPVC thermal pad at the bottom of clip to reduce or eliminate thermal bridging effect. The panel overlapping shall be mechanically field seamed using electric steamer tool achieve increased weather durability and greater resistance to wind uplift. The profile should be capable to take care of flat, curved or tapered shapes to achieve various architectural requirements.~~

~~The steel sheet shall be 0.55 mm bmt (0.60mm TCT) having yield strength 300MPa ($F_y=300\text{Mpa}$), metallic coated with Zinc Aluminium alloy (i.e. 55% Al, 43.4% Zinc, 1.6% Si), AZ150 (min 150 gm/m² total on both side) conforms to IS15961 / AS1397, pre-painted with Super Durable Polyester paint system includes inorganic infrared reflective pigment (High-SRI- "Thermatech technology") of 20µm exterior coat on top surface and 5µm reverse coat on back surface over 5µm primer coat on both surfaces of approved color shade by concern authority. The sheet conforms to general requirement of AS/NZS 2728 type 4 / IS 15965 class 3 durability and BIS registration having the license of Bethlehem International Engineering Corporation (BIEC).~~

~~The sheet shall have brand marking of the manufacturer giving product details on the back of the sheet at every 1 meter c/c for confirming genuinely of the material. Concealed fix cladding shall be fixed using Aluminium clip, fastened with 40µm zinc coated or 25µm zinc tin alloy coated, Hex head, self-drilling screw as per AS 3566-2002 Class 3 fasteners of approved make (Buildex/Roofix or equivalent) as per the requirement considering the profile shape and design load. The fastener size shall be calculated as per the design or manufacturers recommendations. The profile sheet, fastener size etc. shall be approved by the concern authority. The measurement shall be based on finished/covered surface area.~~

~~The insulation shall be minimum 100 mm thickness with minimum density 65 kg/m³ rockwool or 25 kg/m³ glass wool density with thermal conductivity of $K=0.034\text{ W/mk}$ at 20/ 25 degrees Celsius when tested to ASTM C518/ C177. The Thermal U-value of the complete roof built up shall be maximum 0.20W/ m²K & Acoustic Insulation STC value 41 +/- 2 dB as approved by Engineer-In-charge.~~

~~Fire Resilience Non-Combustible A1 Class as per EN13501/As per BS 476 Part 4~~

~~Flame Spread Index (FSI) and Smoke Development Index (SDI) 0 as per UL723~~

~~Health & Safety Non-Carcinogenic Certification Certified by EUCEB~~

~~Water Vapour absorption Less than 0.08% as per ASTM C1104/C1104M, in case of Rockwool~~

~~Water absorption Less than 0.5 kg/m² (Partial Immersion) as per ISO 29767, in case of Rockwool~~

~~Acidity Co-efficient (Mass Ratio: $(\text{SiO}_2 + \text{Al}_2\text{O}_3)/(\text{CaO} + \text{MgO})$) > 1.6, in case of Rockwool.~~

The liner sheet shall be 1015 mm effective cover width, 28.5mm rib height, spaced at 203 mm center with subtle square fluting in the pan. The sheeting material shall be 0.45 mm Base Metal Thickness (BMT), Hi-Strength steel with min. 550 MPa yield strength, metallic hot dip coated with AZ150 Aluminium-zinc alloy (55% Aluminium, 45% Zinc) as per IS 15961.

The color coated sheet shall be oven baked Super Durable Polyester paint system of 20 microns on exposed surface and 5 micron reverse polyester coat on back surface over 5 micron primer coat on both surfaces of approved color. The exposed paint system shall have stable inorganic pigments for better color performance conforming to AS/NZS 2728 type 4 / IS15965 class 3 for the durability having the license of Bethlehem International Engineering Corporation (BIEC) or relevant licensing authority.

The supplier and applicator shall have the necessary ISO 9001:2000, 14001:2004 & OHSAS 18001 certification or relevant certification. The insulation material should conform to ECBC /GRIHA recommendation.

The two sheets shall sandwich with minimum 100 mm thick with minimum density 65 kg/m³ rockwool or 25 kg/m³ glass wool density with thermal conductivity of $K=0.034$ W/mk at 20/ 25 degrees Celsius when tested to ASTM C518/ C177. The Thermal U value of the complete roof built up shall be maximum 0.26W/ m²K & Acoustic Insulation STC value 41 +/- 2 dB. A Vapor barrier of 400 gauge polythene sheet should be provided on either side of the insulation. The entire Double skin system is installed over the structure purlin. The contractor shall prepare the shop drawings based on the drawings supplied by the Engineer-in-charge for approval. The rate shall includes for flashings, sealants and work shall carried out by specialized agency. (The erection / fixing / installation shall be done by specialized agency as approved by AAI.)

The above work shall be carried out by an agency having sufficient experience in concerned work and should ensure a guarantee for any defective installation, material composition and water tightness for a period of 10 years from the date of completion of the said work. Only skilled and experienced persons shall be employed for this purpose.

~~1.1 SPECIFICATIONS:-~~

- (a) The thermal U value of the roof built up shall be minimum of 0.26 W/m²K.
- (b) Acoustic requirement: Sound Transmission class (STC) = 39±3 Impact Insulation (IIC) = 42±3.

~~1.2 STEEL SHEET MATERIAL~~

~~1.2.1 Top Sheet:~~

The top sheet shall be manufactured from Color coated Zinalume having 0.55mm base metal thickness (BMT) with minimum 300MPa Yield Strength coated with hot dip metallic Aluminium-Zinc alloy coating, AZ150 (150 gms/sq.mt total on both sides) confirms to IS 15961 with Super Durable Polyester paint system conforms to IS 15965.

~~1.2.2 Liner Sheet:~~

The liner sheet shall be manufactured from 0.45mm base metal thickness (BMT) with minimum 550 MPa Yield Strength coated with hot dip metallic Aluminium/Zinc alloy coating, AZ150 (150 gms/sq.mt total on both sides) confirms to AS 1397 with Super

Durable Polyester paint system confirming to IS: 15965. The panel shall be of 1015mm effective cover width, 28.5 mm rib height, 203 mm pitch, manufactured out of Hi tensile pre-painted steel Color coated.

1.2.3 ~~Metallic Coating~~

The top and bottom sheet shall have a hot dip metallic Aluminium-Zinc alloy coating of Aluminium (55%) & Zinc (45%) with total mass coating of 150 gms/sq.mt on both sides as AZ150 or equivalent coating as per AS 1397/IS 15961.

1.2.4 ~~Color Coating~~

The color coated sheet shall be oven baked Super Durable Polyester paint system of 20 microns on exposed surface and 5 micron reverse polyester coat on back surface over 5 micron primer coat on both surfaces of approved color. The exposed paint system shall have stable inorganic pigments for better color performance conforming to AS/NZS 2728 type 4 / IS:15965 class 3 for the durability.

1.3 ~~INSULATION~~

The two sheets shall sandwich with minimum 100 mm thick with minimum density 65 kg/m³ rockwool or 25 kg/m³ glass wool density with thermal conductivity of K=0.034 W/mk at 20/ 25 degrees Celsius when tested to ASTM C518/ C177. The Thermal U-value of the complete roof built up shall be maximum 0.26W/ m²K & Acoustic Insulation STC value 41 +/- 2 dB. A Vapor barrier of 400 gauge polythene sheet should be provided on either side of the insulation. The entire Double skin system is installed over the structure purlin.

1.4 ~~Coating Mass~~

The sheet is pre-painted having zinc-aluminium alloy coating total mass of 150 gm/sqm i.e. AZ 150 on both sides as per coil manufacturers test certificate and AS 1397 & IS 15961

~~Specifications for Color Coating~~

a)	Paint coating	÷ Super Durable Polyester Paint System
b)	Thickness of paint	
	i) Top coat	÷ 20 microns
	ii) Bottom coat	÷ 5 microns
c)	Hardness (Pencil) As per AS 2728	÷ HB or Harder
d)	Adhesion (T-bend)	÷ Minimum 5T (no cracking)

	As per AS 2728	
e)	Flexibility (T-Bend) As per AS 2935	÷ Minimum 7T (no cracking)
f)	Resistance to corrosion (Salt spray test as per ASTM B-117)	÷ 1000 hrs at 35 deg. C ± 1 deg. C (Passed)
g)	Scratch resistance As per AS 1580.403.1	÷ For 1500 gms minimum (no scratch)
h)	Resistance to heat at 100 deg. C for 24 hrs	÷ No change in color (Passed)

Specifications for Self-Drilling Fasteners

Self-drilling fasteners would comply as per following specifications:

- a) Resistance to corrosion : Neutral Salt Spray Test for 1000 hrs.
- b) Humidity exposure test : 1000 hrs.

1.5 ACCESSORIES

1.5.1 Self drilling roofing and wall cladding Fasteners

The steel sheet shall be fastened with min. 40 micron zinc coated (hot dipping) or min. 25 micron Zinc Tin alloy coated (mechanically plated with min 8 porosity rating, coating composition should be 20-30% Sn) Hex head, self-drilling screw as per AS 3566; 2002 Class 3 fasteners of approved make (Buildex/ Roofix or equivalent) with EPDM washer on each crest of sheets for connecting with purlin (or as per design) perpendicular to the sheeting and in the centre of the corrugation or rib. The fastener size shall be calculated as per the design requirement.

1.5.2 In-fill strips (foam closures)

The infill strips are manufactured from closed cell polyethylene foam. This material should have uniform compressibility, waterproof, weather resistance, UV resistance, chemical resistance, nontoxic, odorless and environment, friendly to meet installation requirement in accordance with AS 2424 4 3 A & B or equivalent and approved by engineer in-charge.

1.5.3 Sealant

It should be acetic acid free and amine free neutral curing silicone rubber sealant of approved make. It shall be applied at all end laps as per manufacturer's recommendation and approval by engineer in-charge.

~~1.6 ERECTION AND FIXING~~

- ~~(a) The installation shall be done in accordance to the standard practices as specified by the manufacturer and as approved by the concern authority. All sheets and accessories must be stored and finally erected without any damage.~~
- ~~(b) Single length sheet shall be installed from ridge to eave (on site roll forming) or the end laps shall be 200mm (min) with appropriate two silicon strip barrier and fasteners as per manufacturer's recommendations.~~
- ~~(c) The contractor shall also submit methodology for fixing and also a maintenance manual for routine maintenance.~~
- ~~(d) Flashing, capping and trims shall be manufactured from the material in the length as per manufacturer's recommendation. The shape and girths shall be as per design requirement and shall be approved by the concern authority.~~
- ~~(e) The contractor shall ensure that panel erector is familiarized with the erection procedure and all the supporting members are straight, level and true (according to AISC) before starting panel erection, Panels shall be erected according to approved shop drawings by the concern authorities.~~

~~1.7 Testing and Acceptance Criteria~~

~~Materials~~

~~Prior to delivery, manufacturers test certificates shall be supplied for all materials certifying grade and conformity with applicable standards. At owner's discretion on number and frequency, random samples drawn from material at site will be got tested at an independent test house/laboratory approved by the owner. The materials shall be tested for and demonstrate to meet performance criteria and requirements listed elsewhere.~~

~~Load testing~~

~~Test certificates to justify load/span data furnished by manufacturer in accordance with IS-801/AS/BS standards should be submitted. Profiles must exhibit deflection less than L/150 under live load and point load (as per IS 875) and less than L/100 under wind load.~~

~~Performance parameters check for STC and wind uplift has to be done by a third party agency.~~

~~Test Frequency~~

- ~~(a) Minimum one test for 1000 sqm area or part thereof of sheet after random sample for all tests.~~
- ~~(b) Testing of color coated sheet coils shall be carried out at the coil manufacturer lab. As per direction of engineer in charge, contractor has to be carried out the test by any third party lab and the cost of the test shall be borne by the contractor.~~

- (c) ~~The testing of stonewool slab or fiber glass shall be carried out and witnessed at manufacturer's works and type test reports for "non-combustibility", Thermal Conductivity and Noise Reduction Coefficient (NRC) shall be submitted by the contractor for review.~~

~~Warranty period~~

~~The Roofing System shall be guaranteed for **10 years (05 years Guarantee Bond (BG) of value of 5% of total roofing system + 05 years Corporate Guarantee)** by the manufacturer with regards to its performance parameters, material composition, surface properties and Physical Properties, in legal paper as per acceptable format.~~

~~The installation team shall be fully trained and approved by the manufacturer. All installation team must obtain the training certificate from the manufacturer and also certify that the installation team is qualified to install approved roof system. The printed instructions; installation manual shall be strictly adhering to.~~

~~In addition, the manufacturer should employ necessary personal at site to supervise the installation work and shall provide workmanship warranty for any defective installation, water tightness of the system for a period of **10 years (05 years Guarantee Bond (BG) of value of 5% of total roofing system + 05 years Corporate Guarantee)** from the date of completion of the said work, as per special conditions.~~

~~Manufacturer should ensure the performance guarantee of the system by submitting a Guarantee Bond for **5(Five)%** value of total Roofing System work, for a period of **05 years** and **Corporate Guarantee** for further **05 (Five) Years**~~

II. ~~ALUMINIUM INSULATED GUTTER:~~

1. ~~General~~

~~Aluminium insulated gutter of 2mm thickness with built up comprising of cement board, Rockwool insulation, liner and gutter expansion joints @ 12m. It includes necessary down take spout with diameter 160 mm at required intervals & other accessories like Cover plate, end caps, and welding at joints. The Girth of gutter would be up to 2400mm. Dye Penetration test to be conducted wherever Aluminium welding has been done. All complete as per direction of Engineer In Charge.~~

2. ~~Specification~~

~~The complete system shall be planned, designed and installed to cater proper roof drainage, as per the direction of Engineer in charge.~~

~~The specification of the system is as mentioned below:~~

Gutter material	Aluminium Alloy AA 1100/3011
Size	2400mm Girth and 2mm thick
Down take pipe material	HDPE pipe make Supreme/Prince/Finox or approved equivalent make 160mm Dia. Class 3, 6Kg/Sqcm HDPE pipes conforming to IS standard including cost of fittings, clamps, consumables etc. complete as per drawing, specifications and as directed by Engineer in charge.
Expansion Joint	Double side vulcanised rubber with welded Aluminium cover plate. Expansion joints to be installed at every 12m length by welding to Aluminium gutter to effectively compensate expansion & contractions.
Miscellaneous accessories	Cover Plate, end Caps, Brackets for Gutter
Welding	Gutter joints to be welded with Argon welding @1200/1500mm

III. ROOF HATCH SYSTEM:

1. GENERAL

Designing, Supply and Providing & fixing Roof Hatch Single leaf on the standing seam roofing sheet for roof access as approved by Standing Seam Roof manufacturer including supporting equipment such as Ladder/Elevated Works Platform (EWP)/Lifting tool/Scaffolding etc and as per Technical Specifications for this item as detailed in this tender.

The complete system shall be planned, designed and fixed at site to cater access to the roof complete all, as per the direction of Engineer in charge.

2. THE SPECIFICATION OF THE SYSTEM IS AS MENTIONED BELOW:

Leaf	Single Leaf
Opening Size	Minimum 900 mm x 900mm (Clear Opening).
Material	Aluminium Cover & Frame in 2.5 mm thick
Cover	break formed, hollow metal design with 1" (25.4mm) concealed fiberglass insulation, 3" (76mm) beaded,

	overlapping flange, fully welded at corners, and internally reinforced for 40 puff (195 kg/m2) live load.
Curb	Shall be 12" (305mm) in height with integral cap flashing, 1" (25.4mm) fiberboard insulation, fully welded at corners, and 3 1/2" (89mm) mounting flange with 7/16" holes (11mm) provided for securing frame to the roof deck.
Gasket	Extruded EPDM rubber gasket permanently adhered to cover.
Hinge	Heavy duty Pintle Hinge of SS-316.
Latch	Single leaf: Shall have slam latch with interior and exterior turn handles and padlock hasps.
Lift Assistance	Compression spring operators /Hydraulic arm be enclosed in telescopic tubes. Shall have automatic hold open arm/Hydraulic arm with grip handle release.
Performance Ratings	Shall comply with UL 790 Class A (burning brand test).
Hardware	Aluminium engineered composite compression spring tubes.
Finish	aluminium: Mill Finish

3. ~~Warranty period:~~

~~The installation team shall be fully trained and approved by the manufacturer. All installation team must obtain the training certificate from the manufacturer and also certify that the installation team is qualified to install approved roof system. The printed instructions; installation manual shall be strictly adhering to.~~

~~In addition, the Contractor shall employ necessary personal at site to supervise the installation work and shall provide workmanship warranty for any defective installation, water tightness of the system for a period of 10 years.~~

SECTION - 3: FACADE SYSTEM

SEMI-UNITIZED STRUCTURAL GLAZING SYSTEM

1. FAÇADE SYSTEM

Designing, fabricating, supplying, testing, protection, installing and fixing in position semi (grid) unitized system of structural glazing (with open joints) for linear as well as curvilinear portions of the building for all heights and all levels, including:

- a. Structural analysis & design and preparation of shop drawings for the specified design loads conforming to IS 875 part III (the system must passed the proof test at 1.5 times design wind pressure without any failure), including functional design of the aluminium sections for fixing glazing panels of various thicknesses, aluminium cleats, sleeves and splice plates etc. gaskets, screws, toggles, nuts, bolts, clamps etc., structural and weather silicone sealants, flashings, fire stop (barrier)-cum-smoke seals, microwave cured EPDM gaskets for water tightness, pressure equalisation & drainage and protection against fire hazard.
- b. Fabricating and supplying serrated M.S. hot dip galvanised / Aluminium alloy of 6005 T5 brackets of required sizes, sections and profiles etc. to accommodate 3 Dimensional movement for achieving perfect verticality and fixing structural glazing system rigidly to the RCC/ masonry/structural steel framework of building structure using stainless steel anchor fasteners/ bolts, nylon separator to prevent bimetallic contacts with nuts and washers etc. of stainless steel grade 316, of the required capacity and in required numbers.
- c. Providing and filling, two-part pump filled, structural silicone sealant and one part weather silicone sealant compatible with the structural silicone sealant of required bite size in a clean and controlled factory / work shop environment, including double sided spacer tape, setting blocks and backer rod, all of approved grade, brand and manufacture, as per the approved sealant design, within and all around the perimeter for holding glass.
- d. Providing and fixing in position flashings of solid aluminium sheet 1 mm thick and of sizes, shapes and profiles, as required as per the site conditions, to seal the gap between the building structure and all its interfaces with curtain glazing to make it watertight.
- e. Making provision for drainage of moisture/ water that enters the curtain glazing system to make it watertight, by incorporating principles of pressure equalization, providing suitable gutter profiles at bottom (if required), making necessary holes of required sizes and of required numbers etc. complete. This item includes cost of all inputs of designing, labour for fabricating and installation of aluminium grid, installation of glazed units, T&P, scaffolding and other incidental charges including wastages etc., enabling temporary structures and services, cranes or cradles etc. as described above and as specified.

- f. Providing, assembling, supplying & Fixing of vision glass panels (IGUs) comprising of hermetically-sealed 6-12- 6 mm insulated glass (double glazed) vision panel units of size and shape as required and specified, comprising of an outer heat strengthened float glass 6 mm thick, of approved colour and shade with reflective soft coating on surface # 2 of approved colour and shade, an inner Heat strengthened clear float glass 6 mm thick, spacer tube 12 mm wide, dessicants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances, as per the Architectural drawings, as per the approved shop drawings, as specified and as directed by the Engineer-in-Charge. The IGUs shall be assembled in the factory/ workshop of the glass processor.

The item includes the cost of getting all the structural and functional design including shop drawings checked by a structural designer, dully approved by Engineer-in-charge. The item also includes the cost of all mock ups at site, cost of all samples of the individual components for testing in an approved laboratory, field tests on the assembled working structural glazing as specified, cleaning and protection till the handing over of the building for occupation. In the end, the Contractor shall provide a water tight structural glazing having all the performance characteristics etc. all complete as required, as per the Architectural drawings, as per item description, as specified, as per the approved shop drawings and as directed by the Engineer- in-Charge.

2. MATERIAL

2.1. Metals & accessories

Component	Material & Grade
Aluminium Extrusion	<ul style="list-style-type: none"> Grades 6063-T5, 6063-T6, similar or stronger
Aluminium Brackets	<ul style="list-style-type: none"> Grades 6061-T6 or approved equivalent
Sheet, strip and plate	<ul style="list-style-type: none"> Sheet Grade: 3003 or 5005/5052 Not less than 1mm thick GI for hidden flashings. Not less than 3mm thick for components exposed to view or to impact.
Aluminium Coating	<ul style="list-style-type: none"> Super Durable Exterior Grade Powder Coating- DFT Nominal thickness of 70 microns, (Min. 60 micron at any coated surface & not exceeding 120 micron) as per AAMA 2604 Standards. PVDF Coating Min. DFT 45 microns as per AAMA 2605 standards.
Steel Finish	<ul style="list-style-type: none"> Hot Dip Galvanizing- Zinc silicate film thickness of 100 microns. Low VOC Anti-corrosive protective Coating Total Dry Film Thickness-250 Microns (C4 Environment)

Component	Material & Grade
	<ul style="list-style-type: none"> Primer- High solid, zinc phosphate polyamine epoxy primer of approved brand, shade & quality of 75 microns, and volatile organic compound less than 250 gms/litre. Intermediate: Epoxy 125microns. Finish: High solid acrylic aliphatic polyurethane glossy finish coat of approved brand, shade and quality with minimum dry film thickness (DFT) of 50 microns (for visible locations only) and volatile organic compound less than 250 gms/litre.
Anchor Bolts	<ul style="list-style-type: none"> Stainless steel 316 for visible or non-visible areas (same applicable for all cladding systems).
Screws & Bolts	<ul style="list-style-type: none"> Stainless steel grade 316 (for both visible and non-visible)
Sealants	<ul style="list-style-type: none"> Non-Staining Silicone Sealant
Setting Block	<ul style="list-style-type: none"> Shore A durometer hardness: 85 +/- 5 when tested in accordance with ASTM D2240.
Fire & Smoke Seal	<ul style="list-style-type: none"> Mineral wool fiber insulation-min Density 64 kg/m³ Fire & smoke seal acrylic spray/ tray must be continuous at bracket locations.
Stainless steel Elements	<ul style="list-style-type: none"> Grade 316– matt finished

2.2. Glass

Coloured tinted float glass 6 mm thick substrate with reflective soft coating on face # 2, + 12 mm Airgap + 6 mm Heat Strengthened clear Glass of approved make having properties as visible Light transmittance (VLT) of 25 to 35 %, Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) and U value of 3.0 to 3.3 W/m² degree K etc. The properties of performance glass shall be decided by technical sanctioning authority as per the site requirement.

3. TESTING

3.1. Site tests:

Following site tests shall be conducted:

Facade Items to be Tested	Type of Tests	Frequency & Samples
Post Fixed Anchors/Cast in Plates	Pull out test for Proof load factor of 1.5 on Service load anchors.	Min 10% of Installed Anchors shall be tested.
Site Weld Test	Visual Check Die penetration test Magnetic particle test Ultrasonic Examination	<ul style="list-style-type: none"> 1st test Upon Mock-up Approval & Subsequent test should be Periodic. Minimum 25% of connection should be covered.

Facade Items to be Tested	Type of Tests	Frequency & Samples
Typical and Non-Typical Curtain wall & Interfaces	Site Water testing- Testing method to be as per AAMA standard with Monarch Nozzle with standard pressure gauges. The Contractor shall carry out rectification in case of any leakage.	<ul style="list-style-type: none"> 1st test for Typical façades to be tested for field water test upon completion of 1000 sqm façade area or 10% of glazing area whichever is less. Subsequent water test shall be upon progressive work. One test for every 3000 Sqm of façade area or part thereof. Area of testing shall not be less than 100 sqm per test

3.2. Laboratory Tests:

Following laboratory tests shall be conducted:

Material	Parameter	Samples & Frequency of Testing
Aluminium Extrusion	<ul style="list-style-type: none"> Chemical Test- Wet and Spectrograph (per every 5000 Sqm of façade) Mechanical Test- Tensile Proof Stress tests 	<ul style="list-style-type: none"> 3 nos of samples per testing 100 tons / 5000 Sqm of façade
Gasket	<ul style="list-style-type: none"> Shore Hardness Chemical Test 	<ul style="list-style-type: none"> 1 sample per each type of Gasket.
Glass Fittings & Hardware.	<ul style="list-style-type: none"> Mechanical Properties Chemical Properties 	<ul style="list-style-type: none"> 3 no's of Samples shall be for each type of test. Test certificate / MTC which shall be carried out within last one year is acceptable
Glass	<ul style="list-style-type: none"> Glass Performance- Photometric Properties 	<ul style="list-style-type: none"> 2 Samples of Each type of performance glazing / IGUs/DGUs. 2 samples for minimum 2000 Sqm area of façade and one sample for every subsequent 2000 Sqm of façade area.

3.3. Performance tests:

Performance Testing of Structural glazing system Tests to be conducted in the NABL accredited lab or by any other accreditation body which operates in accordance with ISO / IEC 17011 and accredits labs as per ISO/ IEC 17025.

Following are the performance tests to be considered for the glazing system, performance test methods are reviewed and the test witnessed by the Façade consultant. Following tests should be carried out at least once for glazing works:

- i. Performance Laboratory Test for Air Leakage Test (-50 Pa to – 300 Pa) & (+50 Pa to +300 Pa) as per ASTM E-283-04 testing method for a range of testing limit 1 to 200 mVhr
- ii. Static Water Penetration Test. (50 Pa to 1500 Pa) as per ASTM E- 331-09 testing method for a range up to 2000 ml.
- iii. Dynamic Water Penetration (50 Pa to 1500 Pa) as per AAMA 501.01- 05 testing method for a range upto 2000 ml
- iv. Structural Performance Deflection and deformation by static air pressure test (1.5 times design wind pressure without any failure) as per ASTM E-330-10 testing method for a range upto 50 mm
- v. Seismic Movement Test (upto 30 mm) as per AAMA 501.4- 09 testing method for Qualitative test, Tests to be conducted on site.
- vi. Onsite Test for Water Leakage for a pressure range 50 KPa to 240 KPa (35psi) upto 2000 ml.

4. Cleaning and Maintenance access

Facade consultant shall take into account that all facade areas are accessible and provide appropriate access for cleaning & maintenance from inside and outside. Glass handling for replacement at any locations to be demonstrated.

5. Independent Checking of Façade System:

In addition to the specialized facade consultant engaged by the EPC contractor, AAI shall engage an independent facade consultant (IFC) having relevant experiences on Airport facades design and construction. The scope of work and role of IFC engaged by AAI are detailed below:

5.1. Structural Design:

Façade interface details like end closures, roof interfaces, skylight interfaces to be finalized and recommended by the independent façade consultant (IFC) during the design stage.

- i) Flashings, vents and weep holes to be provided to maintain pressure equalization principles and to prevent collection or ponding of water in cavities.
- ii) The effects of differential movement to be considered as the development of details.
- iii) All glazing terminations / interfaces (horizontal, vertical, sloped) to be sealed with appropriate flashing (internal and external) and weather sealant.

5.2. Glazing works:

- Structural design of aluminum extrusions to comply with requirements of IS: 8147.
- Sufficient wall thickness for extrusion to avoid warping and twisting of profiles.
- Setting blocks to be placed at correct position & follow good practice of glazing.
- All materials to comply with respective quality standards.

5.3. Allowances for movement joints- Steel/Concrete to facade:

Following are the building movements that any type of façade system and associated works shall accommodate:

- Temperature movement.
- Vertical / floor movement.
- Concrete shrinkage and creep.
- Main steel structural deflection for longer span.
- Seismic movement as applicable.

5.4. Design Calculations

Supporting design calculations, shop drawings, samples and material should be recommended by Independent Façade Consultant (IFC).

EPC contractor shall provide all assistance to IFC engaged by AAI.

6. Design Life and Durability:

The Works shall be appropriate & adequate for its intended purpose. The Works shall be designed, fabricated and installed to achieve the specified levels of performance throughout the design life in this section, under the general exposure conditions set out in the appendix to BS 7543, subject to any special conditions in this specification:

The Works shall be designed, supplied, installed and warranted by the Contractor to comply with the requirements of this section.

The Facade is to perform satisfactorily for the following Design Life:

The expected life of products used in the Facade shall be confirmed by providing the following information

- i. the economic life of the product/material in the environment in which it shall be used (this is not a warranty or guarantee);
- ii. requisite maintenance procedures which must be followed in order to achieve the economic life of the product/material;
- iii. an assurance from the supplier/manufacture that the product is suitable for its intended application;
- iv. relevant product data including names of supplier and manufacturers.

During construction, the Engineer-In-Charge shall have the absolute right to have any deficient products or materials rectified or replaced at the Contractor's expense in order to achieve the expected life as stated in these documents. The Contractor will under no circumstance enter into a claim or variation for correction of a product or installation by virtue of the product or material being unfit for its intended purpose.

All materials which are exposed to sunlight, including materials exposed through glass, shall not be affected due to exposure to heat or ultraviolet radiation such that the material can no longer perform as intended, for the aforementioned period.

Structural: Provide systems that have been tested in accordance with ASTM E330 at a design pressure as per IS 875-Part 3 and have been certified to be without permanent deformation or failures of structural members.

7. Warranty:

Submit written Guarantee agreeing to repair or replace defective materials and workmanship during the guarantee and defects liability period. Defective materials and workmanship include, and is not limited to the following

- Abnormal deterioration
- Aging or weathering of the work
- Water leakage
- Air leakages exceeding specified limits.
- Structural failure of components resulting from exposure to pressures and forces up to specified limits
- Failure of operating parts to function normally
- Deterioration or discoloration of finishes in excess of normal weathering and aging.
- Glass breakage, secondary glass damage or breakage due to falling glass fragments, deterioration of glass reflective coating.
- Scratching denting other type of surface damage to the composite Aluminium panels.
- Silicone sealant failure to the work to fulfill other specified performance requirements
- Super Durable Powder Coating finish on Aluminium works.
- The Guarantee does not include damage caused by vandalism or natural condition exceeding the performance requirements. This Guarantee and its enforcement shall not deprive the Employer/Architect of other action, Right or remedy available to him.

Following are the requirements of warranty -

- Contractor has to submit a written warranty for failures of any façade element includes but are not limited to structural, weather performance, durability and finishes.
- Suppliers of the glass, Façade panel systems and sealants will be required to supply warranties direct to the client for supply and installation for 10 years after the end of defects liability period.
- Glass supplier to provide specific warranty against Toughened glass NiS breakages for 5 years and provide free replacement against NiS breakages during the warranty.
- The Glass supplier / processor shall require to provide warranty of minimum 5 years for any type of glass lamination, high performance coating of glass, DGUs, etc.
- The system warranty shall include all materials and workmanship.
- The general Guarantee for the systems and for the performance of the materials used in the systems shall be provided for a period of ten (10) years

after the date of final acceptance / virtual completion of the project. This Guarantee shall include the following special Guarantee from the manufacturer /suppliers also.

- The Guarantee period for peeling or deterioration of glass reflective coating shall be for ten (10) year period after the date of final acceptance / virtual completion of the project.
- The Guarantee for Aluminium composite panel shall be provided for a period of 15 years after the date of final acceptance / virtual completion of the project.
- The Guarantee period of sealant shall be 15 (fifteen) years after the date of final acceptance /virtual completion of the project.

SECTION - 4: LANDSCAPE & HORTICULTURE WORKS

SPECIFICATION FOR LANDSCAPE & HORTICULTURE WORKS

1. The work will be carried out as per CPWD DSR, DAR & specifications (Horticulture and landscaping) 2020 with upto date correction slips.
2. All liabilities of the labour is the responsibility of the contractor and not that of AAI.
3. The trees/ shrubs to be planted as per the details in layout plan to be prepared by EPC contractor and with approval of Engineer in-charge.
4. At least 300 mm thick good earth will be provided by the contractor for landscape area and 6mm cow dung manure.
5. Provision of pump house with irrigation system for lawn area and planters etc. the maximum distance of the hydrant of 20mm size will be 25 meters.
6. Path in green area will be chequered tiles path or as per direction of landscape architect.
7. The contractor shall arrange his own T&P required for development.
8. Tree / shrubs / creeper / hedge plant will be approved by the Engineer-in- charge.
9. The City side landscape area will be 1850 sqm+/- 20% as per sole discretion of EIC.
10. The payment of all operations is inclusive in this contract.
11. Trenching in ordinary soil up-to a depth of 30cm including removal and stacking of serviceable materials and then disposing of by spreading and neatly levelling with in a lead of 50m and making up the trenched area to proper levels by filling with earth or earth mixed with sludge or/and manure before and after flooding trench with water.
12. Supplying and stacking of good earth at site including royalty and carriage upto all leads and lifts.
13. Supplying and stacking of cow dung at site including royalty and carriage upto all leads and lifts.
14. Fine dressing the ground to levels specified.
15. Mixing earth and sludge or manure in proportion 2:1 and to be laid in required thickness.
16. Spreading of cow dung manure or / and good earth in required thickness.
17. Grassing with 'doob' grass including watering and maintenance of the lawn till the grass forms a thick lawn, free from weeds and fit for mowing including supplying good earth if needed. Grass to be planted in rows 5cm apart in either direction
18. Preparation of beds for hedging and shrubs by excavating 60cm deep and trenching the excavated base to a further depth of 30cm, refilling the excavated earth after breaking clods and mixing with cow dung manure in the ratio of 8:1 (8 part of stacked volume of earth after reduction by 20%: 1 part of stacked volume of cow dung manure after reduction by 8%) flooding with water, filling with earth – if necessary, watering and finally dressing, levelling etc. including stacking and disposal of materials declared unserviceable and surplus earth by spreading and levelling as directed within a lead of 50m, lift upto 1.5m complete.
19. Digging holes in ordinary soil and refilling the same with the excavated earth mixed with manure or sludge in the ratio 2:1 by volume (2 part of stacked volume of earth after reduction by 20%: 1 part of stacked volume of cow dung manure after reduction by 8%) flooding with water, dressing including removal of rubbish and surplus earth, if any with all leads and lifts (cost of manure, sludge of extra good earth, if needed is to be provided without any extra cost).
(i) Holes 0.90m dia. and 0.90m deep. (ii) Holes 60cm dia. and 60cm deep.
20. Supplying best quality grown healthy trees in pots of 90-120cm height, of species as specified. All trees to be approved before planting.

21. Supplying best quality, pots grown healthy climber plants with minimum 90cm stem length of species specified, inclusive of preparation and cultivation. All plants to be approved before planting by AAI (Hort.).
22. Supplying best quality, pots grown healthy shrubs plants with minimum 60cm tail of species specified, inclusive of preparation and cultivation of shrubs beds as specified. All plants to be approved before planting by AAI (Hort.).
23. Supplying and applying chemical emulsion of approved quality in sealed containers for termites 50ml. per sqm. including delivery as specified.

GENERAL SCOPE

24. All plant material shall be healthy, sound, vigorous, free from plant diseases, insects /pests or their eggs and shall have healthy, well developed root systems. All plants shall be hard under climatic conditions, similar to those in the locality of the project. Plants supplied shall conform to the names listed on both the plan and plant list. No plan material will be accepted if branches are damaged or broken. All materials must be protected from the sun and weather until planted.
All nursery stock shall be inspected and approved by the Director (Hort.), Director Landscape Architect / Engineer-in-charge.
All plants shall conform to the requirements specified in the plant list, except those plants larger than specified may be used, if approved but use of such plants shall not increase the contract price.
If the use of such large plant is approved, the spread of roots or ball of earth shall be increased in proportion to the size of the plant. Plants to be delivered with legible identification labels.
25. Top soil (Good earth PH range from 6.5 to 7.5): Top soil or good earth shall be a friable loam typical. It shall be free of subsoil, stones, earth clods, sticks, roots or other objectionable extraneous matter of debris. It shall contain no toxic material. No topsoil shall be delivered in a muddy condition. The PH value of the soil in between 6.5 to 7.5).
26. Fertilizer: Dry farm yard manure shall be used. Measurement shall be in stacks, with 8% reduction for payment. It shall be free from extraneous matter, harmful bacteria, insects or chemicals.
27. Root System: The root system shall be conducive to successful transplantation. Where necessary, the root-ball shall be preserved by support with Hessian or other suitable material. On soils where retention of a good ball is not possible, the roots should be suitable/ protected in some other way which should not cause any damage to roots.
28. Marking: Each specimen of tree or shrub, or each bundle, shall be legibly labelled with particulars.
29. Tree Planting: Trees should be supplied with adequate protection as approved. After delivery, if planting is not to be carried out immediately, Balled plants should be placed check to check and the ball covered with sand to prevent dying out. Bare rooted plants can be heeled in, by placing the roots in a prepared trench and covering them with the earth which should be watered in, to avoid air packets around the roots.
30. Planting: No tree pits shall be dug until final tree positions have been pegged out for approval. Care shall be taken that the plant sapling when planted is not buried deeper than in the nursery, or in the pot/polythene bag. Planting should not be carried out in water logged soil.
Plants / trees at the original soil depth, the soil marks on the stem is an indication of this, and it should be maintained on the finished level allowing for setting on the soil after planting. All plastic and other imperishable containers should be removed before planting. Any broken or damaged roots should be cut back to sound growth.

All shrubs which are supplied pot grown shall be well soaked prior to planting. Watering in and subsequent frequent watering of summer planted container- grown plants is essential

31. In the absence of rain, in the Monsoon, Landscape area shall be watered with sprinklers every three days, soaking the soil thorough to a depth of at least 20cm. Damage, failure or dying back of grass due to heat etc. shall be the responsibility of the contractor.
32. The contractor has to exercise care in the use of rotary cultivator and mowing machines to reduce to a minimum, hazards of flying stones and brickbats. All rotary mowing machines are to be fitted with safety guards.
33. Nursery Stock:
Planting should be carried out as soon as possible after the plant material has arrived at the site. Where planting is delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be heeled-in, as soon as received or otherwise protected from drying out, and others set closely together and protected from the wind and frost. If planting is to be delayed for more than a week, packaged plants should be unpacked, the bundles opened up and each group of plants separately and clearly labelled. If for any reason, the surface of the roots becomes dry, the roots should be thoroughly soaked before planting.
34. A 'No Claim Certificate' in the prescribed form or a list of claims not included in the final bill with full details.
The Engineer-in-charge shall examine and certify the final bill for payment after satisfying that the works have been satisfactorily completed and that all properties, works and things removed or disturbed or damaged in consequence of the works, have been properly replaced and made good, and all expenses and demands incurred or made by one company or in respect of any damage or loss by/from or consequences of the works have been satisfied, all materials have been returned and the site cleared.



Appendix-‘XXX-B’

SPECIFICATIONS & LIST OF PREFERRED MAKES FOR E&M WORKS



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Package	Description
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B	SPECIFICATIONS OF POWER SUPPLY (SUB-STATION EQUIPMENTS) & UPS SYSTEM
C	SPECIFICATIONS OF FOR LPS
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E	SPECIFICATIONS OF FIRE PROTECTION SYSTEM
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G	SPECIFICATIONS OF SIGNAGES
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L	SPECIFICATIONS OF BHS SYSTEM
M	LIST OF PREFERRED MAKES



PACKAGE –A

SPECIFICATIONS OF

INTERNAL & EXTERNAL EI



I - GENERAL- EI works

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to the installation. Electrical work in general shall be carried out as per following CPWD Specifications amended upto date.

General Specifications for Electrical Works.

Part -I : Internal Work - 2013

Part -II : External Work - 1994

Wherever this specifications calls for a higher standard of material and or workmanship than those required by any of the above mentioned regulations and specification then the specification here under shall take precedence over the said regulations and standards.

1.0 GENERAL INSTRUCTIONS

1.1 The Contractor shall include whole of the new material in accordance with the Particular Specifications for supply & fixing accessories for the complete installation. This shall also include any materials, appliances, equipment not specifically mentioned herein or noted on the drawings as being furnished or installed but which are necessary and customary to make the installation complete in all respects. In general the work to be performed under this contract shall comprise supply, installation, testing and commissioning of the following as per scope of work of EPC.

- All conduit work shall include for junction boxes, outlet boxes, swapping and drawing fish wires etc. as required and directed.
- Light control switches, LED Fixture plug sockets, cover plates, metal boxes etc. shall include under the wiring accessories. Back boxes required for the control switches shall also form part of the scope of work.
- HT and LT Cables for power to equipment(s), sub-main panel boards and final distribution boards (DB's).
- Lighting Fixtures, ceiling / exhaust fans, etc.
- DB type panel, feeder pillar etc.
- External Lighting with High masts as per design in CAR park (02 nos) complete as required.
- Earthing & loop earthing.
- Any other items, which are required for successful completion & put into operation of the EI system.



- 1.2 The Scope of work covered in this tender is for proposed Airport as per layout plan enclosed. The contractor has to co-ordinate with the other agencies/ sub-agencies for proper co-ordination and execution of the work at site.

2.0 QUALITY OF WORK

The work shall be carried out to the satisfaction of the Engineer-in-charge. The supply, Installation testing and commissioning shall comply with the latest requirements of Bureau of India Standard and code of practice as amended upto date. All equipment and material being supplied shall meet the requirements of IS, Indian Electricity Rules, Local Electrical Inspectorate and other governmental statutory bodies.

3.0 FEES, PERMITS AND TESTS

The Contractor shall obtain and pay for any and all fees and permits required for the installation of this work. Fee paid / deposited with local Authorities will be reimbursed on production of cash receipt in original. On completion of the work the contractor shall obtain and deliver to the owner certificates of final inspection and approval by the local electricity authority.

4.0 SPECIFICATIONS & DRAWINGS

4.1 Specifications

As described in subsequent paras.

4.2 Shop drawings

The Contractor shall prepare and submit shop drawings scale not less than 1:100 to the Engineer In charge for approval. The detailed shop drawing shall include all Schematics, Load distribution and balancing, Cable routing and Schedule, all lighting, UPS, signages, network/ telephone and power layout, conduit layout, Control wiring / logics, SLD of distribution boards(DBs), switch boards, special pull boxes, raceway & junction boxes layout, earthing etc. and any other items provided by the contractor.

4.3 Completion drawings

On the completion of the work and before issuance of certificate of virtual completion, the Contractor shall submit a soft copy of as built drawings in a CD with soft media after incorporating changes done during execution. These drawings should necessarily show the following details:



A Complete conduiting and wiring diagram including control circuits as installed from starting point i.e. power supply panel / telephone / network panel to last receiving end i.e. power / light / telephone/ network point and schematic drawings showing all connections, control logic (wherever applicable), Junction box, DBs, Raceway, Electrical switch gears, accessories etc. in the complete electrical system.

- Location of all earthing stations, routes and size of all earthing conductors, manholes etc.
- Layout and particulars of all cables.
- Instruction, maintenance and operation manuals if any for the equipment.
- Data Sheets / Equipment name plate details.
- Details of Inventory
- Detailed system specification.
- Test Certificates (Factory Tests, site Test)
- Guarantee / Warranty Certificates (where applicable)
- Keys, operating handles, tools etc as applicable.

5.0 MATERIALS AND EQUIPMENT

All materials and equipment shall be of the one of the preferred make listed in “List of Preferred Make “enclosed with this document and design. Unless otherwise called for only the best quality materials and equipment shall be used. The materials and equipment shall conform to relevant IS as listed under the sub-head 'Regulations and Standards'. The contractor shall be responsible for the safe custody of all materials. The materials shall be insured against theft or damage in handling or storage etc. All changes and substitutions shall be requested in writing and approvals obtained in writing from the Engineer In-charge shall be maintained. For common electrical items used in different packages, preferred makes for detailed under electrical package shall be applicable for other packages also.

6.0 TOOLS AND TACKLES

The contractor shall provide and install all necessary hoists, ladders, scaffolding, tools, tackles, plants, transport for labour and materials and plant necessary for the proper execution and completion of the work to the satisfaction of the Engineer In-charge.

7.0 SAFETY PROCEDURES

The policy is to clearly define responsibilities and then to obtain the commitment of all contractors to maintain a high safety standards compatible with the policy. Safe methods of working shall be the main consideration in all operations. Contractors shall provide the Engineer In-charge with details of their methods statement of work, highlighting the safety aspects and they shall update this information as necessary.



It is the responsibility of all persons employed on this project to act responsibly to prevent accidents to themselves and others. The contract shall be governed by the Latest National Safety Rules and Regulations as stipulated from time to time and the contractor shall provide as mentioned herein, wherever required for the safety of working manpower: -

- Providing safe plant, tools, equipment etc. wherever required and working conditions
- Ensure and establish safe working procedures.
- Provide suitable protective equipment, clothing, gloves, ear muffs, goggles, safety belts, Helmets, Aluminium ladders, Steel scaffolding etc.
- Provide adequate job training.
- Provide fire extinguishers and First aid box with adequate medical supplies.
- SOP with emergency contact details etc. for clarity towards action to be taken by various persons, in case of accident / mis-happening.
- Report accidents and dangerous occurrences if any, to the Engineer In-charge with copies of relevant documents.
- Ensure that hazardous materials, if necessary on site, will be stored and used in the safe manner.
- The Contractor shall co-operate with AAI in creating and maintaining a high standard of safety, health and welfare.
- No claim from the contractor for loss of or damage to equipment, materials, crew of the works during the course of the work due to natural causes like cyclones, gales, floods, rains or other cause or combination of causes will be entertained by AAI. The contractor shall be fully liable to compensate AAI for any loss or damage to works till the time of taking over of the work by AAI. A Safety Officer is mandatory for the execution of this project.
- The contractor shall insure the complete installations against any theft or damage. The contractor shall also insure all the labour against any accidents / mis-happening at site.

8.0 COMPLETION

On completion of the Electrical Installation the Contractor shall furnish a certificate signed by the licensed supervisor and Contractor's Engineer, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local Power Supply Distribution Authorities concerned.

9.0 TESTING

- 9.1 On the completion of the work, the entire installation shall be subject to the following tests in the presence of the Engineer-in-charge:



- Insulation resistance test.
- Polarity test of switch.
- Wiring Continuity test
- Earth continuity test.
- Earth electrode resistance test.
- Test as per Appendix 'E' of IS:732-1989
- Tests as per relevant CPWD specifications.

9.2 Besides the above and any other test specified by the Local Statutory Authority/Supply Company shall also be carried out. Approved testing laboratories shall calibrate all testing instruments and the Contractor shall produce the test certificates thus obtained on demand to Engineer-in-charge for his inspection and record.

9.3 For any tests as directed by the Engineer-in-Charge, that have to be carried out at an outside laboratory, the cost of such tests, materials transport etc., shall be borne by the Contractor.

10.0 DEMONSTRATION TO AAI

On completion of the Installations work, all devices shall be operated in presence of Engineer In-Charge or his representative to satisfy operation of the complete system.

11.0 MANUFACTURER'S INSTRUCTION

Where manufacturers have furnished specific instructions relating to the material used in the job and points that are not specifically mentioned in this document, manufacturer's instruction shall be followed.



II - POINTS & SUB-MAINS WIRING / CABLING

1.0 SCOPE

This section covers the general technical requirements and scope of works of the various components in Internal Electrical Installation Works.

2.0 TERMINOLOGY

The definition of terms shall be accordance with IS 732: 1989 (Indian Standard Code of Practice for Electrical Wiring and CPWD Specifications of Internal EI – 2013 with up to-date amendments.

3.0 POINT WIRING

3.1 Definition:

A point (other than socket outlet point) shall include all works necessary in complete wiring to the following outlets from the controlling switch or MCB. The scope of wiring for a point shall, however, includes the wiring work necessary in tapping from another point in the same distribution circuit: -

- a) Ceiling rose or connector (in the case of points for ceiling/ exhaust fan points, pre-wired light fittings and call bells)
- b) Ceiling rose (in case of pendants except stiff pendants)
- c) Back plate (in the case of stiff pendants)
- d) Lamp holder (in the case of gooseneck type wall brackets, batten holders and fittings which are not pre-wired.

3.2 In the case of call bell points, the words “from the controlling switch or MCB” shall be read as “from the ceiling rose meant for connection to bell push”.

3.3 Scope

i) Following shall be deemed to be included in point wiring:

- a) Conduit, accessories for the conduit and wiring cables between the switch box and point outlet, loop protective earthing of each fan/ light fixture i/c loose wire in switch board & points for connection.
- b) All fixing accessories such as clips, nails, screws, Phil plug, rawl plug etc. as required.



- c) Metal GI switch boxes for control switches, regulators, sockets etc. recessed or surface type and outer & inner cover plates of modular type switches. Boxes, plates and switch/ socket shall be of same make.
 - d) Outlet boxes, junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with switchboards for loose wires/ conduit terminations.
 - e) Control switch as required.
 - f) Ceiling rose or connector as required/ flexible conduit for connecting the wires to fitting.
 - g) Connections to ceiling rose, connector, lamp holder, switch etc.
 - h) Interconnection wiring between points on the same circuit, in the same switch box or from another.
 - i) Bushed conduit or porcelain tubing where wiring cables pass through wall including repairing etc.
 - j) Note: In areas where false ceiling is provided, termination of wires should be at the fittings. Flexible conduits from ceiling junction box to the fittings shall be provided duly coupled at both ends. This shall be included within the scope of point wiring.
- ii) Following shall be deemed to be included in group control point wiring :
- Conduit, accessories for the conduit and wiring cables between the Switchboard/ MCBDB to the first point or wiring cable between points forming a group including loop protective earthing of each fan/ light fixture.
- All fixing accessories such as clips, nails, screws, Phil plug, rawl plug etc. as required.
- Junction boxes, pull-through boxes etc. for loose wires/ conduit terminations.
- Connector as required.
- Connections to connector & Switch/ MCB etc.
- Bushed conduit or porcelain tubing where wiring cables pass through wall etc.



4.0 CIRCUIT AND SUB-MAIN WIRING

4.1 Circuit Wiring

Circuit wiring shall mean the wiring from the distribution board to the first tapping point inside the switchbox, from where point wiring starts.

4.2 Sub-main Wiring

Sub-main wiring shall mean the wiring from one Main/Distribution switchboard to another.

5.0 SYSTEM OF DISTRIBUTION AND WIRING

- Each main distribution board and branch distribution board shall be controlled or provided with miniature circuit breaker (MCB) of specified rating on the phase or live conductor or combined phase and neutral control gear for incoming and outgoing as per system design required.
- Generally, no switchboard will have more than one source of incoming supply.
- Distribution of sub-main and circuits.- As per system design required for light, power and UPS load of light & power. DB should be separate for light, power and UPS.

5.1 Balancing of Circuits

The balancing of circuits in three wire or poly phase installations shall be done before handing over to the satisfaction of the Engineer-In-Charge.

5.2 Wiring System

- i) Unless and otherwise specified in the tender documents, wiring shall be done only by the "Looping System". Phase of live conductors shall be looped at the switch boxes and neutral conductors at the point outlets.
- ii) Power wiring shall be kept separate & distinct from light wiring, from the level of circuits, i.e., beyond the branch distribution board. Conduit for light/ power wiring shall be separate.
- iii) The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear.
- iv) All DB's should have 20% spare outgoing MCB's



- v) Non-essential, essential & UPS distribution, each will have a completely independent & separate distribution system starting from the main switch board upto final wiring for each system. Conduit carrying Non-essential supply wiring shall not have essential or UPS supply. Wiring for inverter supply will have their own conduit system. No mixing of wiring is allowed.
- vi) Generally, no switchboard will have more than one source of incoming supply. More than one incomer supply will be allowed only at LT panel with proper safety & interlocking so that one source can be switched on at a time.
- vii) Light, fans and call bells shall be wired in the 'lighting' circuits. 15A / 16A socket outlets and other power outlets shall be wired in the 'power' circuits. 5A / 6A socket outlets shall also be wired in the 'power' circuit both in residential as well as non-residential buildings.
- viii) Ferrules of suitable size indicating circuit & DB numbers are to be provided at both the ends.

5.3 Run of Wiring

The type of wiring shall be carried out as per system design required.

Surface wiring shall run, as far as possible, along the walls and ceiling so as to be easily accessible for inspection.

In no case, the open wiring shall be run above the false ceiling without the approval of Engineer-In-Charge.

In all types of wiring, due consideration shall be given for neatness, good appearance and safety.

5.4 Passing through walls or floors

When wiring cables are to pass through a wall, these shall be taken through a protection (Steel) pipe of suitable size such that they pass through in a straight line without twist or cross in them on either end of such holes. The ends of metallic pipe shall be neatly bushed with approved material.

Where a wall pipe passes outside a building so as to be exposed to weather, the outer end shall be bell mouthed and turned downwards and properly bushed on the open end.

All floor openings for carrying any wiring shall be suitably sealed after installation.



5.5 Joints in Wiring

- i) No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/or protective conductors in wiring shall be permitted.
- ii) There shall be no joints in the through runs of cables. If the length of final circuit or sub-main is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.
- iii) Termination of multi-stranded conductors shall be done using suitable crimping type thimbles.

6.0 Interchangeability

Similar parts of all switches, lamp holders, distribution boards, switchgears, ceiling roses, brackets, fans and all other fittings of the same type shall be interchangeable in each installation.

7.0 Wiring Cables

- i) Copper conductor cable only will be used for sub-main/circuit/point wiring.
- ii) Minimum size of wiring:
 - Point wiring : 1.5 sq.mm
 - Circuit wiring : 2.5 sq.mm.
 - Power wiring : 4.00 sq.mm.
 - Power circuit rated : more than 1 kW, size as per calculation.
- iii) Insulation: Copper conductor cable shall be PVC insulated, HHFR type conforming to BIS specification.
- iv) Multi-stranded: cables are allowed to be used.

8.0 Flexible Cables

- i) Conductor of flexible cables shall be of copper and HHFR type conforming to BIS specification. The minimum cross sectional area of conductor for flexible cable shall be as per design
- ii) Only 3 core flexible cables shall be used for connecting single-phase appliances.
- iii) Unless flexible cables are mechanically protected by armour, or tough rubber, or PVC sheath, these shall not be used in workshops and other places where they are liable to mechanical damage.
- iv) Flexible cable connection to bell push from ceiling rose shall be taken through steel conduit/ metallic casing and capping.



9.0 WIRING ACCESSORIES

9.1 A) Control Switches for Points

- i) Control switch (single pole switch) carrying not more than 16 A shall be modular type. The switch shall be on when the knob is down.
- ii) For AC points 25 Amp 3 pin socket outlet controlled by 25 A modular SP MCB housed in suitable GI box shall be used.
- iii) Control switch shall be placed only in the live conductor of the circuit. No single pole switch or fuse shall be inserted in the protective (earth) conductor, or earthed neutral conductor of the circuit.

B) Switch box (Back Box)

Switch box shall be hot dip galvanized, factory fabricated, suitable in size for surface/ recess mounting and suitable in size for accommodating the required number of switches and accessories. The switch boxes shall be of same make as of switch / socket offered.

9.2 Socket Outlets

Combined switch cum socket shall not be permitted.

9.3 Switch box covers

Modular type switches/sockets suitable outer and inner cover plates as specified shall be provided over the standard box as recommended by the manufacturers of modular type switch/ sockets and no separate sheet cover is required to be provided.

NOTE: The make & model of switch, socket, GI boxes, etc. shall be selected as per List of Preferred make & subject to the approval of EIC. The colour of switch, socket, etc. should match with the architecture features of surroundings or as per the Architect decision. The contractor shall take prior approval of the same from Engineer-in-charge.

9.4 Ceiling Rose

- i) A ceiling rose shall not be used on circuit the voltage of which normally exceeds 250 Volts.
- ii) Only one flexible cord shall be connected to ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.
- iii) A ceiling rose shall not embody fuse terminal as an integral part of it.



9.5 Lamp Holders

The standard constructional feature of manufacturers (ISI approved) of lamp holders is acceptable. Where the lamp holders are part of light fixtures, the holders shall be suitable for the type of lamps used.

MARKING OF SWITCH BOARDS

(i) Marking of each Main Board

Each main board/sub main board shall be marked indicating rating of each incoming / outgoing switch and the details of load/area it feeds. Detail /size of incoming and outgoing cable shall also be marked indicating from where the incoming cable has originated.

(ii) Marking of Distribution Board

Each Distribution Board shall be marked indicating detail of incoming switch (Size of cable and from where it is fed) and marking of each outgoing MCB indicating the area it feeds. Suitable marking sticker will be suitably fixed to indicate such details.

(iii) Marking of Power / Light DBs

Power/light DBs shall be marked 'P' and 'L' respectively.

(iv) Marking for Non-essential / Essential / UPS / Switch Boards

Each switchboard shall be marked essential / non-essential / UPS to indicate the nature of such switchboards.

(v) Marking of Main Earthing Terminal

Main earthing terminals in main / sub main switchboard shall be permanently marked, as "Safety Earth – Don't Remove".



10.0 TESTING OF INSTALLATION

All the completed installations shall be tested as per specification for “Testing of Installation”.

10.1 Drawings

- I. The work shall be carried out in accordance with the approved drawings and also in accordance with modification thereto from time to time as approved by the Engineer-In-Charge.
- II. All wiring diagrams shall be deemed to be ‘Drawings’ within the meaning of the term as used in the Conditions of Contract. They shall indicate the main switchboard, the distribution boards (with circuit numbers controlled by them), the runs of various mains and sub-mains and the position of all points with their controls.
- III. All circuits shall be indicated and numbered in the wiring diagram and all points shall be given the same number as the, circuit to which they are electrically connected.

11.0 COMMISSIONING ON COMPLETION

Before the workman leaves the work finally, he must make sure that the installation is commissioned, after due testing.

11.1 Conformity to IE act, IE rule & standard

Conformity to IE Act, IE Rule & standard. All Electrical works shall be commitment in Accordance with the provisions of Indian Electricity Act 2003 and Electricity Rules 1956 amended upto date.



III - METALIC CONDUIT & ACCESSORIES

1.0 SCOPE

This section covers the detailed requirements for wiring work in metallic conduits both surface and recessed types of works.

2.0 APPLICATIONS

Conduit system used shall be Rigid.

3.0 MATERIALS

3.1 Conduits:

- i) All rigid conduit pipes shall be of steel and be ISI marked. The wall thickness shall be 1.6mm (16 SWG) for conduits upto 32mm dia. and 2mm (14 SWG) for conduits above 32mm dia and as per IS. These shall be solid drawn or reamed by welding, and finished with galvanized or stove enameled surface.
- ii) The maximum number of PVC insulated cables conforming to IS: 694-1990 that can be drawn in one conduit is given size wise in Table I., and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.
- iii) No steel conduits less than 20mm in diameter shall be used.

3.2 Conduits Accessories :

- i) The conduit wiring system shall be complete in all respects, including their accessories.
- ii) All conduit accessories shall be of threaded type, and under no circumstances pin grip type or clamp grip accessories shall be used.
- iii) Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works.
- iv) a) Saddles for surface conduit work on wall shall not be less than 0.55mm (24 gauge) for conduits upto 25mm dia and not less than 0.9mm (20 gauge) for larger diameter. The corresponding widths shall be 19mm and 25mm.
b) The minimum width and the thickness of girder clips used for fixing conduits to steel joints, and clamps shall be as per Table-II.



1.3 Outlets:

- i) a) Outlet boxes for light/ power sockets shall be of standard size of manufacturer to accommodate required number of modular switches, socket outlet.
b) Where a large number of control switches and/ or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.
- ii) An earth terminal with stud and metal washers shall be provided in each DB/MS box for termination of protective conductor and for connection to socket outlet/ metallic body of fan regulator etc.

4.0 **INSTALLATION**

4.1 Common aspects for recessed and surface conduit works.

i) Conduit Joints

- a) The conduit work in each circuit or section shall be completed before the cables are drawn in.
- b) Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13mm to 19mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.
- c) Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.
- d) The Engineer-In-Charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.
- e) No bare threaded portion of conduit pipe shall be allowed, unless such bare threaded portion is treated with anticorrosive preservative or covered with approved plastic compound.

ii) Bends in Conduit

- a) All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with bending radius of not less than 7.5 cm., or alternatively, by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.
- b) No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.



- c) Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. Where necessary, solid type fittings shall be used.

- iii) Outlets

- a) All outlets such as switches, wall sockets etc. may be either flush mounting type, or of surface mounting type.

- iv) Painting after erection

After installation, all accessible surface of conduit pipes, fittings, switch and regulator boxes etc. shall be painted in compliance with the clauses under the painting specification.

4.2 Additional requirements for surface conduit works

- i) Painting before erection

The outer surface of conduit including all bends, unions, tees, junction boxes, etc. forming part of the conduit system, shall be adequately protected against rust, by painting with 2 coats of red oxide paint applied before they are fixed.

- ii) Fixing Conduit on Surface

Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the centre of such fittings.

Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps as required by the Engineer-In-Charge.

In long distance straight run of conduit, inspected type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.

- iii) Fixing Outlet Boxes

Only a portion of the switch box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.



4.3 Additional requirements for recessed conduit works

i) Making Chase

- a) The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the manner desired.
- b) In the case of building under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.
- c) In chase of exposed brick/ rubber masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

ii) Fixing Conduits in Chase

- a) The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart, or by any other approved means of fixing.
- b) All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against the rust.

iii) Fixing Conduits in RCC work

- a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.
- b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with all long radius, which all permit easy drawing in of conductors.

iv) Fixing Inspection Boxes

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary. The distance between inspection / junction boxes shall not exceed 12.5 mts in straight run.

Location of inspection/ junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

These shall be mounted flush with the wall or ceiling concrete. Minimum 65mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS : 2667-1977.

Suitable phenolic laminated sheet cover shall be provided on the inspection box.

Suitable ventilating holes shall be provided in the inspection box covers.



v) Fixing Switch Boxes and Accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified.

vi) Fish wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.6mm / 1.2mm (16/ 18 SWG) shall be provided alongwith the laying of the recessed conduit.

vii) Bunching of Cables

- a) Cables carrying direct current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables are drawn into the same conduit.
- b) Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit.
- c) In case of three phase loads, separate conduits shall be run from the distribution boards to the load points or outlets as the case may be.

4.4 Earthing Requirements

- i) The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double check nuts at termination. The conduit shall be continuous when passing through wall or floors.
- ii) Protective (loop earthing) conductor (s) shall be laid inside the conduit between the metallic switch boxes and the distribution boards/ switchboards and terminated into proper earth lugs/terminals. Only PVC insulated copper conductor cable of specified size, green in color shall be allowed Such conductor will not run external to the conduit.
- iii) The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.
- iv) Gas or water pipe shall not be used as protective conductor (earth medium).



TABLE – I

Maximum number of PVC insulated 650/1100 V grade aluminium/copper conductor cable conforming to IS: 694 – 1990

Nominal Cross- Sectional area of Conductor in sq.mm	20mm		25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	0	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

NOTE:

1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
2. The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
3. Conduit sizes are the nominal external diameters.



TABLE - II

Girder clips or clamps

Size of Conduit	Width	Thickness
i) 20 mm - - - -	19 mm	0.9mm (20 SWG)
ii) 25 mm - - - -	19 mm	0.9mm (20 SWG)
iii) 32 mm & above - - - -	25 mm	1.2mm (18 SWG)

5.0 **PAINING**

5.1 **SCOPE**

This section covers the requirements of painting work in internal electrical installations, carried out manually by brush. This does not cover spray painting work of factory made items.

5.2 **PAINING WORK IN GENERAL**

5.2.1 **PAINTS**

Paints, oils, vanishes etc. of approved make, in original tin to the satisfaction of the

Engineer-In-Charge shall only be use.

5.2.2 **PREPRATION OF THE SURFACE**

The surface shall be thoroughly cleaned and made free from dust or foreign matter before painting is started. The proposed surface may be inspected by the Engineer-In-Charge before the paint is applied.

5.2.3 **APPLICATION:**

- i) Paint shall be applied with brush. The paint shall be spread as smooth and even as possible. Particular care shall be paid to rivets, nuts, bolts and over- lapping. Before drawing out in small containers, it shall be continuously stirred with a smooth stick, while painting work is taken up.
- ii) Primary coat of anti-corrosive paint shall be given in the case of steel work, after preparation the surface. In all cases of painting work, finishing shall be with 2 coats of paint in approved shade.
- iii) Each coat shall be allowed to dry out sufficiently before a subsequent coat is applied.



5.2.4 PRECAUTIONS

All furniture, fixture, glazing, floors etc. shall be protected by suitable covering. All stains, smears splashing, dropping etc. shall be removed. While painting of wiring etc. it shall be ensured that the painting of wall and ceiling etc. is not spoiled in any way.

5.2.5 COMMON ASPECTS FOR BOTH RECESSED AND SURFACE CONDUIT WORKS

5.2.5.1. The erection of conduits of each circuit shall be completed before the cables are drawn in.

5.2.5.1.1 Conduit Joints

5.2.5.1.1.1 All joints shall be sealed/cemented with cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

5.2.5.1.1.2 The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.

5.2.5.2.2 Bends in Conduit

5.2.5.2.2.1 All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

5.2.5.2.2.2 Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

5.2.5.2.2.3 Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

5.2.5.4 Outlets:- All switches, plugs, fan regulators etc. shall be fitted in flush pattern. The fan regulators can be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge.



- 5.2.5.5 Painting:-After installation, all accessible surfaces of metallic accessories shall be painted in compliance with clauses mentioned above.
- 5.2.2 Additional Requirements for Surface Conduit Work
- 5.2.2.1 Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base, secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a closer distance from the center of such fittings. Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots.
- 5.2.2.2 Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer-in-charge. Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall be used.
- 5.2.2.3 If the conduit pipes are liable to mechanical damage, they shall be adequately protected.
- 5.2.3 Additional Requirements for Recessed Conduit Work
- (i) Making Chase
 - (a) The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired.
 - (b) In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.
 - (c) In case of exposed brick / rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.
 - (ii) Fixing Conduits in Chase
 - (a) The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart or by any other approved means of fixing.
 - (b) All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.
 - (iii) Fixing Conduits in RCC Work
 - (a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.



- (b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.
 - (c) Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.
- (iv) Fixing Inspection Boxes
- (a) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.
 - (b) These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS 2667: 1988.
 - (c) Suitable ventilating holes shall be provided in the inspection box covers.
- (v) Fixing Switch Boxes and Accessories:-
- Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.
- (vi) Fish Wire to facilitate subsequent drawing of wires in the conduit, GI fish wire shall be provided along with the laying of the recessed conduit.
- (vii) Bunching of Cables
- (a) Cables carrying Direct Current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables are drawn into the same conduit.
 - (b) Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit.
 - (c) In case of three phase loads, separate conduits shall be run from the distribution boards to the load points, or outlets as the case may be.

Gas or water pipe shall not be used as protective conductors (earth medium).



TABLE III

Dimensional Details of Rigid Non-metallic Conduits

(All dimensions in mm)

S No.	Nominal outside Diameter (in mm)	Maximum outside Diameter (in mm)	Maximum inside Diameter (in mm)	Maximum Permissible Eccentricity (in mm)	Maximum Permissible Ovality (in mm)
1	20	20 + 0.3	17.2	0.2	0.5
2	25	25 + 0.3	21.6	0.2	0.5
3	32	32 + 0.3	28.2	0.2	0.5
4	40	40 + 0.3	35.8	0.2	0.5
5	50	50 + 0.3	45.0	0.4	0.6

TABLE IV

Ordinary Clips or Girder Clips

Size of Conduit	Width	Thickness
(1) 20 mm & 25 mm	19 mm	20 SWG (0.9144 mm)
(2) 32 mm & above	25 mm	18 SWG (1.219 mm)



IV - TESTING OF INSTALLATION

1.0 SCOPE

This section describes the details of test to be conducted in the completed internal electrical installation, before commissioning.

1.1 GENERAL:

1.1.1 TESTS

On completion of installation, the following tests shall be carried out:-

- i) Insulation resistance test.
- ii) Polarity test of switch.
- iii) Wiring Continuity test
- iv) Earth continuity test.
- v) Earth electrode resistance test.
- vi) Test as per Appendix 'E' of IS:732-1989
- vii) Tests as per relevant CPWD specifications.

1.1.2 WITNESSING OF TESTS

Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Engineer-In-Charge by the Contractor. All test results shall be recorded and submitted to the AAI

2.0 INSULATION RESISTANCE

The tests described below shall be made before the installation is permanently connected to the supply. For these tests large installations may be divided into groups of outlets, each containing not less than 50 outlets. For the purposes of this code the term 'outlet' includes every point and every switch except that a socket outlet, appliance or luminaire incorporating a switch is regarded as one outlet. The test voltage for insulation resistance measurement shall be 500 V.

When measured with all fuse links in place, all switches (including, if practicable, the main switch) closed and, all poles or phases of the wiring electrically connected together, the insulation resistance to earth shall be not less than 1 mega ohm.

When measured between all the conductors connected to any one phase or pole of the supply and, in turn, all conductors connected to each other phase or pole the insulation resistance shall be not less than 1 mega ohm. Wherever practicable, so that all parts of the wiring may be tested, all lamps shall be removed and all current-using equipment shall be disconnected and all local switches controlling



such lamps or other equipment shall be closed. Where the removal of lamps and/or the disconnection of current-using equipment is impracticable, the local switches controlling such lamps and/or equipment shall be open. Particular attention shall be given to the presence of electronic devices connected in the installation and such devices shall be isolated so that the test voltage does not damage them.

Where equipment is disconnected for the tests prescribed above, and the equipment has exposed conductive parts required by these clauses to be connected to protective conductors, the insulation resistance between the exposed conductive parts and all live parts of the equipment shall be measured separately and shall comply with requirements of the appropriate Indian Standard and the insulation resistance shall not less than 0.5 mega ohm.

3.0 **POLARITY TEST OF SWITCH**

In a two wire installation, a test shall be made to verify that all the switches in every circuit have been fitted in the same conductor, throughout, and such conductor, shall be labeled or marked for connection to the phase conductor, or to the non-earthed conductors of the supply.

In a three wire or a four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled, or marked for connection to one of the phase conductors of the supply.

The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to earth. Glowing of test lamp to its full brilliance, when the switch is in 'ON' position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

4.0 **TESTING OF EARTH CONTINUITY PATH**

The earth continuity conductor, including metal conduits and metallic envelopes of cables in all cases, shall be tested for electric continuity. 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.



5.0 **MEASUREMENT OF EARTH ELECTRODE RESISTANCE –**

As described in earthing section.

6.0 **TEST CERTIFICATE**

On completion of an electrical installation or an extension to an installation, a certificate shall be furnished by the Contractor, countersigned by the certificate supervisor under whose direct supervision the installation was carried out. The certificate shall be in the prescribed form in addition to test certificate required by the local Electricity supply authorities.



V - OUTDOOR AREA LIGHTING

Detail specifications of Galvanized Octagonal poles

The Octagonal Poles shall be designed to withstand the maximum wind speed as per IS 875 Part-3-2015. The head loading i.e. windage area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BSEN 40-3-1 & 3.

The pole shaft shall be made from hot rolled steel plate confirming to IS 2062/ BS EN 10025. All octagonal pole shafts shall be provided with the rigid base plate manufactured from MS steel confirming to IS: 2062 of suitable thickness with provision for fixing foundation bolts.

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process. The base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside.

The octagonal Poles shall have door of approximate 500 mm height at the elevation of 500 mm from the base plate. The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

The hinged door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing. The welding shall be carried out confirming to approved procedures qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

The Octagonal Poles shall be in single section up to 12-meter height and there shall not be any circumferential weld join except at base flange.

The Manufacturing unit shall have in house galvanizing facility; the poles shall be hot dip galvanized as per BSEN ISO 1461 standard. Zinc used for galvanizing shall have purity of 99.995% as per IS 209. The galvanizing shall be done in single dipping. The galvanized mounting bracket shall be supplied along with the Octagonal Poles for installation of the luminaries.

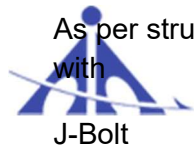
Provision should be provided in the bottom compartment to mount PVC /Bakelite sheet along with connectors for cable looping and single pole MCB to isolate individual luminaire.

TYPICAL DATASHEET FOR OCTAGONAL POLE

OCTAGONAL POLE

Material construction of Shaft	Hot Rolled Steel Plate as per IS 2062 / BS EN 10025 Or Equivalent.
Grade of Steel	Hot Rolled Steel Plate as per IS 2062 / BS EN 10025 Or Equivalent.
Thickness	To be decided as per height of pole and site condition
No. of longitudinal welds /section	One
Cross section of Pole	Octagonal (8-sided polygon)
Base diameter and top diameter (A/F)	As per structural design calculations.
Metal protection treatment for Pole Section	Hot Dipped Galvanized, as per BS EN ISO 1461
Height of door	To be decided as per height of pole and site condition
Door type	To be decided as per height of pole and site condition
Dimension of base plate	As per structural design calculations.
Thickness of base plate	As per structural design calculations.
Grade of Steel for Base Plate	As per IS 2062
Max. wind speed	As per IS 875 Part III – 2015
2.	FOUNDATION BOLTS
Number of foundation bolts	As per structural design calculations
PCD of foundation bolts	As per structural design calculations.
Grade of Foundation Bolts	As per structural design calculations.

Bolt diameter/Length



As per structural design calculations
with

J-Bolt



VI –RACE WAY & PVC TRUNKING

1.0 GENERAL:

This section covers the detailed requirement of provision of Pre-Galvanized metal steel sheet raceways with junction boxes/ cross over junction boxes etc with material specification conforming to IS 277 and provision of PVC trunking with junction boxes/ cross over confirm to BS EN 50085-1:1999 & BS EN 61386-1:2004 for distributing data, power and communication cables as per site condition.

All safety standards shall be followed for separations of compartment for under raceway as well as for PVC trunking and their accessories.

2.0 SCOPE OF WORKS

The scope of works broadly covers the following:

- a) Design, supply and installation of under floor raceway with junction boxes/ cross over junction boxes, jointing sleeve/ bracket complete. The junction boxes & raceway shall be selected as per load capacity required. The junction boxes should have adjustable height with a minimum height of 45 mm.
- b) The raceway shall be laid for drawing power and control circuit wiring / cabling separately as per design requirement having compartment 1/2/3 along with progress of civil flooring works. The raceways shall be fabricated out of corrosion proof pre-galvanized sheet steel with 1.6 mm thickness.
- c) The raceway shall be considered in floor for – terminal building.
- d) On award of works, contractor has to develop the raceway layout for terminal building to extend power as well as control circuit wiring / cabling with separate raceways so that wiring/ cabling can be extended easily from switch room/ equipment room power/ data source for all floor/ column and for equipment / fixtures in the terminal building areas.
- e) PVC trunking layout shall be worked out for extending data, power & communication cables within the equipment room server Room, Fire Control Room, UPS Room as per site conditions. PVC trunking should have pre-punched bases, inbuilt dividers with knockouts for wiring to make it more installation friendly. PVC trunking to be provided with 1/2/3 compartments as per site conditions. The required switch, socket etc shall be of same make and model to suit for installation in PVC trunking.
- f) The Stainless steel grade-304 cover plate with chamfering the edges shall be provided over the raceway junction boxes in terminal building areas. In all other areas, the GI cover supplied along with the boxes shall remain as final cover to be finishes with floor.



- 3.0 Contractor shall submit the sample along with technical data sheet and test certificate suitable for load bearing capacity to withstand the site condition for approval of Engineer –in –charge before procurement.



**VII -LIGHT FIXTURES, FANS, DB PANEL & FEEDER
PILLARS, ETC & ITS ATTACHMENTS**



1.0) GENERAL

This section cover provision of –

- Indoor lighting for terminal building, ESS block(sub-station), Service block, etc. with LED fixtures and desired lux level.
- The architectural layout plan for terminal building, ESS block(sub-station), etc. is enclosed for reference.
- Soft Copy of Catalogues, Polar Diagrams, Cone Diagrams, IES Files. Test Certificates - relevant LM 79 from NABL, LM80-TM21, IEC 60598, LM 80 test certificates of the luminaires submission is mandatory. LM80-TM21& LM 80 test certificates should be duly sealed & signed by authorised representative from OEMs manufacturing facility only.
- Ceiling fan and exhaust fan shall be provided in non air-conditioned space of terminal building and ancillary buildings like switch rooms etc.
- Ceiling fan, wall mounted fan, exhaust fan for sub-station.

STANDARD & CODES:

Code No		Description
IS 10322 (All Parts)	:	Specification for Luminaires
LM-79	:	Electrical and Photometric Measurements for Solid State Lighting Products.
LM80	:	Measuring Lumen Maintenance of LED Light Sources
SP 72 : 2010	:	National Lighting Code
16103(Part 1)	:	2012 Led Modules for General Lighting- Safety Requirements
16103(Part 2)	:	2012 LED Modules For General Lighting Part 2 Performance Requirement.
IS 16107 (Part 1)	:	Luminaire performance Part 1 General Requirement
IS 16107 (Part 2)	:	Luminaire performance Part 2 Particular Requirements Section 1 LED Luminaires.
IS 16104	:	2012 - d.c. or a.c. Supplied Electronic Control Gear for LED Modules - Performance Requirements
EN 61547	:	Immunity to interference
EN 60928 / IEC 928 / IS 13021 (Part I)	:	Safety
EN 60929 / IEC 929 / IS 13021 (Part II)	:	Performance
IEC 68-2-6 FC / IEC 9001	:	Vibrations & Bump tests
ISO 14001	:	Environmental Standard
EN 55015 & EN 55022	:	RFI Compliance
EN 6 1000-3-2	:	Harmonics



CISPR-15	:	EMI Compliance
EN 61000-3-2	:	Current waveform

1.1) LIGHT FIXTURES

- i) LED type light fixtures shall be used for illumination to achieve the desired lux level as per the below mentioned technical parameters.
- ii) Technical parameters of LED light fixtures as as under.

STANDARD FOR LED LIGHT FITTINGS FOR DIFFERENT APPLICATIONS

S. NO	TECHNICAL PARAMETER	RECOMMENDATION FOR LED LIGHT FITTINGS		
		INDOOR LIGHT	OUT DOOR LIGHT	RESIDENTIAL LIGHT
1	Efficiency of LED light fitting (Efficacy)	Min 100 Lumens / Watt	Min 110 Lumens / Watt	Min 70 Lumens / Watt
2	Life of LED light fitting	Not less than 50000 burning Hours	Not less than 50000 burning Hours	Not less than 35000 burning Hours
3	Approved make for LED	As per preferred make list	As per preferred make list.	As per preferred make list.
4	CRI (Colour Rendering Index)	Min 80 for indoor applications.	Min 70 for outdoor applications.	Min 70
5	THD (Total Harmonic Distortion)	Less than 10%	Less than 10%	Less than 20%
6	Voltage Range	140 V to 270 V	140 V to 270 V	140 V to 270 V
7	Type of Housing	Extruded aluminum / CRCA / Standard alloy housing	High pressure die cast aluminium / Standard alloy for outdoor applications.	Extruded aluminum / High pressure die cast aluminum / Standard alloy.
8	IP Category	IP 20 or higher for indoor applications	> IP65	≥IP 20
9	Surge Protection	Shall be provided conforming to relevant IS standard / IEC For LED Driver (In-built): EN61000-4-5	> 4KV	>2 KV



10	Labeling / identification Mark	Manufactures Name/ Logo shall be engraved / Embossed on housing / body or on aluminium plate Labels or screen printed on housing / body.	Manufactures Name/ Logo shall be engraved / Embossed on housing / body or on aluminium plate Labels or screen printed on housing / body.	Manufactures Name/ Logo shall be engraved / Embossed on housing / body or on aluminium plate Labels or screen printed on housing / body.
11	Warranty period	5 years warranty from actual date of completion of work on complete luminaire including driver / control gear, LED, all accessories etc.	5 years warranty from actual date of completion of work on complete luminaire including driver / control gear, LED, all accessories etc.	5 years warranty from actual date of completion of work on complete luminaire including driver / control gear, LED, all accessories etc.
12	Power Factor	Equal to 0.95 or More	Equal to 0.95 or More	Equal to 0.95 or More



13	Total Power consumption of fitting.	Not More than 110 % of rated capacity of LED Light fitting.	Not More than 110 % of rated capacity of LED Light fitting.	Not More than 110 % of rated capacity of LED Light fitting.
14	Approval Make of Driver	Meanwell / Inventronics / C&S / Moso Power / BAG / Phillips / Wipro / Osram / Bajaj / Pharos / Fulham / Helver / OEM of Light Fixture	Meanwell / Inventronics / C&S / Moso Power / BAG / Phillips / Wipro / Osram / Bajaj / Pharos / Fulham / Helver / OEM of Light Fixture	Meanwell / Inventronics / C&S / Moso Power / BAG / Phillips / Wipro / Osram / Bajaj / Pharos / Futham / Helver / OEM of Light Fixture
15	Type of Driver	Enclosed / Encapsulated	Enclosed / Encapsulated	Enclosed / Encapsulated
16	Efficiency of Driver	$\geq 85 \%$	$\geq 85 \%$	$\geq 85 \%$
17	Testing Facility	LED Luminaire manufacturer shall have in-house NABL accredited Photometry lab.	LED Luminaire manufacturer shall have in-house NABL accredited Photometry lab.	LED Luminaire manufacturer shall have in-house NABL accredited Photometry lab.
18	BIS Registration	All luminaires & drivers shall be BIS registered.	All luminaires & drivers shall be BIS registered.	All luminaires & drivers shall be BIS registered.



19	Housing thickness	Housing of luminaires shall ≥ 0.5 mm for CRCA or 1 mm for Extruded Aluminium or 1.5 mm for PDC aluminium or heavier if so required to meet the application requirement.	Housing of luminaires shall >0.5 mm for CRCA or 1 mm for Extruded Aluminium or 1.5 mm for PDC aluminium or heavier if so required to meet the application requirement.	Housing of luminaires shall >0.5 mm for CRCA or 1 mm for Extruded Aluminium or 1.5 mm for PDC aluminium or heavier if so required to meet the application requirement.
20	IK Rating	IK 04 or above	IK 07 or above	NA
	LED Binning (Standard Deviation colour Matching)	< 5 (SDCM)	< 5 (SDCM)	< 7 (SDCM)
22	Unified Glare Rating (UGR)	≤ 19	NA	NA

Note: Output voltage ripple factor to be $<5\%$ as per IEEE Std. 1789-2015 to avoid stroboscopic effect wherever mentioned.

i) Area wise selection level of light fixtures to achieve minimum lux level shall be selected as below:

S. No.	Location/Area	Lux Level & Uniformity
1	Airline Counters/Hotel Reservation/ Backup Offices/ Restaurant/ Offices/Departure/SHA/ Check-In-Counters, Concessionary, Fire Ctrl Room etc.	300 & 0.4



2	VIP Lounge, Child Care Room	300 & 0.4
3	Visitor Lounge/Airport Manager	300 & 0.4
4	Switch Room & Maint. Room, smoking, Lobby/Corridor, IT Server Room, CCTV Room/ Security Room, ESS Block(Sub- Station).	200 & 0.4
5	Arrival Hall, Double Height area/ City/Air Side Canopy, UPS & Battery Room, corridors F&B and Retail.	200 & 0.4
6	Car Parking	40 Uniformity –Min/Max- 0.33 Min/Avg –0.4
7	City Side	20 & uniformity – Min/Avg- 0.25

The fixtures proposed above area-wise are tentative. EPC contractor is requested to submit the fixtures selection w.r.t. area, type of mounting etc. to AAI. Final selection/ approval shall rest with Engineer-In-charge to meet the technical as well as operational requirement.

ii) Lux level requirement:

- a) The lighting system should be designed in such a manner that the desired Lux Level and uniformity (as mentioned above) will be same at the end of warranty period of light fixtures, i.e. of 5 years.
- b) Lux Level Measurement
 - Before taking up the work, the contractor shall furnish the typical lux level calculation sheet for the given fixtures, lamp wattage, etc to achieve the desired lux level. Similarly for car park areas, the typical lux level calculation sheet shall be submitted with a standard grid.
 - On completion of work, contractor shall demonstrate & furnish the same as final lux level of typical areas and submit for acceptance of Engineer In charge.

iii) ATTACHMENT OF FITTINGS AND ACCESSORIES

Conduiting Wiring System

- i) All accessories like switches, socket outlets, call bell push and regulators shall be fixed in flush pattern inside the switch boxes. Accessories like ceiling roses, brackets, batten holders, stiff pendants etc. shall be fixed on metal outlet boxes.
- ii) Antirust machined finish screws shall be used to fix the accessories to their bases.
- iii) The switch box shall normally be mounted with their bottom 1.2 m from floor level, unless otherwise directed by the Engineer-In-Charge.



Fixing on Walls and Ceiling

- i) PVC sleeves / dash fasteners should normally be used for fixing to walls or ceiling.
- ii) Plugging of walls or ceiling is to be done in a better way for neatness. In all such cases, an approved type of asbestos or fiber fixing plug (rawl or Phil plug) with correct size of tools shall be used and done in a workman like manner.
- iii) Looping of fittings etc. shall be done using connectors of suitable rating.

1.2 FANS, REGULATORS AND CLAMPS

a) Ceiling Fans

- i) Ceiling fans including their suspension shall conform to relevant Indian Standards.
- ii) Any additional hardware items required for installation of ceiling fans including fan hooks/ clamps shall be provided as required.
- iii) All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.
- iv) Recessed type fan clamp inside a metallic box shall be used. The metallic box shall suitably be covered with 3mm thick phenolic laminated sheet.
- v) Canopies on top of suspension rod shall effectively hide the suspension.
- vi) The leading in wire shall be of copper and nominal cross sectional area not less than 1.5 Sq.mm. and shall be protected from abrasion.
- vii) All ceiling fans shall be hung at a height as directed by the Engineer-In-Charge.
- viii) Extra down rod with wiring as required.
- ix) Energy efficient fans with BEE 5- star rating amended upto date shall be used.

1.3 Exhaust Fans

- i) Exhaust fans shall conform to relevant Indian Standards.
- ii) Exhaust fans shall be erected at the places indicated by the Engineer-In-Charge, additional hardware items required for installation of exhaust fans including clamps etc. shall be provided as required.
- iii) Louvers shall be erected with exhaust fan at the existing opening with the required hardware clamps etc. as required.
- iv) Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.

1.4 Distribution Boards-

MCB type DB's shall be used on account of their superior technical features, compared to conventional DBs, which don't allow for proper wiring space and wiring termination. Re-wirable fuse type DBs shall not be used.



DBs shall have following feature:

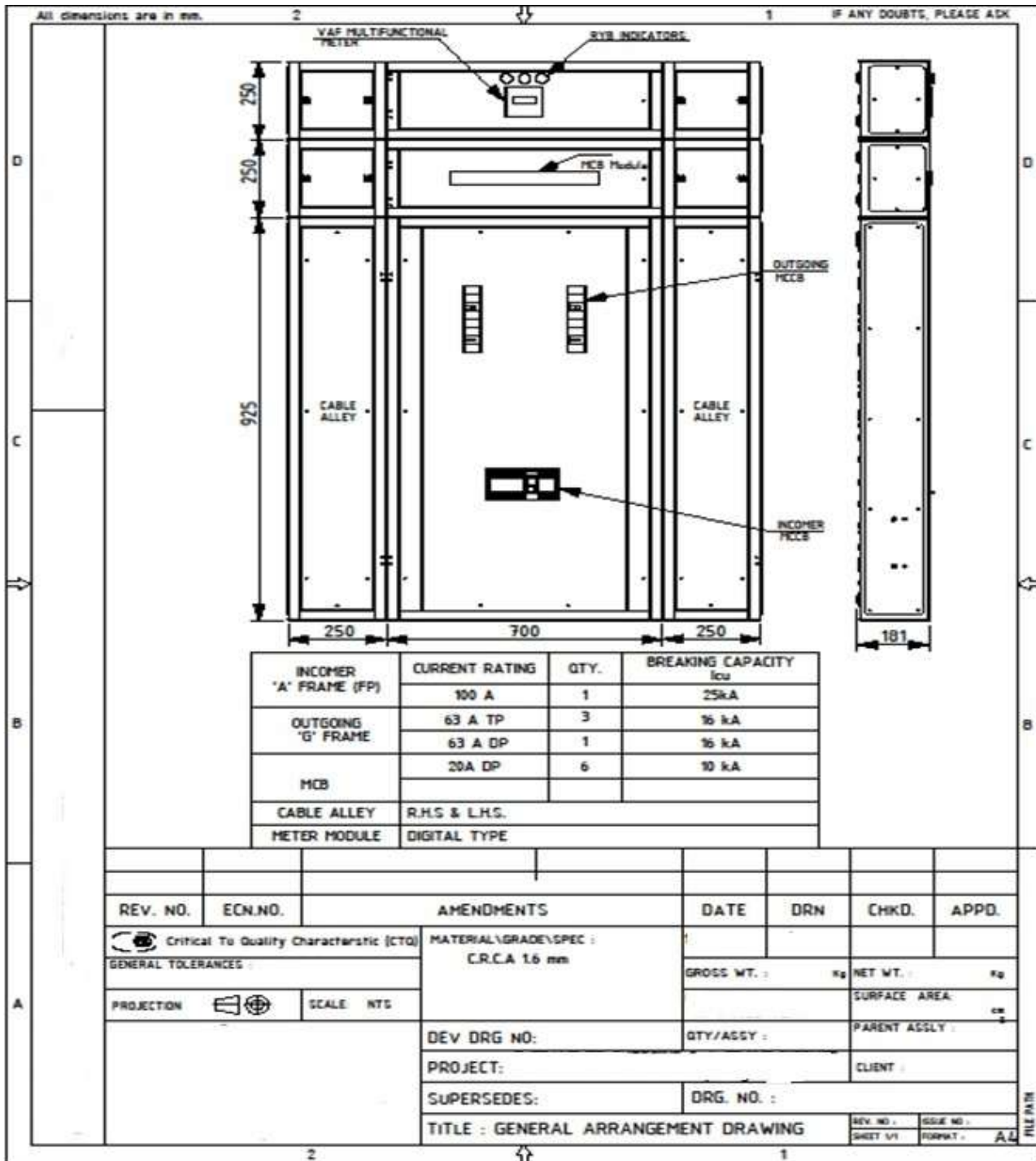
Phase / neutral / earth terminal blocks for termination of incoming & outgoing wires.

- i) DIN Channel arrangement for mounting incomer / outgoing MCB/RCCB/RCBO/MCCB as required.
- ii) Electrolytic Copper Bus bar & neutral link.
- iii) Earthing terminals.
- iv) Wiring from MCB's to phase terminal block.
- v) Interconnection between terminal block / incoming switch / bus bar/ neutral terminal block/ earth terminal connector with specified size of HHFR pre insulated copper conductor cable duly fitted with copper lugs.
- vi) Terminal blocks should be suitable for termination of conductor / cable of required size but minimum rated cross section of the terminal blocks should be 6 sq mm.
- vii) Colored terminal blocks and HHFR wires for easy identification of RYB Phases, Neutral and Earth.
- viii) The DB shall have peel able poly layer on the cover for protection from cement, plaster, paints etc. during the construction period.
- ix) Detachable plate with Knock out holes shall be provided at the top / bottom of board. Complete board shall be factory fabricated and pre-wired in factory ready for installation at site. The box and cover shall be fabricated from min 1.0 mm sheet steel, properly pretreated with powder coated finish.
- x) It shall be of double door construction provided with hinged cover in the front.
- xi) Wiring diagram of each DB shall be fixed inside the DB clearly indicating ferrule numbers.
- xii) DB shall be sectioned in such a manner that incomer has separate row.
- xiii) MCB shall comply IS/IEC 60898-1-2002.
- xiv) MCB used for light circuit & power circuit shall be C series.
- xv) MCB used for motor /UPS circuit shall be D series.
- xvi) DB used for indoor application shall comply IP-43 & IK09.
- xvii) DB used for Outdoor application shall comply EN 60439-3, IP-65, IK09
- xviii) DB shall have RCCB on each phase for phase separation.

Recess / Surface type loose wire box & cable End Box shall be provided as per site requirement with respect to individual DB or for group of DBs. The material of construction and shade of loose wire box & cable End Box shall be as per DB finishes.

1.5) MODULAR DB PANEL & FEDDER PILLAR

- a) The modular DB panel with all switchgears, control, metering etc shall be supplied as per GA drawing placed below and shall be installed wall / floor mount as per site conditions.





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b) Out Door Type Feeder Pillar

This specification covers the design, manufacture, shop floor tests, type and routine tests and delivery of outdoor floor mounted Feeder Pillar, voltage rating 415, 3 phase, and 4 wire systems. The switchgear must have been type tested in the same configuration that has been offered.

- a. All out door type feeder pillar shall be floor mounted, front operated with Double door with lockable arrangements.
- b. 2 mm Thickness of CRCA sheet shall be used for all load bearing parts and rest may be 1.6 mm with power coated.
- c. Base frame shall be of power coated MS Angle. (35 x 35 x 6mm).
- d. Inside and Outside painting shall be of approved shade as per IS:5 unless otherwise specified.
- e. Enclosure shall be IP ≥ 55 protected with canopy.
- f. Flat Neoprene gasket shall be provided wherever required.
- g. Cable entry shall be from Bottom side.
- h. Double compression gland shall be used.
- i. Bus bar material shall be pure annealed copper with 99.99% purity.
- j. Heat shrinkable – color coded sleeve to be provided.
- k. The minimum fault level should be considered as 25 KA.
- l. Bus bar supports shall be Epoxy/as recommended by OEM of suitable size to be used.
- m. Feeder pillar shall be suitable for installations of two numbers change over switch, inter-connected and suitable for -
 - Receive two numbers power Al armoured cables of size upto 300mm² to change over No.1 ;



- For connecting portable DG set with feeder pillar, provision of 3 Phase, 4 wire Industrial type Plug & Socket (IP -67) shall be provided. Socket shall be kept in vacant compartment of feeder panel
 - Supply of copper cables for inter-connecting, all inter-connections with cable glands and end terminations are included in scope of works.
- c. All switch gears & control gears shall be as per approved make.
- d. Danger Plate and Identification Feeder Pillar number plate to be provided as required.
- e. Continuous earthing provision to be provided to connect at two points. All doors and structural parts to be earthed with adequate copper braided wires.

PACKAGE – B

SPECIFICATIONS FOR
POWER SUPPLY
(SUB-STATION EQUIPMENTS) & UPS
SYSTEM

I - HT PANEL

1.0 General

The scope of these specifications cover the detailed requirements for design, supply, installation, testing and commissioning of High Voltage panel board system including all that reasonably inferred as necessary for the proper installation and putting the installations in operational of the type extended in the following specification, Technical data sheet enclosed and Scope of works (SOW) & as specified.

2.0 H.V. PANEL

The Panel board shall be of indoor type, having the incoming sectionalisation and outgoing switch gear as per IS 13118-1991 of VCB, IEC 62271-100 for Breakers and – 200 for Panels/IS 3427 of switch board. The degree of enclosure protection shall be minimum IP-4X. The panel should be from the factory of AAI approved makes of VCB or their license partner for HT panel mentioned in AAI approved make list enclosed.

Rating: The panel assembled to form a board shall be suitable for the nominal operation voltage and rupturing capacity as specified. They shall be rated as specified and suitable for operation on 3 phase, 50 Hz, 3 wire system. *A circuit breaker for a given duty in service is best selected by considering the individual rated value required by load & that of fault conditions.* The panel should be internal arc tested for 25 KA for 0.5 sec as per IEC 62271-200 in all 3 compartment viz- cable, busbar & breaker.

Type: The HV panel shall be metal clad cubicle pattern extensible on both sides, indoor, floor mounting & free standing type. It shall be totally enclosed dust, damp and vermin proof.

General Construction: Separately earthed compartment shall be provided for circuit breaker, bus bars, relay & instruments, CT & PT and cable boxes, fully and effectively segregating these from one another so that fault in any one compartment do not cause damage to equipment(s) in other compartment(s).

The housing shall be of bolted construction to ensure compact and rigid structure, presenting a neat and pleasing appearance. The sheet steel enclosure shall not be less than 2 mm thick.

The panel board shall be bolted together to form a continuous flush front switch gear suitable for front operation of board and for extension at both ends.

General Design Aspects: The HV panel board shall be designed such that the switchgear, instruments, relays, Busbars, small wiring etc. are arranged and mounted with due consideration for the followings:-

- i) Facility for inspection, maintenance and repairs of testing terminals and terminal boards for ease of external connection.
- ii) Minimum noises and vibrations.
 - Risk of accidental short circuits and open circuits.
 - Secured and vibration proof connections for power and control circuits.
- iii) Risk of accidental contact and danger to personnel due to live connections.
- iv) Mounting at approachable height.

3.0 CIRCUIT BREAKER:

GENERAL ARRANGEMENTS: The circuit breaker panel boards shall be complete with the following:-

- (a) Racking in / Racking out mechanism.
- (b) Single pole Isolating plugs and sockets.
- (c) Mechanical inter-locks and automatic safety shutters.
- (d) Internal Earth switch with electro-mechanical interlock. Cable earth switch on all outgoings and bus bar earth switch in each section.

OR

Manufactures shall provide two earthing truck. One cable side earthing truck another for busbar bus earthing truck.

- (e) Minimum of 4 NO and 4 NC Auxiliary contacts directly operated by the circuit breaker. Additional NO & NC contacts shall be provided with auxiliary contactors for the functional requirement.
- (f) Anti-condensation space heaters suitable for operation on 240V, single phase, 50 Hz , A.C. supply for each switch gear panel with manual ON/OFF switch.
- (g) Suitable tripping arrangement with push button etc.
- (h) Mechanical counters to assess the total number of operations of the breaker.
- (i) Mechanical ON/OFF indicator, Auxiliary switches etc.
- (j) Emergency trip push buttons etc.
- (k) Wherever cassette design of CB is offered, two CB handling trolleys shall be provided with switchboard
- (l) Lifting lugs shall be provided for lifting the entire shipping section without distortion of any part of any enclosure

Type: The circuit breaker shall be of Floor/cassette Mounted horizontal isolation, horizontal draw out pattern only.

Breaker Truck:

The breaker carriage shall be fabricated from steel, providing a sturdy vehicle for the circuit breaker and its operating and tripping mechanism. The carriage shall be mounted on wheels, moving on guides, designed to align correctly and allow easy movement of the circuit breaker and for removing the carriage for inspection and maintenance purposes. Vacuum interrupters shall be fully encapsulated hermetically sealed and shall be designed for minimum contact erosion, fast recovery of di-electric strength, maintenance free vacuum interrupter, suitable for auto-reclosing. The drive mechanism shall preferably be provided with facility for pad locking at any position namely, 'Service', 'Test' and "Fully Isolated". It shall be possible for testing the circuit breaker for its operation without energizing the power circuit in the 'Testing' position. The contacts shall be made only after the breaker is inserted into service position. Interlocking shall prevent contacts from being disconnected if circuit breaker is tried to be moved from service position.

General Features: Single break contacts are provided in sealed vacuum interrupter.

Rating: The circuit breaker shall be continuously rated for its required rating specified.

Operating Mechanism:

The operating mechanism shall be with manual as well as motor wound spring charged with both mechanical and electrical release for closing.

The operating mechanism shall be trip free.

The external auxiliary power required for HT panel board shall be extended as under:

- a) DC Power: This shall be extended from the battery charger.
- b) Single phase 240V AC power shall be extended from nearest power DB or from nearby 15A power point(s).

The power shall be extended by supply & laying of copper XLPE insulated & PVC FRLS/HHFR armoured cable including terminations. If cable is un-armoured then it shall be protected with metallic conduit. The cable extended from power point shall be provided with 15A ISI mark TOP at power point side or DP MCB from DB.

4.0 BUS BAR SECTION:

General Requirement: The switch board shall be single bus bar pattern with air insulated encapsulated bus bars housed in a separate compartment, segregated from other compartments.

Material: The bus bars shall be of high conductivity electrolytic copper rated as specified and it shall be sized for carrying the rated current. The bus bars shall be sized for carrying the rated and short circuit current of 25kA for 1 sec without over-heating. Maximum bus bar temperature shall not exceed 95 degree centigrade at the local climatic condition.

5.0 CURRENT TRANSFORMER (CT):

General Requirements: Accommodation shall be provided in the circuit breaker panel to mount set of HT CTs for metering and protection purposes as specified. Access to CTs for cleaning, testing or changing shall be from the front, back or top of the panel.

Rating: Dual core CTs of suitable burden (but not less than 15 VA) shall be preferred with 1 Amps secondary. The CT ratio shall be as specified & as required. The ratio shall be compatible with the loading pattern on HV side.

The CTs shall conform to relevant Indian Standards. The design and construction shall be robust to withstand thermal and dynamic stresses during short circuits. The CT shall be of cast epoxy resin construction. Secondary terminal of CTs shall be brought out suitably to a terminal block and shall be easily accessible for testing & terminal connections. The protection CTs shall be of class 5P10 of IS 2705- Part III- 1992.

The metering CTs shall conform to the metering ratio and accuracy class for incomer and outgoing VCB panels as specified and as required.

Note: Make of CT's installed / supplied by HT board Manufacturer is acceptable

6.0 VOLTAGE TRANSFORMER (VT):

General Requirement: A voltage transformer of required burden of proper ratio & class of accuracy as required shall be provided at the incoming panel. The accuracy class for the VT shall be 0.5 as per IS 3156 parts I to III for incomer VCB Panel & class I for outgoing of Panel and as specified & as required. The VT shall be of cast epoxy resin construction. The basic impulse level (BIL) of the VT shall be same as that of switch gear. External connection to the VT secondary shall be through a test block. It shall be fixed type (draw out type VT shall be acceptable without any extra cost). HRC fuses & MCB's of required breaking capacity shall be provided on both HV & LV sides respectively as protection.

7.0 PROTECTION AND TRIPPING ARRANGMENT:

- 7.1 The Relays shall be microprocessor based numerical type for over current, earth fault & short circuit protection with -
- a) Triple pole non-directional IDMT & instantaneous (high test) characteristics.
 - b) Master trip relay for tripping against fault in circuit.
 - c) Trip circuit supervision relay for healthiness of trip circuit.
 - d) Suitable auxiliary relays for protection of transformer with electrical contact for alarm & trip for winding temperature, oil temperature & oil pressure etc. and as required.

Tripping relay shall be used for tripping signal to the Shunt Trip Coil of Circuit Breaker operating on 24V DC supply/ 110V VT Supply as per OEM requirement.

- 7.2 Suitable contacts of the relays will be wired out to terminal blocks for remote Trip Indication and these will be manually resettable.
- 7.3 Relay should have inbuilt facilities to change setting and record event, fault etc. and with open protocol software. Relay should have in built RS 485 port for communications.

8.0 SAFETY ARRANGEMENT

The following safety arrangement shall be provided for the safety of the personal & to prevent mal operation:

- 8.1 Interlock to prevent the circuit breaker from being forwarded or reversed unless the breaker is off.
- 8.2 Interlock to prevent the truck from being withdrawn or replaced except in the fully withdrawn position.
- 8.3 Interlock to prevent the breaker from being closed unless it is fully engaged.
- 8.4 Interlock to prevent the earth connection from being made by the earthing device except than the circuit breaker is open.
- 8.5 Interlock to prevent the breaker from being made alive without its carriage in position.
- 8.6 Interlock to prevent the lockable and remote control apparatus from being in operation at the same time.
- 8.7 Inter-lock to prevent the circuit breaker from being racking in and racking out when closed.
- 8.8 Interlocking which prevents manual or electrical closing of the circuit breaker in the intermediate positions between connected or isolated.

- 8.9 Inter-lock to prevent earth connection from being made by the earthing device except than the circuit breaker is open.
- 8.10 Inter-lock to prevent the breaker from being made alive without its carriage in position.

The breaker should have test positions to facilitate testing of control circuit. Removable automatic dust proof safety shutter assembly should be provided for shrouding of live terminals while the breaker is drawn out.

The HT panel shall have a Hooter with acknowledge push button in case of tripping of any of its incoming or outgoing VCB breaker.

9.0 SMALL WIRING:

The small wiring shall be carried out with FRLS/HHFR insulated copper conductor cables of minimum 1.5sq. mm. For CT wiring shall be done with minimum 2.5sq mm. The color code of wire shall be: RYB, Gray for auxiliary DC circuits and Black for auxiliary AC circuits. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification tags shall be fitted to all wire terminals to render identification easy facilitate checking in accordance with IS 375. Necessary terminal block and cable entries shall be provided for RTD relay wiring, power supply etc.

10.0 METERING INSTRUMENT, PANEL ACCESSORIES (DIGITAL):

10.1 Instrument Panel:

The instrument panel shall form part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by contractor & approved by AAI. All instruments & switches shall preferably be flush mounting type at a maximum height of 1800mm.

All voltmeter and ammeter and other instruments shall be flushed mounted Digital type of suitable size to read conforming to class 1.0 or as specified to IS 1248 for accuracy. All volt meters shall be protected with Fuses/MCBs.

Multi-function meter: Since the Multi-function meter has the features of measuring characteristic. The Multi function meter shall be of high quality with features explained in the following paras.

The Multifunction meter shall be of Flush / surface mounting technology, Back lit LCD / LED type Digital display, provided with isolated compatible serial port for BMS/SCADA system either inbuilt or separate is acceptable having bezel size as required. It shall be of AC, 3 phase, three wire CT/PT operated and suitable for measuring parameters like Voltages, Currents, Active power, Reactive power, Apparent power, Power Factor, Frequency, Phase angles, Maximum Demand, active (kWH), reactive (kVARH) and apparent (kVAH) energies, Current and Voltage total Harmonics distortion(THD). Measurement accuracy of kWH and kVARH as required with RS 485 port.

The Multifunction meter shall also be suitable for displaying all the three parametrs,

viz KW/KVAR/KVA simultaneously.

Multifunction meter shall be suitable for operation on 3 phase, 110 volts, AC power supply and shall be fully rated for operation at ambient conditions of proposed location of the Airport.

The panel assembly shall also take care of the following requirements:

- i) Lamp indication shall be provided to indicate ON/OFF (BY red/green respectively) of switch gear.
- ii) Panel illuminating lamp.
- iii) Mechanical indication for spring charged status. Indication by Blue lamp.
- iv) Lamp indicating tripping at fault status.
- v) Healthy trip supply shall be indicated by clear lamp.
- vi) Separate Fuses/MCB's protection shall be provided for lamp, heaters, voltmeters and other instrumentations etc. on each panel as specified & as required.
- vii) Anti- condensation space heater shall be provided, and shall be suitable for operation on 240 V, single phase, 50 Hz, A.C. for each panel.
- viii) HT panel board receiving more than one incomer and bus section, these shall be castle key interlocked.

10.2 Cable Boxes:

Cable boxes shall be situated in a compartment at the rear of the housing as specified.

10.3 Cable Entry:

Provision for bottom side entry shall be made as per requirement with sufficient head room for cable termination. 3mm thick removable gland plate shall be provided for cable termination.

10.4 Earthing:

The earthing of the breaker body and moving portion shall be so arranged that the earthing of the non-current carrying structure to the frame earth bar is completed well before the main circuit breaker plugs enter the fixed house sockets. The entire panel board shall be a common tinned copper earth bar of suitable section with 2 earth terminals for effectively earthing metallic portion of the panels and shall be provided as per specifications.

10.5 Installation:

The installation work shall cover assembly of panel boards, lining up, grouting the units etc. After connecting up the bus bar, all joint shall be insulated with HV insulation tape or with approved insulation compound. A common earth bar shall be run preferably at the back of the switch board connecting all the sections for connecting to the earth system. All protection, indication & metering connections and wirings shall be completed. Where trip supply battery is installed, the unit shall be commissioned, completing initial charging of the batteries. All relays,

instruments & meters shall be mounted and connected with appropriate wiring. Calibration checks of unit as necessary and required by the licensee like CTs, VTs, metering etc. shall be completed before pre-commission checks are undertaken.

10.6 TOOLS AND PLANTS (T&P):

Two sets of T&P with tool box shall be supplied along with HT VCB & panel board as recommended by OEM complete.

10.7 PRE-DELIVERY INSPECTION AT WORKS:

The HT breaker shall be tested for routine and acceptance test at the manufacture works as per relevant IS specifications in presence of AAI authorized representative.

10.8 TESTING AT SITE AND COMMISSIONING:

Procedure for testing and commissioning of relay shall be in general accordance with good practice. Commissioning checks and tests shall include in addition to checking of all small wiring connections, relays calibration and setting tests by secondary injection method and primary injection method. Primary injection test shall be preferred for operation of relay through CTs. Before panel board is commissioned, provision of the safety namely fire extinguishers, rubber mats and danger board shall be ensured. In addition all routine IR tests shall be performed. Checks and test shall include following:

- (a) Operation Checks and lubrication of all moving parts.
- (b) Interlock function checks.
- (c) Three pole timing tests.
- (d) Contact resistance test
- (e) Continuity checks of wiring, protection control by Fuses/MCB's etc. as required.
- (f) Insulation tests.
- (g) Trip test and protection gear tests.

The complete panel shall be tested with 5000V IR test equipment for insulation between poles and poles to earth. Insulation test of secondary of CTs and VT to earth shall be conducted using 500V IR test equipment.

Where specified, the entire switch board shall withstand high voltage test after installation.

Any other tests as shall be required by the Licensee/ Inspector shall be conducted.

TECHNICAL PARTICULARS OF SWITCHGEAR EQUIPMENT:

S. No	Description		11 KV
1.	Type	:	Indoor, cubicle type
2.	System rated voltage	:	11 KV
3.	System maximum voltage	:	12 KV
4.	Frequency	:	50 Hz.
5.	Insulation Level		
	a)	1.2/50 microseconds impulse withstand voltage	: 75 KV peak
	b)	One minute power frequency withstand voltage	: 28 KV rms
6.	Rated Current		
	a)	Continuous	
		Bus bar	: 800 Amp.
		Incoming Vacuum circuit breaker	: 630 Amp.
		Outgoing Vacuum circuit breaker	: 630 Amp.
	b)	Short time current for 1 seconds	: 25 KA rms
7.	Vacuum Circuit Breaker:		
	a)	Quantity	
		Incoming Feeder	: 2 Nos.
		Outgoing Feeder	: 2 Nos.
		Bus coupler	: 1 No.
	b)	Rated breaking capacity symmetrical	: 500 MVA
	c)	Total breaking time	: 3 Cycles (maximum)
	d)	Auxiliary voltage	
		Control Circuit	: 24 V DC
		Space heater and illumination lamp, etc.	: 230 V, 1 Ph., 50 Hz.
8.	Potential Transformers		: (At Incoming)
	a)	Quantity	: One on each incoming panel
	b)	Voltage Ratio	: 11 KV/110 V
	c)	Over voltage factor	: As per IS – 3156
	d)	Accuracy class	: 1.0
	e)	Rated burden	: 100 VA
9.	Current Transformer:		

33 kV	Circuit	Ratio	Accuracy class	Burden	Ratio	Accuracy Class	Burden
	Incoming – I						
	For relay	50/1A	5P10	15 VA	As reqd.	5P10	15 VA
	For metering	50/1A	1.0	15 VA	As reqd.	1.0	15 VA
	Outgoing – I, II				As reqd.		
	For relay	50/1A	5P10	15 VA	As reqd.	5P10	15 VA
	For metering	50/1A	1.0	15 VA	As reqd.	1.0	15 VA
11 kV	Circuit	Ratio	Accuracy class	Burden	Ratio	Accuracy class	Burden
	Incoming – I						
	For relay	As reqd.	5P10	15 VA	As reqd.	5P10	15 VA
	For metering	As reqd.	1.0	15 VA	As reqd.	1.0	15 VA
	Outgoing – I, II	As reqd.					
	For relay	As reqd.	5P10	15 VA			
	For metering	As reqd.	1.0	15 VA			

II- DISTRIBUTION TRANSFORMER

(UPTO 2500KVA)

1.0 GENERAL

The scope of these specifications covers the detailed requirement of Supply Installation, Testing & Commissioning of oil filled /dry type transformers (1Working+ 1Standby) suitable for BMS /SCADA system either inbuilt or separate compatible including all that reasonably inferred as necessary for the proper installation and putting the installations in operational of the extended in the following specifications and Scope of work (SOW) as specified.

The transformer shall be indoor / outdoor as specified. All transformers shall have thermal as well as dynamic ability to withstand external short circuit as per standard. However, Selection of Voltage will depend upon the design considering the location and safety factors submitted by the successful bidder.

2.0 STANDARDS

The oil filled/ dry type Transformer shall comply with the following Indian standard specifications as amended up to date.

IS 2026 Part – I to V	:	Power Transformers
IS-1180 (LEVEL-2)	:	Distribution Transformers (OIL TYPE)
IS 11171- 1985	:	Dry type power transformers
IS 335-1993	:	Insulating oil.
IS 10028 (Part-II & III)	:	Installation & Maintenance of Transformers.
2099	:	Bushings
IS 2705	:	Current Transformer
IS 2071	:	Method of high voltage testing technique.
IS 6600	:	Guide for loading of oil immersed transformer.
ECBC 2017	:	Losses of transformer as per latest revision

3.0 OIL COOLED TRANSFORMER (Indoor / outdoor)

3.1 Transformer Operation

The transformer shall be suitable for operation on 11KV / 415V, three phase, 50 cycle, earth system, oil immersed natural air cooled (ONAN), double winding type, connected delta on HV side and star on LV side (Dyn-11) with neutral brought out separately for earthing. The transformer shall be suitable for continuous operation at the rated capacity under site conditions specified.

3.2 Transformer Characteristics

The no load voltage ratio of the transformer shall be 11KV / 415V and the percentage impedance shall be as per IS 1180-2 as amended up to date.

3.3 Transformer materials & its enclosure

The material used in the manufacture of the transformer shall be of the best quality of their respective kind available as per standard specifications.

The transformer shall be provided with a mild steel Tank with adequate provision for ventilation. The degree of protection for Tank shall be IP 55. Thickness of Tank shall be as per IS-1180.

After rigorous cleaning & surface treatment, the transformer shall provide primer coat, finished with two coats of weather resisting or enamel machinery paint conforming to relevant IS.

3.4 CORE

The magnetic iron core shall be made up of high grade, low loss grain oriented CRGO steel stamping, HI-B grade steel or superior grades. The maximum flux density at any point in core and York shall not exceed 1.6 Tesla on normal rated voltage and frequency and 1.76 Tesla at 110% rated voltage & frequency. Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil. A margin of 10 to 12.5% for over fluxing may be provided for the worst combination of voltage and frequency within the ranges specified.

Note:

No core of second grade / scrap materials will be acceptable. The manufacturer of the transformer shall select prime (first) grade core materials. OEM undertaking shall be submitted to authority along with technical submittal for approval/ acceptance by the bidder.

Core shall have boltless design.

3.5 WINDING & ITS INSULATION:

The winding shall be of copper wound. The insulation material used shall be insulation class 'A'. The conductors shall be of electrolytic grade copper. Better insulating material shall be used and compression of the windings after drying out shall be carried out at a pressure exceeding one and a half to twice the force which can occur in the transformer; to impart greater mechanical strength to the windings against heavy short circuit stresses.

3.6 EXPLOSION VENT:

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might

result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and of such a design to prevent gas accumulation.

3.7 BUCHHOLZ RELAY

Oil and gas actuated relay equipment shall conform to IS 3637-1966 and shall be double float type having contacts which close falling oil surge or under incipient fault condition. Buchholz relay shall have contact for alarm / trip as required. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure. The contacts of relay shall be properly housed, sealed and gasket to make the arrangements water proof.

3.8 OIL:

The insulating oil should have non-sludging low viscosity property and comply with the requirement of relevant IS.

3.9 TAPINGS:

The tapping shall be arranged on the high voltage windings only to provide for a voltage adjustment of +5% to -10% in steps of 2.5% of rated voltage at constant KVA output. Full output shall be available on all the tapping's specified above. The tapping shall be brought out to terminal block located just below the oil level. A triple pole off load hand wheel tap changing switch with position indicator and locking arrangement shall be provided for operation without removing the tank covers or lowering off the oil levels.

3.10 TERMINALS:

Primary terminal arrangement shall consist of 3 pole-single gland cable sealing box fitted to the underside of the connection chamber. Secondary terminal arrangement shall consist of 4 pole bus trunking/cable(s) connections. Appropriate characters in accordance with relevant IS shall be indelible and clearly marked upon on adjacent to terminal and sub-terminals.

3.11 RATING AND DIAGRAM PLATES:

The following plates shall be fixed to transformer in a visible position.

- a) A rating plate of weather proof material bearing the data specified in the appropriate clauses of IS: 1180.
- b) A diagram plate showing the internal connection and also the voltage vector relationship of the several windings in accordance with IS: 1180 and a plan

view of the transformer giving the correct physical relationship of the terminals.

3.12 JOINTS AND GASKETS

All gaskets used for making oil tight joints shall be of proven material such as granulated cork bonded with synthetic rubber gaskets or synthetic rubber or such other good material.

3.13 Transformer shall be complete with first filling oil, control cable between transformer marshalling box upto HT panel including interconnection and with following fittings & accessories conforming to IS 3639- (with upto date amendment) shall be provided with each transformer:

- a. Inspection cover.
- b. External hand operated **off-circuit** tap changing switch with position indicating plate & locking arrangement.
- c. Oil conservator with filling hole and cap having detachable end cover.
- d. Plain / Magnetic oil level gauge with minimum oil level marking.
- e. Oil drain valve of size as per ISS with plug or cover plate.
- f. Silica-gel dehydrating breather along with breather pipe of suitable size.
- g. Rating plates and terminal marking plate of stainless steel / brass / aluminium engraved containing the information specified in relevant IS.
- h. Two earthing terminals for body earthing consisting of hexagonal bolts of size M-20 as per relevant IS.
- i. Lifting lugs/cover lifting eyes.
- j. Radiator for the cooling system (natural air cooling) by means of pressed /round tubes and fins around transformer tank.
- k. Four bi-directional flat rollers of suitable size fitted on cross channels, corresponding to weight of transformer to facilitate movement of transformer.
- l. Thermometer pocket with plug.
- m. Air release device.
- n. Explosion vent.
- o. 50 mm dial type winding and oil temperature indicator with potential free electrical contact for alarm & trip, fitted with Anti-vibrating mounting with maximum reading pointer.
- p. Oil filter valve at TOP of the tank.
- q. Marshalling box to terminate the control cables of thermometer etc.
- r. HT side cable end box suitable for heat shrinkable termination of maximum size and type of HT cable(s) as required /specified.
- s. LT side cable (up to 400KVA transformer) / bus trunking termination arrangements suitable for rating & type as required /specified.
- t. Facility to connect Buchholz Relay (shall be applicable for transformer rating above 400KVA).
- u. Additional neutral separately brought out on a bushing for earthing for all transformers.

3.14 PRE-COMMISSIONING TESTS

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

- i) IR Test
- ii) DC Resistance measurement of windings
- iii) Ratio test on all taps
- iv) Phase relationship test (Vector grouping test)
- v) Buchholz relay alarm & surge operation test
- vi) Low oil level (in conservator) alarm
- vii) Temperature Indicators
- viii) Marshalling kiosk
- ix) Protective relays
- x) Magnetizing current

The following additional checks shall be made:

- i) All oil valves are in correct position closed or opened as required.
- ii) All air pockets are cleared.
- iii) Thermometer pockets are filled with oil
- iv) Oil is at correct level in conservator, diverter switch & tank etc.
- v) Earthing connections are made. Colour of Silica gel is blue. CT polarity and ratio is correct.

4.0 PERFORMANCE TEST: The following performance test shall be conducted on one transformer for each design:

4.1 TEMPERATURE RISE:

Rise in temperature of transformer when tested at continuous maximum rating at a peak ambient temperature of 50 deg. C shall not exceed the limits given below:

- a) **WINDINGS:** Average temperature rise as measured by increase in resistance of windings connected between terminals shall not exceed 115 deg. C in case of oil and 90deg. C for dry type transformer.
- b) **OIL:** Temperature rise as measured by thermometer in case of oil of the transformer shall not exceed as **per IS-1180.**
- c) **CORES:** Temperature rise when measured by thermometer on the external surface of core shall not exceed the temperature permitted as per relevant **IS-1180**

5.2 IMPULSE STRENGTH OF WINDINGS:

The impulse strength of winding of the transformer when tested with the standard 1.2/50 micro sec. positive wave shall not be less than specified in the IS. The transformer shall have fully insulated windings designed to meet impulse levels. If no test is carried out of such transformer, the same should be carried out for at least on one transformer. The copies of valid calibrated instruments shall also be submitted for record.

5.3 **FREQUENCY:**

The transformer shall be designed for a normal frequency of 50 Hz and shall be capable of giving the rated output with the frequency varying by plus or minus 3% from the rated frequency.

5.4 **IMPEDANCE:**

The percentage impedance shall be as per IS standard. Duration of short circuit with reference to impedance voltage for each transformer shall be in accordance with relevant IS.

5.5 **EXTERNAL SHORT-CIRCUIT:**

Transformer shall be designed to be capable of withstanding without injury, the thermal and mechanical effect of short circuit at the terminals of any windings for the period in accordance with relevant IS. **OEM to submit Certificate for similar or higher rating from CPRI or approved Govt. Lab.**

5.6 **EFFICIENCY AND REGULATION:**

Efficiency and regulation shall be based on loading at rated KVA and at unity power factor and at 0.8 lagging power factor and shall be computed in accordance with relevant IS respectively.

5.7 **TRANSFORMER LOSSES:** The associated losses of oil filled distribution transformers shall be as per IS-1180 (Level-2) & Cast Resin Dry type transformers shall comply as per latest ECBC-2017 at different loads.

6.0 **TESTS AT MANUFACTURER'S WORKS:**

The transformers are subject to inspection during their manufacture. All routine & other tests prescribed in IEC 60076 -11 and relevant IS-11171 & ECBC 2017 norms with upto date amendments shall be carried out before despatch at manufacturers works in presence of inspecting officer and of following :

6.1 **MEASUREMENT OF WINDING RESISTANCE TEST:**

The resistance of each winding and the marking of the terminals between which it is measured shall be recorded. While measuring the resistance care shall be taken to determine the temperature of windings. The temperature at which the measurement is made shall be recorded.

6.2 **RATIO - POLARITY & PHASE RELATIONSHIP TEST:**

The turns ratio shall be measured on each tapping and the polarity & winding phase relationship shall be checked.

6.3 MEASUREMENT OF IMPEDANCE VOLTAGE:

The impedance voltage shall be measured at rated frequency, using an approximately sinusoidal supply. The measurement may be made at any current not less than 50% rated current and the value so obtained shall be increased in the ratio of the rated current to the test current. The test result shall be corrected to the reference temperature of the 75 deg.C.

6.4 MEASUREMENT OF NO- LOAD LOSSES AND NO-LOAD CURRENT:

No load losses shall be measured at rated frequency with rated voltage applied to one of the three phase windings, the other windings being open circuited. No load current shall also be recorded.

6.5 MEASUREMENT OF LOAD LOSSES:

This test shall be performed as per clause of relevant IS.

6.6 MEASUREMENT OF INSULATION RESISTANCE:

The oil and windings temperature shall have measured and recorded immediately prior to the test. The Insulation resistance of each windings, in turn, to all the other windings, cores and frame or tank connected together, and to earth shall be measured and recorded.

6.7 INDUCED OVER VOLTAGE WITHSTAND TEST:

This test shall be performed as per clause of relevant IS.

6.8 SEPARATE SOURCE VOLTAGE WITHSTAND TEST:

This test shall be performed as per clause of relevant IS.

6.9 OIL TEST: IN CASE OF OIL COOLED TRANSFORMER

Oil test specified in British standard specifications No. 148/IS 335 shall be carried out and maker's certificate forwarded.

The offered equipment or the same equipment of higher capacity must have successfully type tested as per IS-2026 (with upto date amendment). The type test certificate and test equipment, valid test copies shall be submitted before inspection at works. If the impulse voltage withstands and temperature rise is not type tested, firm to carry out the same during inspection at works.

7.0 Type test certificate of CPRI or any other approved test house for **similar or higher rating** of transformer to be submitted along with the approval of technical submittal & drawings.

8.0 PARALLEL OPERATION

The transformer shall be suitable for parallel operation. Therefore, selection of transformer should be ensured for percentage impedance, voltage ratio, vector groups, phase sequence etc. are same for all units.

9.0 **TRANSFORMER INSPECTION AT SITE ON ARRIVAL**

- i. The transformer shall be inspected on arrival as per the inspection manual of the supplier.
- ii. The transformer shall be examined of any sign of damage and special attention shall be given to the following parts of **oil cooled transformer as applicable**:
 - Oil tank and cooling tubes.
 - Bushes cracks or broken.
 - Oil sight glass.

10.0 **INSTALLATION & COMMISSIONING:-**

- i. The transformer shall be installed as per installation manual of the transformer suppliers and conforming IS 10028 (Part-II & III) - Code of practice for Installation and Maintenance of transformers. Necessary foundation and/or support channels shall be grouted in the flooring as required within the scope of works.
- ii. The transformer supplied shall be lifted by lifting lugs for the purpose of avoiding imbalance in transit.
- iii. The transformer shall be moved to its location on grouted channels & wheels shall be locked by suitable locking arrangement to avoid accidental movement of the transformer.
- iv. The transformer cable end boxes shall be sealed to prevent absorption of moisture.
- v. The transformer neutral earthing, body earthing & other wiring shall be done as shown on the approved drawings and as per specifications.
- vi. All devices shall be checked for satisfactory operation.

11.0 **TESTS AT SITE:-**

In addition to tests at manufacturer's premises, all relevant pre-commissioning checks and tests conforming to IS code of practice No.10028 (Part II & III) shall be done before commissioning. The following tests are to be particularly done before cable jointing or connecting up the bus bar trunking.

- a. Insulation test between HV to earth and HV to MV with a 5000 Volts IR tester.
- b. Insulation test between MV to earth with 500 volts IR tester.
- c. Winding resistance of all the windings on all the tap positions shall be taken.

- d. Di-electric strength of transformer oil shall be checked in accordance with IS 335. In case the test is not satisfactory, the oil shall be filtered till proper dielectric strength of oil is obtained and also top up within the scope of the bidder.
- e. Buchholz relay operation by simulation test when fitted.

All test results are to be recorded and reports should be submitted to the Engineer In Charge for its acceptance.

IV - SPECIFICATION FOR AMF DG SET

(Above 200KVA & upto 1000KVA)

1.0 GENERAL CONDITIONS

This General Specifications cover the equipments and materials for the selection of AMF DG sets (1Working+ 1Standby) of upto 1000KVA, their testing and / or inspection as may be necessary for assembled silent DG set & AMF panel which is dispatched from the works, its delivery at site, all preparatory works, assembling, installation and adjustments, commissioning, final testing, putting into operation and handing over of the complete system.

The EPC contractor shall select DG sets complying National Clean Air Programme (NCAP) guidelines launched by Ministry of Environment, Forest and Climate Change (MoEF & CC) to maintain Particulate Matter (PM) capturing efficiency of at least 70% according to type of approval by one of the five CPCB recognized labs.

The emission parameters stipulated by CPCB shall be checked and confirmed after the installation. These parameters shall be within permissible limits as specified in above guidelines of National Clean Air Programme (NCAP) report clause 7.5.3.

STANDARDS & CODES:

The design, manufacture and testing of the AMF DG sets & its components shall be carried out as per latest applicable Indian Standards, Indian Electricity Rules, relevant code of practices and requirement of Chief Electrical Inspectorate of the State Government and International Electro Technical Commission (IEC) Standards. However, for ready reference some of the Standards and Code of Practices are given below:

All components shall conform to relevant Indian Standard Specifications, wherever existing, amended to date.

All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 as amended up to date. They shall also conform to CPWD General Specifications for Electrical works, Part-I (Internal), 2013 and Part-II (External), 1994 and Part IV (Sub-station), 2013, as amended up to date.

Clearance/ Approval of the complete installation from CPCB/ State Pollution Control Board, Central Electricity Authority (CEA)/ Local Bodies and other licensing authorities, wherever required.

IS 1601	:	Performance and testing of 1C engines for General Purpose
BS-649	:	Performance and testing of diesel engines for General Purpose.
IS-4722	:	Rotating electrical machines.
IS-4889	:	Method of determination of efficiency of Rotating Electrical machinery
IS-6491	:	Degree of protection provided by enclosures for Rotating Electrical machinery
IS-4729	:	Measurement and evaluation of vibration of Rotating Electrical machines.
AIEE-606	:	Recommended specification for speed governing of internal (1959) combustion engine generator units.
IS-2705	:	Current transformers
IS-1248	:	Electrical indicating instruments.
ISO-8528 (Part II)	:	Reciprocating IC engine driven AC Gensets Section
IEC 60439	:	Low voltage switchgear & control gear Assemblies
Part – I	:	Partially Type Tested Assemblies
IEC 62208 / IS 2147	:	Empty enclosures for low voltage switchgear and control gear assemblies – General Requirements
IEC 62262	:	Degree of protection provided by enclosures for electrical equipments against external mechanical impacts (IK code)
IS IEC 60947	:	Low voltage switch gears

1.1 Works to be done by the contractor

Unless otherwise mentioned in the tender documents, the following works shall be done by the contractor and therefore, their cost shall be deemed to be included in their tendered cost – whether specifically indicated in the schedule of work or not:-

- i) AVM type pad shall be used as per recommendation of manufacturers. The design of the foundation for installation of complete DG set with canopy shall be submitted duly vetted by structural engineer for approval by Engineer In Charge.

- ii) Making good all damages caused to the structure during installation and restoring the same to their original finish.
- iii) Minor building works necessary for installation of equipments, foundation trench for fuel lines & cables, making of opening in walls or in floors and restoring them to their original condition / finish and necessary grouting etc., as required.
- iv) All supports for exhaust pipes, sundry equipments, fittings, assemblies, accessories, hardware items, etc. as are necessary.
- v) All electrical works and neutral earthing, body earthing, required for engine & alternator, main board/ control panels and control wiring including loop earthing, as required. The Neutral connection inside the canopy shall be extended with flexible copper cable with lugs etc.
- vi) All pipes, cable connections etc.
- vii) POL i.e. HSD oil and lub oil for diesel engine for testing & commissioning and for trial run as per conditions of the contract. All tools and tackles required for unloading / handling of equipments and materials at site, their assembly, erection, testing and commissioning shall be the responsibility of the contractor.
- viii) Painting of all exposed metal surfaces of equipments and components with appropriate colour.
- ix) Approval / clearance of the complete installation shall be obtained by the contractor from CPCB / State Pollution Control Board / Local Bodies / Central Electricity Authority (CEA) / other licensing authorities, wherever required. However, application shall be made by Department and any statutory fee, as applicable, shall be paid by Department directly to the Govt. authorities.
- x) Carry out routine and preventive maintenance as per manufacturer's standards for a period of 24 months from the date of handing over i.e. during defect liability period shall be contractor scope of works. The fuel shall be supplied departmentally for operation of DG set.

1.2 **Location:** Substation building at proposed Airport.

1.3 **Climatic conditions:**

The output of DG set shall be considered under climatic conditions to be in conformity with CPCB approved type tests for the proposed location of the Airport for: -

- i) Outside maximum ambient temp.
- ii) Height above Mean sea level
- iii) RH

1.4 **SHOP DRAWING SUBMISSION** :

- a) On award of work contractor shall submit shop drawing along with technical compliance of contract specification and supporting calculation sheets for selection of DG set rating, complete.
- b) On approval of technical submittal, four sets of working drawings to be submitted by the contractor to Engineer – In – charge.
- c) On completion of work, four sets of **as built drawing** to be submitted.

2.0 **DIESEL ENGINE:**

- 2.1 **Standard:** The Engine shall conform to IS;10000/ISO 3046/BS; 649/BS 5514 amended upto date. /
- 2.2 **Rating:** The engine shall be of standard design of the original manufacturers. It should be 4 stroke cycles, water cooled, turbo charged, diesel engine developing suitable BHP for giving a power rating as per ISO 8528-Part-1 in KVA at the load terminals of alternator at 1500 rpm after accounting for derating in engine out put if any, as per the climate conditions of proposed site & due to acoustic enclosure.
 - 2.2.1.1 The engine shall be capable for delivering specified Prime Power rating at variable loads for PF of 0.8 Lag with 10% overload available in excess of specified output for one hour in every 12 hours continuous operation. The average load factor of the Genset over period of 24 hours shall be at least 85% for prime continuous power output.
 - 2.2.2 Necessary certificate indicating the compliance of the above capacity requirement for the engine model so selected along with compliance of Noise and Emission norms as per latest CPCB guidelines for DG set capacities should be furnished from the manufacturer.
- 2.3 The engine shall be fitted with following accessories subject to the design of the manufacturer:
 - i) Dynamically balanced fly-wheel.
 - ii) Air cleaner (dry type).
 - iii) A Electronic governor to maintain engine speed at all conditions of load.
 - iv) Dry exhaust manifold with suitable exhaust hospital grade silencer to reduce the noise level.
 - v) Suitable self starter for 12 V/24V DC.

- vi) Battery charging alternator unit and voltage regulator, suitable for starting batteries, battery racks with interconnecting leads and terminals. The Charger shall be SMPS type.
- vii) Necessary gear driven oil pump for lubricating oil as well as fuel systems as per manufacturer standard.
- viii) Turbo charger.
- ix) Lubrication oil cooler.
- x) Cartridge type Lubrication oil filters.
- xi) **Fuel injection:** Engine should have suitable fuel injection system in order to achieve low fuel consumption.
- xii) Fuel control solenoid
- xiii) Fuel pump with engine speed adjustment.
- xiv) **Engine Control Panel:** fitted and having digital display for following:
 - a) Start /stop key and or switch.
 - b) Water temperature indication
 - c) RPM indication
 - d) Engine Hours indications
 - e) Battery charging indication
 - f) Low lube Oil pressure trip indication
 - g) High water temperature indication.
 - h) Over speed trip indication.
- xv) All moving parts of the engine shall be mechanically guarded in such a manner that a human finger cannot touch any moving part.
- xvi) Radiator.
- xvii) Any other item not included / specified, but is a standard design of the manufacturer.

2.4 **Governor:**

Electronic governor of class A1 as per ISO 3046/ BS 5514 with actuator shall be provided as per standard design of manufacturer. Governor shall be a self-contained unit capable of monitoring speed.

The governors shall have drooping characteristics so as to ensure proper load sharing. The governing system shall be complete with all devices / switches for auto / manual operation.

The over speed trip mechanism shall also be provided to automatically shut off the supply of fuel in case the engine speed reaches 110% of rated speed.

2.5 Frequency variation:

The engine speed shall be so maintained that frequency variation at constant load including no load shall remain within a band of 1% of rated frequency.

2.6 Fuel System:

It shall be fed through engine drive fuel pump. A replaceable element of fuel filter shall be suitably located to permit easy servicing.

The separate (not inbuilt) daily fuel tank shall be provided suitable for 990 Ltrs. capacity for each set. The tank shall be fitted with breather, drain plug, transparent PVC pipe connections with valves and calibration strip, low level contacts and alarm, connecting piping works with valves etc. and shall be made out of minimum 2mm thick MS sheet. The piping & valves etc shall be selected / planned / design to meet the site requirements.

Further, the two DG set tanks shall be interconnected with valves in such a way that each tank can use with either of DG set.

2.7 Lubricating oil system

It shall be so designed that when the engine starts after a long shut down lubrication failure does not occur. Design / selection shall be as per OEM standard.

The lubrication oil shall be recommended grade of engine manufacturer, marketed in India and suitable for climatic conditions of proposed airport site.

2.8 Electric Starting System:

This shall comprise of necessary set of heavy duty batteries 12V/24V DC suitable starter motors, axial type gear to match with the toothed ring on the fly wheel. A timer in the control panel to protect the starter motor from excessively long cranking runs shall be suitably integrated with the engine protection system and shall be included within the scope of the work. Battery capacity shall be suitable for meeting the needs of starting system (as three attempt starting), as well as the requirements of control panel, indications and auxiliaries such as priming pump as applicable etc. The scope shall cover all cabling, terminals, including initial charging etc. The system shall be capable of starting the DG set within 10 seconds, even in winter condition with an ambient temperature down to 0° C.

2.9 Turbo Charger

The turbo charger shall be suitable for being driven by waste gases from the engine and having a common shaft for the turbine and blower. It shall draw air from the air filters and shall be of suitable capacity corresponding to engine requirements. The output of the turbo charger shall be suitably routed through an inter-cooler for obtaining better efficiency.

2.10 Fly wheel:

The engine shall be provided with suitable balanced flywheel to ensure and maintain the cyclic irregularity within the limits specified in BS : 5514. The combined inertia of the flywheel and alternator rotating shall be such that the angular deviation in either direction from the position of uniform rotation shall not at any time exceed limit.

2.11 Piping Work

All pipe lines, fittings and accessories requirement inside the room/enclosure and outside for exhaust piping shall be provided by the contractor. This shall include necessary flexible pieces in the exhaust, fuel, lub. oil and water lines as are necessary in view of the vibration isolation requirement in the installation. Piping of adequate size shall be used for lub. oil of the material as per manufacturer standard. However, only M.S. pipes for the exhaust and fuel oil lines shall be used.

For fuel lines within acoustic enclosure, PVC braided pipe as per manufacturer recommendations can only be used.

The pipe work shall be inclusive of all fittings and accessories required such as bends, reducers, elbows, flanges, flexible connections, necessary hardware etc. the installation shall cover clamps, supports, hangers etc. as are necessary for completing the work. However, the work shall be sectionalized with flanged connections as are necessary for easy isolation for purposes for maintenance of unit as approved by Engineer-in-charge.

2.12 Common base plate

Engine and alternator shall be coupled by means of rigid coupling as per manufacturer standard design and both units shall be mounted on a common base plate together with all auxiliaries to ensure perfect alignment of engine and alternator with minimum vibrations. The base shall have suitable anti-vibration mounting system.

2.13 Exhaust system

i) Exhaust piping :

All M.S. Pipes for exhaust lines shall be conforming to relevant IS. The runs forming part of factory assembly on the engine flexible connections upto exhaust silencer shall be exclusive of exhaust piping item. The work includes necessary cladding of exhaust pipe work using 50mm thick glass wool / mineral wool/rock wool of density not less than 120 kg/m³ and aluminium cladding (0.6mm thick) for the complete portion. The exhaust pipe work includes necessary supports, Foundation etc. to avoid any load & stress on turbo charger / exhaust piping. The exhaust pipe support structure shall be got approved by engineer-in-charge before execution and with the following:

- a) Exhaust system should create minimum back pressure.
- b) Number of bends should be kept minimum and smooth to minimize back pressure.
- c) Pipe sleeve of larger dia should be used while passing the pipe through concrete wall & gap should be filled with felt lining.
- d) Exhaust piping inside the Acoustic Enclosure / Gen-set room should be insulated with mineral / rock wool along with aluminium sheet cladding to avoid heat input to the room.
- e) Exhaust flexible shall have it's free length when it is installed. For bigger engine, 2 flexible bellows can be used to meet the system design requirement.
- f) 'B' class MS pipes and long bend /elbows should be used.
- g) The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet /windows etc.
- h) When tail end is horizontal, 45 degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.
- i) When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

ii) Support to exhaust piping:

Exhaust pipe should be supported in such a manner that load of exhaust piping is not exerted to turbo charger. In case of installation in sub-station room, the pipe support shall be provided with spring suspension.

iii) Exhaust Stack height:

In order to dispose exhaust above building height, minimum exhaust stack height should be followed as per relevant IS standard and submitted for approval of engineer In Charge for its acceptance before start of work.

2.14 Air System

It is preferable to provide vacuum indicator with all engine to indicate choked filter. Maximum air intake restrictions with clean and choked filters should be within prescribed limit as per OEM / manufacturer recommendation for the particular model of the engine. Genset should be supplied with heavy duty air cleaner.

3.0 ALTERNATOR

3.1 **Standards:** The alternator shall be in accordance with:-

- i) IS:4722 / BS:2613/1970. The performance of rotating electrical machine.
- ii) IS:4889 / BS:269 rules for method of declaring efficiency of electrical machine.
- iii) Alternator shall be in accordance with the relevant Bureau of Indian Standards prevailing on date (IEC 60034) with upto date amendments

3.2 Technical requirement of the Synchronous Alternator : Self excited, screen protected self regulated, brush less alternator, Horizontal foot mounted in Single bearing construction suitable for the following:

Continuous output Rated KVA under proposed site condition i/c considering de-ration, if any).

Rated PF	:	0.8 (lag)
Rated voltage	:	415 volts
Rated Frequency	:	50 Hz
No. of phases	:	3
Duty	:	Prime duty
Enclosure	:	SPDP (Screen Protected & Drip Proof)
Degree of protection	:	IP -23
Ventilation	:	Self ventilated air cooled
Insulation Class	:	H or higher
Temperature Rise	:	With in class H limits at rated load
Voltage Regulation	:	+ 1%
Overload duration / capacity	:	a) 10% for one hour in every 12 hours of continuous operation. b) 50% over load for 15 second
Frequency variation	:	As defined by the Engine Governor (+/- 1%)
Excitation	:	As per system design of OEM (self or separately excited)
Type of AVR	:	Electronic / Digital

Type of Bearing & Lubrication arrangement	:	Long life anti-friction bearing with Grease lubrication at one end.
RTD & BTD	:	Suitable nos. of Resistance Temp. Device (RTD) & Bearing Temp Device (BTD) with wired upto terminal box & temp scanner shall be provided in control panel.
Termination box	:	IP55

3.3 **Excitation:**

The alternator shall be brushless type and shall be self excited or separately excited, self regulated having static excitation facility. The exciter unit should be mounted on the control panel or on the alternator assembly. The rectifier shall be suitable for operation at high ambient temperature at site.

3.4 **Automatic Voltage Regulators (AVR):**

In order to maintain output terminal voltage constant within the regulation limits i.e. $\pm 1\%$, Automatic voltage regulator unit shall be provided as per standard practice of manufacture.

3.5 **Fault tripping :**

In the event of any fault e.g. over voltage or an external fault, the AVR shall remove the excitation voltage to the alternator. An emergency trip shall also be provided.

3.6 **Performance:**

Voltage dip shall not exceed 20% of the rated voltage for any step load or transient load as per ISO: 8528 (Part I). The winding shall not develop hot spots exceeding safe limits due to imbalance of 20% between any two phases from no load to full load.

The generator shall preferably be capable of withstanding a current equal to 1.5 times the rated current for a period of not more than 15 seconds as required vide clause 14.1.1. of IS 4722:1992.

The performance characteristics of the alternator shall be as below:

- | | |
|--------------------------------------|---|
| (a) Efficiency at full load 0.8 P.F. | - Above 250KVA - not less than 92.5 % |
| (b) Total distortion factor | - Less than 3% |
| (c) (i) 10% overload | - One hour in every 12 hrs of continuous operation. |
| (ii) 50% overload | - 15 seconds |

3.7 Terminal Boxes:

Terminal boxes shall be suitable for U.G. cables/ Bus trunking. The terminal box shall be suitable to withstand the mechanical and thermal stresses developed due to any short circuit at the terminals.

3.8 Earth Terminals :

2 Nos. earth terminals on opposite side with vibration proof connections, non-ferrous hardware etc. with galvanized plate and passivated washer of minimum size 12mm dia. hole shall be provided.

3.9 Space Heaters

Alternators of capacity more than 500 KVA shall be provided with suitable space heaters to maintain the winding temperature automatically such that it does not absorb moisture during long idle periods. The heater terminals shall be brought to a separate terminal box suitable for 230 V AC supply and a permanent caution notice shall be displayed.

4.0 AMF CONTROL PANEL WITH BYPASS ARRANGEMENT.

Detailed specification for switchgear, controls, metering, indications, painting etc shall be followed as described in LT panel sections

The design and construction of the AMF control panel shall be partially type tested design as per IEC 61439. The panel shall be manufactured by OEMs or their licence partner within approved make list of AAI.

4.1 General Features:

It shall be made into sections such that as far as feasible, there is no mixing of control, power, DC & AC functions in the same section and they are sufficiently segregated except where their bunching is necessary. Hinged doors shall be provided preferably double leaf for access for routine inspection from the rear. There is no objection to have single leaf hinged door in the front, all indication lamps, instruments meter etc. shall be flushed in the front. The degree of protection required will be IP-42 conforming to IS:2147.

4.2 Terminal blocks and wiring:

Terminal blocks of robust type and generally not less than 15 Amps capacity, 250/500 volts grade for DC upto 100 volts and 660/1100 volts grade for AC and rest of the junction shall be employed in such a manner so that they are freely accessible for maintenance. All control and small wiring from unit to unit inside the panel shall also be done with not less than 2.5 sq.mm copper conductor PVC

insulated and 660/1100 volts grade. Suitable colour coding can be adopted. Wiring system shall be neatly formed and run preferably, function wise and as far as feasible segregated voltage-wise. All ends shall be identified with ferrules at the ends.

4.3 Labelling:

All internal components shall be provided with suitable identification labels suitably engraved. Labels shall be fixed on buttons, indication lamps etc.

AMF panel shall be provided with wiring diagram of all electrical and control circuit with laminated sheet, suitably fixed on inside of the panel doors.

4.4 Equipment requirements:

The control cubical shall incorporate into assembly general equipment and systems as under:

- a) Control system equipments and components such as relays, contactors, timers etc. both for automatic operation on main failure and as well as for manual operation.
- b) Equipment and components necessary for testing generating set's healthiness with test mode and with load on mains.
- c) Necessary instruments and accessories such as voltmeter, power factor meter, KW meter, KWH meter, Ammeter, Frequency meter etc. in one energy analyzer unit with selector switch to obtain the reading of desired parameter.
- d) Necessary indication lamps, circuit protected with MCB, terminal blocks, push buttons, control switches etc., as required.
- e) Necessary engine/generating set shut down devices due to faults/abnormalities.
- f) Necessary visual audio alarm indications and annunciations facility, as specified.
- g) Necessary battery charger circuitry (suitable SMPS) with DC ammeter, voltmeter, selector switches, circuit protection by MCBs. ON/OFF switches, inbuilt auto regulating the charging current etc.
- h) Necessary excitation control and voltage regulating equipment.
- i) Necessary sandwich bus trunking terminations all internal wiring, connections etc., as required.
- j) All incomer power circuit switchgears shall be of FOUR-pole type Switches & contactors as required & as specified.
- k) By pass arrangement with changeover switches for isolating AMF panel from main supply for carrying out maintenance work in AMF panel.

4.5 **System Operation:**

The above-mentioned facilities provided shall afford the following operation requirements.

Auto Mode:

- a) A line voltage monitor shall monitor supply voltage on each phase. When the mains supply voltage fails completely or falls below set value (variable between 80 to 95% of the normal value) on any phase, the monitor module shall initiate start-up of diesel engine. To avoid initiation due to momentary disturbance, a time delay adjustment between 0 to 5 second shall be incorporated in start-up initiation.
- b) A three attempt starting facility shall be provided 6 seconds ON, 5 seconds OFF, 6 seconds ON, 5 seconds OFF, 6 seconds ON. If at the end of the third attempt, the engine does not start, it shall be locked out of start and a master timer shall be provided for this function. Suitable adjustment timers are to be incorporated which will make it feasible to vary independently ON-OFF setting periods from 1-10 seconds. If alternator does not build up voltage after the first or second start as may be, further starting attempt will not be made until the starting facility is reset.
- c) Once the alternator has built up voltage, the alternator circuit breaker shall close connecting the load to the alternator. The load is now supplied by the alternator.
- d) When the main supply is restored and is healthy as sensed by the line voltage monitor setting, both for under voltage and unbalance, the system shall be monitored by a suitable timer which can be set between 1 minute to 10 minutes for the load to be transferred automatically to main supply.

Provision should also be made by way of selector switch for running the set atleast for 30 minutes, 10 minutes & 3 minutes after the restoration of healthy mains before the load is transferred to the mains (commercial supply).

- e) The diesel alternator set reverts to standby for next operation as per (a), (b) and (c) above.

Manual mode:

- a) In a manual mode, it shall be feasible to start-up the generator set by the operator on pressing the start push button.
- b) Three attempts starting facility shall be operative for the start-up function.
- c) Alternator circuit breakers closing and trip operations shall also be through operator only by pressing the appropriate button on the panel and closure shall be feasible only after alternator has built up full voltage. If the load is already on 'mains', pressure on close button shall be ineffective.
- d) Engine shut down, otherwise due to faults, shall be manual by pressing a 'stop' button.

Test mode:

- a) When under 'test' mode, pressing of 'test' button shall complete the start up sequence simulation and start the engine. The simulation will be that of mains failure. Sequence I(a) and (b) shall be completed.
- b) Engine shall build up voltage but the set shall not take load by closing of alternator circuit breaker. When the load is on the mains, monitoring of performance for voltage/frequency etc. shall be feasible without supply to load.
- c) If during test mode, the power supply has failed, the load shall automatically get transferred to alternator.
- d) Bringing the mode selector to auto position shall shut down the set as per sequence I(d) provided main supply is ON. If the mains supply is not available at that time, the alternator shall take load as in (c) above.

Engine shut down and alternator protection equipments:-

Following shut down and protection system shall be integrated in the control panel:

a) Engine:

- i) Low lubricating oil pressure shut down. This shall be inoperative during start up and acceleration period.
- ii) High coolant (water) temperature shut down.
- iii) Engine over speed shut down.

b) Alternator Protection:

- i) Over load
- ii) Short circuit
- iii) Earth fault
- iv) Over voltage

Monitoring and metering facilities:

- a) Necessary energy analyzer unit for visual monitoring of mains, alternator and load voltage, current, frequency, KWH, power factor, etc.
- b) A set of visual monitoring indication for:
 - i) Load on set
 - ii) Load on mains
 - iii) Set on test (Alternator on operation duty, Alternator on standby duty).
 - iv) Set of lamp for engine shut down for over speed, low lub. oil pressure and high coolant water temperature, overload trip of alternator, earth fault trip of alternator, engine lock out and failure to start etc. All these indications shall have an audio and visual alarm. When operator accepts the alarm, the hooter will be silenced and the fault indication will become steady until reset by operating a reset button.

Operating Devices: A set of operation devices shall be incorporated in the front of panel as under:

- a) Master Engine Control Switch: This shall cut off in 'OFF' position DC control to the entire panel, thus preventing start-up of engine due to any cause. However, battery charger and lamp test button for testing the healthiness of indication lamps, DC volt meter/ammeter etc. shall be operative. It shall be feasible to lock the switch in OFF position for maintenance and shut down purposes.
- b) Operation selector switches OFF/AUTO/MANUAL/TEST position.
- c) Energy analyzer unit for display of various electrical parameters like voltage, current, frequency, KW, power factor etc.
- d) A set of push button, as specified.
- e) Relays, contactor, timers, circuit breakers, as required.
- f) Necessary battery charger with boost/trickle selector, DC voltmeter and DC ammeter.

Battery / Electrical System

Batteries supplied with Genset are generally dry and uncharged. First charging of uncharged batteries is very important and should be done from authorized battery charging center. Initial charging should be done for 72-80 hours.

Batteries should be accommodated with enclosure in battery rack. Battery capacity and copper cable sizes for various engine capacities should be as per recommendation of Manufacturer. Cable size shall be of 2m length. If length is more, cable size should be selected in such a way that voltage drop does not exceed 2V.

For AMF applications, a static battery charger working on mains supply is recommended to keep the batteries charged at all times.

1.5 Sq.mm copper wire should be used for wiring between junction box and Control panel

Cable and switchgear selection: refer detailed specification in succeeding paragraphs.

Overheating due to loose connection /undersize cables causes most of electrical failures and hence correct size of cable and thimbles should always be used.

While terminating cables, avoid any tension on the bolts / busbars.

While terminating R,Y&B phase notations should be maintained in the alternator and control panel for easy maintenance.

Crimped cables should be connected to alternator and control panel through cable glands.

Multi-core copper cables should be used for inter connecting the engine controls with the switchgear and other equipment.

For AMF application, multicore 1.5 sq.mm flexible stranded copper cable for control cabling should be used.

All indications shall be LED type or as recommended by the manufacturer.

It is recommended to support output cables on separate structure on ground so that weights of cables should not fall on alternator / base rail.

Alternator Termination Links

i) For proper terminations between links and switchgear terminals, the contact area must be adequate. The situations should also be avoided as they lead to creation of heat sources at the point of termination:

- a. Point contact arising out of improper position of links with switchgear terminals.
- b. Gaps between busbars / links and terminals being remedied by connecting bolt/stud. In such cases the bolt will carry the load current. Normally these bolts/studs are made of MS and hence are not designed to carry currents.

Adequate clearance between busbars / links at terminals should be maintained.

5.0 PCC FOUNDATION

A PCC foundation (1:2:4, M-20 grade) of approximate depth of 300 mm below ground is required so as to provide levelled surface for placement of the acoustic enclosure. About 150 mm foundation height should be above ground level. The length and breadth of foundation should be at least 250 mm more than the size of the enclosure. Genset should be mounted on Anti Vibration Mountings (AVM's) inside the enclosure.

Foundation level should be checked diagonally as well as across the length for even flatness. The foundation should be within ± 0.5 Degree (angle) of any horizontal plane.

6.0 ACOUSTIC ENCLOSURE:

6.1 Standard :

As per CPCB norms, the acoustic enclosure should be type tested at the climatic conditions specified in Para 1.3 through one of the authorized laboratory. A copy of type test to be submitted.

6.2 General Design Guidelines

- a) To avoid re-circulation of hot air, durable sealing between radiator and canopy is must.
- b) Exhaust piping inside the enclosure must be insulated.
- c) Temperature rise inside the enclosure should not be more than 7°C for maximum ambient above 50°C.
- d) There should be provision for oil, coolant drain and fill.

6.3 Service Accessibility

Genset / Engine control panel should be visible from outside the enclosure.

Routine/Periodical check on engine /alternator (filter replacement and tappet setting etc.) should be possible without dismantling acoustic enclosure.

For major repairs /overhaul, it may be required to dismantle the acoustic enclosure.

Sufficient space should be available around the Genset for inspection and service.

6.4 Specification for Acoustic Enclosure

The acoustic enclosure shall be designed and manufactured confirming to relevant standards suitable for outdoor installation exposed to weather conditions, and to limit overall noise level to 75 Db (A) at a distance of one meter from the enclosure as per CPCB norms under free field conditions.

The construction should be such that it prevents entry of rain water splashing into the enclosure and allows free & quick flow of rain water to the ground in the event of heavy rains. The detailed construction shall confirm to the details as under:-

- i) The enclosure shall be fabricated out of the CRCA sheet of thickness not less than 1.6 mm on the outside cover with inside cover having not less than 0.6 mm thick perforated powder coated CRCA sheet.
- ii) The acoustic lining should be made up of high quality insulation material i.e. glass / mineral wool / FOAM of minimum 50 mm thickness and 75 Kg/cubic meter to 100 KG/cubic meter for sound absorption as per standard design of manufacture's to reduce the sound level as per CPCB norms. The insulation material shall be covered with fine glass fiber cloth and would be supported by perforated M.S. Sheet duly powder coated.
- iii) The hinged doors shall be made form not less than 16 SWG (1.6 mm) thick CRCA sheet and will be made air tight with neoprene rubber gasket and heavy duty locks.
- iv) All sheet metal parts should be processed through 7-tank process followed by powder coating.
- v) The enclosure shall be provided with suitable size and No. of hinged type doors along the length of the enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose.

Sufficient space will be provided inside the enclosure on all sides of the D.G. set for inspection, easy maintenance and repairs.

- vi) The canopy should be provided with high enclosure temperature safety device, general illumination with CFL light fixtures and 5A plug points for maintenance purpose as required. The complete enclosure shall be of modular in construction, compact as possible with good aesthetic look.
- vii) The forced ventilation shall be as per manufacture design using either engine radiator fan or additional blower fan(s). If the acoustic enclosure is to be provided with forced ventilation then suitable size of axial flow fan (with motor and auto-start arrangement) and suitable size axial flow exhaust fan to take the hot air from the enclosure complete with necessary motors and auto start arrangement should be provided. The forced ventilation arrangement should be provided with auto stop arrangement to stop after 5 minutes of the stopping of D.G. sets.
- viii) The acoustic enclosure should be suitable for cable connection. Such arrangements on acoustic enclosure should be water proof and dust-proof conforming to CPCB norms.
- ix) Installation of AMF Panels shall be planned inside the substation building.

6.5 Installation

Acoustic enclosures are supplied with built in Anti Vibration Mountings (AVMs). As such Genset can be installed directly on the leveled surface.

Exhaust piping outlet should not be turned towards window/ventilator of home or occupied building. Provision of rain cap should be ensured as per site condition & as per approved drawing.

The acoustic enclosure placement should be such that there is no restriction in front of air inlet and outlet from canopy.

7.0 INSPECTION AND TESTING

Pre-delivery inspection shall be conducted on assembled DG sets, AMF control panels etc. at the respective manufacturers work by the authorized inspecting officer of AAI prior to dispatch of these equipment.

7.1 Assembled DG set with canopy at OEM works:

DG set will be tested on load of unity power factor for the rated KW rating. During testing, each of the DG sets covered under scope of work, shall be operated for a period of 12 hours on the rated KW at DG set's KW rating including one hour on 10% overload after continuous run of the 12 hours. During testing all controls / operations safeties will be checked and proper record will be maintained. Any defect / abnormality noticed during testing shall be rectified. The testing will be declared successful only when no abnormality / failure are noticed during the testing. The DG set will be cleared for dispatch to site only when the testing is

declared successful by authorized representative / Engineer-in-charge.

7.2 AMF panel at OEM works if offered separately:

- a) General inspection to confirm compliance with specification approved, GA drawings and single line diagrams (SLD).
- b) Insulation resistance test.
- c) Functional check for all controls, switchgears and continuity of internal wiring etc.

7.3 Submission of test Certificates:

Copies of all documents of routine and type test certificates of the equipment, carried out at the manufacturers premises shall be furnished to the inspecting officer. The valid calibrated test report copy should also furnish for the equipments used during testing.

7.4 Site testing along with AMF Panel & arrangement loads :

After completion of the installation work in all respects, the contractor shall offer the performance test at site for the complete AMF DG set(s). Testing shall be carried out exactly as mentioned above at OEM works.

The load bank required for testing of DG set at site is to be arranged by the contractor, necessary cables for inter-connection of load bank with DG set & the main power required for carrying out successful testing of DG set are to be arranged by contractor. The cost of consumables like fuel & oil required for testing etc. to be borne by the contractor.

The test carried out shall be as per the relevant standards. The test shall include complete functional test of DG philosophy complete as a system including all its component and associated systems like fuel system, Exhaust system, cooling system, synchronization panel & synchronization philosophy etc.

During these test periods the engine running data shall be recorded at an interval of half an hour.

Test to determine frequency, voltage regulations, switch overtime under the following conditions shall be carried out:-

- a) No load to full load instantaneously
- b) Full load to no load instantaneously
- c) Load variation up & down in steps of approx. 20% of rated load.

7.5 Trial Run / Running-in-Period

After successful testing of the DG set, a trial run at available load will be carried out for each DG set for 120 hrs. or 15 days whichever is earlier. The DG set will

be operated and a log of all relevant parameters will be maintained during this period. The arrangement of staff for trial run / running in period will be made by the successful tenderer. However, diesel shall be provided by Department. The contractor will be free to carry out necessary adjustments. The DG set will be said to have successfully completed the trial run, if no break down or abnormal / unsatisfactory operation of any component of the entire installation included in the scope of work of the contract, occurs during this period, the DG set shall be taken over. After trouble free operation during the trial run / running-in-period, shall be the date of acceptance / taking over.

VI - L.T. PANELS

1.0 MV SWITCHBOARD

1.1 General

This section covers the detailed requirements of medium voltage switchboard panel for 415 volts, 3 phase, 50 Hz, 4 wire system. These shall be TTA/ PTТА panel as per IEC. All switchgears shall be fully rated at an ambient of 45 Deg C.

1.2 Standards and Codes

Updated and current Indian standard specifications and codes of practice will apply to the equipment and the work covered by the scope of this contract.

Low Voltage switchgear Assemblies			IEC 61439-1& 2	For TTA
			IEC 60439-1& 2	For PTТА
<u>Low Voltage switchgear & control gear :</u>				
Part I	:	General rules	IEC60947-1	
Part II	:	Circuit Breakers	IEC60947-2	
Part III	:	Switches, disconnectors, switch disconnectors and fuse combination units.	IEC60947-3	
Part IV	:	Contactors and Motor starters	IEC60947-4	
Part V	:	Control circuit devices and switching elements	IEC60947-5	
Degree of Protection of Enclosures for low voltage switchgear.			IEC60529 / IS 2147: 1962	
Internal arc tests			IEC61641	
Seismic compliance			IS 1893	

1.3 Switch Boards

1.3.1 General Construction

The LV switchboards shall be Type Tested as per the relevant IEC standards to form compartmentalization and suitable to withstand short circuit level as per design.

The LV switchboards shall be manufactured by OEM of switchgears OR their license partner mentioned in AAI approved make list enclosed only. To comply with Type-2 coordination, all switchgears and control gears shall be of same makes.

The Switchboards shall be metal clad totally enclosed, floor mounted free standing

type of modular extensible design suitable for indoor mounting.

Switchboard panel and cubicle shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be fabricated from CRCA sheet steel of thickness as per manufacturer standard to form a switch board panel compartmentalization as specified. Hylem / PVC sheets shall not be allowed for separation.

The enclosures shall be designed to take care of normal stress as well as abnormal electro-mechanical stress due to short circuit conditions. All covers and doors provided shall offer adequate safety to operating persons and provide ingress protection of IP 42 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that same ingress protection of IP 42 is retained.

Incomer and bus section panel or section(s) shall be separate and independent and shall not be wired with sections required for feeder. The incomer and out going panel shall be suitable for receiving bus trunking or MV cable of sizes as specified or as required.

Switchboards shall be made up of requisite vertical sections, which when coupled together, shall form continuous dead front switchboards.

Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers.

The switchboards shall be designed for use in high ambient temperature & humid tropical conditions and /or as per site conditions as specified. Ease of inspections, cleaning and repairs while maintaining continuity of operation shall be provided in the design.

Metal based neoprene/ glue gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide required degree of protection. The unused openings within the switchboards shall be closed using suitable grommets.

Special care to be taken to ensure effective earthing of the frame and doors of the switchboards.

Each vertical section shall be provided with a rear or side cable chamber housing the cable end connections and power/control cable terminations. There should be generous availability of space for ease of installation and maintenance with adequate safety for working in one vertical section without coming into contact with any live parts. The design of the switchboard shall allow standard extension chambers if required to accommodate cables. It should be possible to access the ACB & MCCBs without opening the front door of the panel.

The overall height of the switchboard shall be limited to 2400 mm or less as per

manufacturers standards for all the Busbar ratings and type of switchboards. The height of the operating handle, push buttons etc shall be restricted between 300 mm and 1800 mm from finished floor level.

Each section of MV switch board shall have base channel of MS section not less than 100mm x 50mm x 5mm.

All panels and covers shall be properly fitted. The holes in the panel shall be correctly positioned.

Switchboard shall be provided with "Danger Notice Plate" conforming to relevant Indian Standards.

In case of TTA switch board –

- design shall comply to requirement of Internal Arc test as per IEC61641 of 50KA for 0.3 sec.
- switchboard along with ACBs / MCCBs and connections should have been type tested design as per IEC 61439 1 & 2 for short circuit, temperature rise, protective earth short circuit test and dielectric tests of the ratings required and glow wire test.
- The panel design should be tested for an Impulse Withstand Voltage of 8kV.
- The panel design shall be type tested as per IS 1893 for seismic compliance as per seismic zone of location.

1.3.2 Switchboard Configuration

The Switchboard shall be configured with Air Circuit Breakers (ACB's) , MCCB's, MPCB, MCB's and other equipment as required

All MCCB's & outgoing ACB's (rating upto 630A) shall be arranged in multi-tier formations. However, All Incoming ACBs & out going ACB above 630A rating shall be arranged in Single tier formation only.

The Switchboards shall be of adequate size with a provision of spare space to accommodate possible future additional switchgears.

1.3.3 Switchboard Compartmentalization

For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alleys.

Earthed metal or insulated shutters shall be provided between draw out and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be at least IP 2X.

Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position.

For all Circuit Breakers, adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, busbars and connections. For Some MCCB feeders for critical loads like UPS it may be required to have operation only after opening the door, all other facilities like pad lockable rotary handle to be provided for such feeder.

Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only.

A suitable wire way with cover shall be provided to take interconnecting control wiring between vertical sections.

Cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables.

Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary adequate and proper support in cable compartments to support and clamping the cable in the cable alley / cable chamber.

1.3.4 Switchboard Bus Bars

Busbars shall be made of high conductivity, 99.9% purity, high strength Aluminium of ETP grade and shall be of rectangular cross sections, suitable for full load current for phase bus bars and half/ full rated current for neutral bus bar as required. Busbar shall be suitable to withstand the stresses of fault level as required.

The bus bar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars run in bus bar alley on either side in which the circuit could be arranged with front / rear access for cable entrances as per approved GA drawings.

The bus bars shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports able to withstand operating temperature of 110 deg C at regular intervals, to withstand the forces arising from a fault level. The material and the spacing of the Busbar supports should be same as per the type tested assembly.

Auxiliary wires for control & space heater power supply or any other specified service shall be provided. These wires shall be insulated, adequately supported and sized to suit specific requirement. The material of wires/cables will be FRLS/HHFR insulated electrolytic copper.

The busbar support to be supplied by OEM or by approved supplier of OEM. Minimum clearance between phases / live parts shall be as per IS IEC 61439.

1.3.5 Switchboard Interconnection

All connection and tap offs shall be through adequately sized connectors. This shall include and suitable for fault level for tap off to feeders and instrument/control transformers.

For switchgears rating upto 100 amps, FRLS/HHFR copper conductor wires/cables of adequate size to carry full load current shall be used. The terminations of such interconnections shall be crimped. Solid copper strip connections shall be used for all ratings above 100 amps.

All connections, tapings, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with even tension. Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All screws, bolts, washers shall be zinc plated. Suitable grade nuts and bolts shall be used for busbar connections.

1.3.6 Draw out Features

Air Circuit Breakers (ACBs) shall be provided in fully draw out type design in, such way that draw out is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. Mechanical latches shall be integrated in ACB at service, test and isolated position to ensure that breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated.

1.3.7 Instrument Accommodation

All voltmeter, ammeter and other instruments shall be flushed mounted back lit LCD/LED Digital type of size 96 mm x 96 mm conforming to class 1.0 or as specified to IS 1248 for accuracy. The minimum display for Multi-function meter (MFM) for Incomer feeders shall have - A , V, Pf , Hz , Kw , KVA, KVA_r, KWh, KVA_rh, average and maximum values, maximum demand values, % THD.

Multi functional meters shall have in-built RS485 port.

The current transformers for metering and for protection shall be mounted on the solid copper/aluminium busbars with proper supports. CT with inbuilt feature of ACB with terminations module is also acceptable.

On all the incomers of switch boards, ON/OFF (and Trip in case of ACB & for micro-processor MCCB provided) and for out going ON LED Type indicator lamps shall be provided suitable for operation on AC 230 volts supply.

All lamps & meter shall be protected by MCBs.

Meter's for all sections of LT Panels & others, to be provided as per following details:

Provision of Meters in HT / LT Panels				
Area		Ammeter	Voltmeter	Multi-function Meter
11 KV /33 KV Panels	Incomer	✓	✓	✓
	Outgoing			✓
All Panels in utility Building	Incomer	✓	✓	✓
	Outgoing			✓
All panels in terminal Building	Incomer	✓	✓	✓
	Outgoing			✓
Motor Control Panels	Incomer	✓	✓	✓
	Outgoing			✓

1.3.8 Wiring

All wiring for relays and meters shall be with 1.5 mm² FRLS/HHFR insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 sq. mm. For CT & current carrying, wiring shall be done with minimum 2.5 Sq.mm. Runs of wires shall be neatly bunched and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board. The cables and control wires shall be suitable for withstanding 105 deg C.

1.3.9 Space Heaters

Anti- condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 240 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 50 Deg C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.

1.3.10 Earthing

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors / frames to be connected to earth through adequately sized flexible braids.

1.3.11 Sheet Steel Treatment and Painting

Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment of minimum seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognized phosphating process after which a coat of primer paint compactively with the final paint shall be applied over the treated surface. Final paint/ coat of oven baked powder coating, of minimum 50-micron thickness, of shade approved by Engineer-in-Charge shall then be provided.

1.3.12 Name Plates and Labels

Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

Note – Main LT panel shall be equipped with surge protection device (**SPD**) Type-1) and their sub LT panels with SPD Type- 2 as per IEC 62305-4/ NBC 2016 part 8. These SPD's should have inbuilt fuse & tested by KEMA /VDE/ any other accredited international lab.

2. SWITCHGEAR

2.1 LT Air Circuit Breakers (ACB)

2.1.1 General

The circuit breakers shall be of the air break type, robust and compact design suitable for indoor mounting and shall comply with the requirement of IEC 60947-1/ IS 13947-2 and 2.

The breaker shall comply with the isolation function requirement of IEC 60 947-2/ IS 13947-2 section 7.12 to be marked as suitable for isolation / disconnection to facilitate safety of operating personal while the breaker is in use.

The breaker shall provide IP 2X protection between the front panel and internal power circuits to avoid any accidental contact with the live main current carrying path with the front cover open.

Protective devices, metering, CTs, PTs, push buttons and indicating lamps shall be provided as required and specified.

ACB shall be type tested & certified for compliance to standards from–CPRI, ERDA / NABL accredited lab/ any international lab. The circuit breaker shall be suitable for 415 V \pm 10%, 50Hz supply system. Manufacturer should submit Combined

sequence test certificate.

2.1.2 Constructional Features

The Circuit Breaker shall be flush front, modular construction, horizontal draw-out pattern; three/four pole as required and fully interlocked. Each Circuit Breaker shall be housed in a separate compartment enclosed on all sides. In case of 4 pole breaker, neutral shall be fully rated with adjustable settings from 50% to 100% of I_n .

The Circuit Breaker cradle shall be designed and constructed to permit smooth withdrawal and insertion. The movement shall be free of jerks, easy to operate. Mechanical Latch to be provided to identify the isolated, test & service position of breaker to prevent over racking.

Main current carrying parts in the breaker shall be silver plated and suitable arcing contacts shall be provided to protect the main contacts which shall be separate from the main contacts and easily replaceable. In addition, Arc chutes shall be provided for each pole, and these shall be suitable for being lifted out for the inspection of the main and the arcing contacts without using any tools.

The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (I_{cs}) shall as per design. Rated Ultimate breaking capacity (I_{cu}) and short circuit withstand values (I_{cw}) for 1 sec.

The ACB shall have double insulation with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts.

The circuit breakers shall be for continuous rating at 50 deg C ambient temperature. The Rated insulation voltage shall be 1000 volts AC & Rated impulse withstand Voltage shall be 12kV for main circuit.

The ACB shall be provided with a door interlock i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

2.1.3 Operating Mechanism

The Circuit Breaker shall be trip free with independent manual spring operated or motor wound spring operated mechanism as specified and with mechanical ON/OFF indication. The operating mechanism shall be such that the circuit breaker is at all times free to open immediately the trip coil is energized. The breaker shall be provided with in built anti pumping mechanism.

The closing time shall be less than or equal to 80 ms to ensure faster closing of the breaker. And tripping time should be less than 70 ms to reduce the let through energy in the event of fault.

The operating handle and mechanical trip push button shall be at the front of and integral with the Circuit Breaker. Handle for rack in & rack out shall have positive

locking arrangement.

There shall be mechanical / electrical indicator on the front panel for 'Ready to close' situation for the breaker by checking all inter locking.

The Circuit Breakers cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. There shall be 3 distinct and separate position of the circuit breaker on the cradle-Service, Test & Isolated.

2.1.4 Circuit Breaker Interlocking

Sequence type strain free interlocks shall be provided to ensure the following:

It shall not be possible for the Breaker to be withdrawn from the cubicle when in the "ON" position. To achieve this, suitable mechanism shall be provided to lock the Breaker in the tripped position before the Breaker is isolated.

It shall not be possible for the Breaker to be switched "ON" until it is either in the fully inserted position or, for testing purposes, it is in the fully isolated position.

It shall not be possible for the Circuit Breaker to be plugged in unless it is in the OFF position. The racking shutters should open only when ACB is OFF position

Mechanical and electrical anti pumping devices shall be incorporated in the EDO ACB's as required with manual operation also.

2.1.5 Circuit Breaker Auxiliary Contacts

The Circuit Breaker shall have minimum 4 NO/NC auxiliary contacts rated at 10 amps 415 volts 50 Hz. These contacts shall be approachable from the front for connecting all external wiring. They shall close before the main contacts of Circuit Breaker are plugged in and vice versa, when the Circuit Breaker is Drawn Out of the cubicle.

2.1.6 Circuit breaker Releases

The breaker should be equipped with microprocessor based release to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones:

- Long time protection with adjustable time delay
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection with instantaneous delay

All the protection release shall have following features and settings:

- a. True RMS Sensing- Sense true RMS value of current to avoid nuisance tripping during starting.

- b. Thermal Memory: Incorporates thermal memory feature to achieve faster tripping in case of repetitive overloads.
- c. Defined time-current characteristics.
- d. Trip Indication- Provide local LED indication for identification of type of fault, without requiring using external power supply.
- e. Self-powered.
- f. Manufacturer shall furnish total discrimination charts / curve study for coordination between upstream and downstream devices.
- g. Meet the EMI / EMC requirements.
- h. ACB shall display % loading, last 10 trip History for fault diagnosis and Current parameters, etc.

All ACBs shall be provided with Mechanical Operation counter

For incomer ACBs (except APFC Panels) shall have following additional protections by separate relay (in-built release with ACB is also acceptable without any extra cost)-

Under and over voltage

Under and over frequency

Reverse Power, in case DG incomer is provided.

2.1.7 Earthing

The frame of the Circuit Breaker shall be positively earthed pit when the Circuit Breaker is racked into the cubicle.

2.2 MOULDED CASE CIRCUIT BREAKERS (MCCB)

2.2.1 General

The circuit breakers shall comply with the requirement of IEC 60 947 / IS 13947-2 : 1993. All MCCB shall be current limiting type features of load line reversibility and suitable for horizontal / vertical mounting without any derating.

MCCBs shall be suitable for 3 Phase 415 Volts AC 50 HZ supply. Rated insulation voltage (Ui) 690V AC and rated Impulse voltage 8 KV.

Three/ four phase MCCBs shall have a common handle for simultaneous operation and tripping of all the three phases. All MCCB shall be door interlock provision.

MCCBs should have $I_{cs}=100\%I_{cu}$ with Minimum fault level.

The MCCBs shall be made of halogen free high strength heat resisting and flame retardant thermo setting insulating material.

Manufacturer shall furnish total discrimination curve study for coordination between upstream and downstream devices.

2.2.2 Protection Functions

Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of RMS current values, electromagnetic compatibility, etc.).

All MCCBs 100 Amp and below with Thermal Magnetic release shall have Adjustable Thermal (O/L) & fixed Magnetic (S/C) protection settings.

All MCCBs above 100 Amp and upto 250 Amp with Thermal Magnetic release shall have Variable Thermal (O/L) & Variable Magnetic (S/C) protection settings.

All incomer MCCBs and outgoing above 250A shall be of Microprocessor based with adjustable - Overload, Short Circuit and In-Built Earth Fault protection settings. All microprocessor MCCBs should have trip indication on Panel door.

For Motor application, motor duty type MCCBs shall be selected with reference to Type 2 coordination chart provided by the manufacturer.

2.3 MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4. MPCB shall have a rated operational and insulation voltage of 415 V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the "isolated" position.

The motor circuit breakers shall be equipped with a "PUSH TO TRIP" device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1. Type 2 co-ordination shall be guaranteed by tables tested and certified by an

official laboratory.

The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 50° C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available.

2.4 MINIATURE CIRCUIT BREAKERS (MCB)

Miniature Circuit Breaker shall comply with IS/IEC 60898 and 60947-2. 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. MCBs 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. MCB should provide separate mechanical indication for tripping due to Short circuit faults

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 have minimum Elect Endurance of 10,000 operating cycles.

3.0 Acceptance Tests

Acceptance tests on completed switchboards shall be as follows:

A general visual check shall be carried out. This shall cover measurement of overall dimension, location, number and type of devices, terminal boxes, location and connection of terminals etc.

Checking of bill of materials as per approved drawing.

Checking of operation of various feeders as per approved schematic drawings.

Operation check shall be carried out for every control function as per schematic

drawings by manually simulating fault conditions and operation of control switches/relays etc.

Checking of interchange-ability of identical feeders.

Insulation resistance test and value measurement on power and control circuits before and after high voltage withstand test.

High voltage test on power and control circuit as per IEC-61439.

For equipment bought from other suppliers, certified test reports of tests carried out at the manufacturers works shall be submitted.

4.0 DOCUMENTATION

On award of work, bidder to prepare / submit three sets of following shop drawings and got approved by the Engineer-in-charge before commencement of panel manufacture :

- a) General arrangement (GA) drawing of each panel duly endorsement of switchgears OEM complying applicable standard for fabrication etc. The set of GA drawings shall be supported with :
 - Detailed drawings showing General Arrangement, plans, sections, elevations, foundation details, base plate details with dimensions and critical information.
 - Single Line Diagram
 - Control & Schematic Diagram
 - Bill of Materials/quantities indicating makes, technical specs, quantity etc.
 - Data sheets (where applicable)
 - Control logic and write up (where applicable)
 - Technical leaflets / specifications.
 - Characteristic curves of equipment's (where applicable)
 - b) Bus bar sizing calculation for various bus bars rating for incomer/outgoings.
 - c) Type test certificate of similar design panel, Internal Arc test etc as applicable
- Final two sets on approval shop drawings shall also be submitted for manufacture of panel & execution of the works at site.

5.0 COMPLETION PLANS

On completion of work, the contractor shall submit 4 sets of following documents along with soft copy of as built drawings. The drawings shall be Computer aided design drawings (CADD).

- General Arrangement Layout drawings with dimensions, plans, sections, etc.
- Single Line Diagram
- Control & Schematic Diagram
- Bill of Materials/quantities indicating makes, technical specs, quantity etc.
- Data sheets
- Control logic (where applicable)

- Details of Inventory
- Equipment name plate details
- Installation & Maintenance Manuals
- Test certificates (Factory tests, Site tests)
- Guarantee/Warranty certificates (where applicable)

VII - LV HYBRID COMPENSATION SYSTEM -
(ACTIVE POWER FILTER + CAPACITOR BANK + INCOMER
SWITCHGEAR)

1. GENERAL

This section covers the detailed requirement of LV hybrid compensation system suitable for operation on 415V, 3 phase, 4 wire, AC supply. The panel shall be Hybrid compensation system which will take care of power factor and harmonics both for the connected LV system.

2. STANDARDS & CODES:

The design, manufacture and testing of the LV hybrid compensation system & its components shall be carried out as per latest applicable Indian Standards, Indian Electricity Rules, relevant code of practices and requirement of Chief Electrical Inspectorate of the State Government and International Electro Technical Commission (IEC) Standards. However, for ready reference some of the Standards and Code of Practices are given below:

IEC 60831-1&2 / IS 2834	:	Shunt capacitors for power system
IS IEC 60947	:	Low voltage switchgears
IEC 61921 / IS 16636	:	Low voltage power factor correction Panel.
IEC 60076-6	:	Power transformers - Part 6: Reactors
IEC 60439	:	Low-Voltage Switchgear and Control gear Assemblies - Part 1: Partially Type-Tested Assemblies.
IEC 62208 IS 2147	:	Empty enclosures for low-voltage switchgear and control gear assemblies – General requirements
IEC 62262	:	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
IEC 61326-1	:	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements.
IEC 61000-6-4	:	Electromagnetic compatibility – Generic standards – Emission standard for industrial environments
IS 1248	:	Electrical indicating Instruments

3. DESIGN AND SCOPE OF WORK

The power factor of inductive load as assumed of the system shall be improved from 0.8 power factor to 0.98 (minimum). The kVAR rating of the capacitor bank shall be as per system requirement to be worked out by the EPC contractor. It shall be able to maintain consistent high power factor. It shall be designed to prevent leading power factor in the installation during low load conditions and modularity should be available so that capacity can be enhanced as and when required.

The harmonic levels of the system shall also be improved from 25% iTHD to less than 5% ITHD at full load condition so as to ensure IEEE 519: 2014 standards as well as local utility regulations. The system should be able to consistently maintain the harmonic levels in the system.

The scope of works broadly covers the following

- i) Selection of active power filter + capacitor bank + incomer switchgears as per system design requirement.
- ii) Provision of incomer switchgear with MFM to measure & display minimum parameters like – I, V, pf, Frequency, KW, KVAR, KVA, THD & provision of RS 485 port, etc, and LED indications, auto/manual provision complete.
- iii) Provision of outgoing switchgear with ON/ OFF indications etc
- iv) Fabrications panel(s) switchgear, controls, metering, indications, painting etc shall be followed as described in LT panel sections.
- v) LV hybrid compensation system with a single integrated controller for active and passive or separate panel for passive (capacitor) and active (power filters) shall be acceptable as per OEM standard design complying detailed specifications as described in succeeding paras.
- vi) For sensing correction of PF and or harmonic, set of CT's shall be provided in horizontal busbar section(s) as required.
- vii) **SHOP DRAWING SUBMISSION :**
 - a) On award of work contractor shall submit shop drawing along with technical compliance of contract specification and supporting calculation sheets for selection of LV hybrid compensation system rating complete.
 - b) On approval of technical submittal, four sets of working drawings to be submitted by the contractor to Engineer – In – charge.
 - c) On completion of work, four sets of **as built drawing** to be submitted.

4. **Operation Philosophy:**

The Active Correction device (active power filters) shall work on the principle of measurement of load current and decomposing it into harmonic currents, reactive (lead and lag), negative and zero sequences and generate actively the required reference to the measured requirement. Active power filter shall be installed to ensure that the installation is Power Quality ready from day 1. The equipment shall

be able to reduce harmonic levels as per the local utility regulation and as described above. The active filter equipment shall be able to correct either leading (capacitive) or lagging (reactive) power factors and load balancing as well. The Passive AC capacitors (capacitor bank) shall work on the principle of measurement of network power factor and shall switch on required number of capacitor bank stages to improve the power factor of the electrical network.

The contractor should prove through third party calibrated power quality measurement equipment or submission of software simulation that the Total Demand Distortion (TDD) is less than 5%. The Total Harmonic Distortion Voltage (THD V) shall be within the limits as specified in IEEE Std 519-2014 (Standards on IEEE recommended practices and requirements for Harmonic Control in Electric Power System). The point of common coupling (PCC) for such calculations shall be at the transformer incomer secondary (415 V Supply). The simulation software should take into consideration the performance of the de-tuned capacitor bank. The Passive AC Capacitors device shall not amplify the existing system harmonics.

The Hybrid Compensation System should comprise Active Correction and Passive Correction devices as per system design required. The Active Correction device would be capable of reactive, harmonics and unbalance compensation while the Passive Correction device should be Capacitor + reactor combination to improve the system displacement power factor. The same shall be achieved through single integrated controller or separate controllers provided, the end result is achieved. The active: passive ratio should be at least 1:1 or active may be higher.

5. TECHNICAL SPECIFICATION

General contractions

Detailed specification for switchgear, controls, metering, indications, painting etc. shall be followed as described in LT panel sections

The design and construction of the Hybrid capacitor panel shall be partially type tested design as per IS 16636 / IEC 61921. The panel shall be manufactured by OEMs or their license partner as per approved make list of AAI.

Passive Correction device (Capacitor Banks)

Capacitor banks: It shall have multiple stages, which shall be switched ON / OFF automatically with the use of electromagnetic (capacitor duty) contactors. The contactor should be suitable for the type of loads connected to the network. The capacitor banks shall incorporate series de-tuning reactors to prevent amplification of system harmonics and prevent resonance.

The capacitor units shall be suitable for a supply voltage of 415 volts and shall be rated at 525 Volts. The de-rating shall be due to factors like temperature, voltage rise due to the connection of de-tuned reactors and harmonics. The capacitor unit

shall be manufactured in full compliance with and tested to the requirements of IEC 60831, Part-1 and Part-2.

System fault level	:	50 kA
Maximum voltage variation	:	+/- 10%
Max frequency variation	:	+/- 5%

The dielectric film used in the capacitor shall be of the self-healing type, heavy duty (MPP-H), utilizing low loss metalized polypropylene with following parameters:

- 3 phase, delta connected, 50 Hz
- Overvoltage +10% (for 8h / 24h)
- Overcurrent: $1.8 \times I_n$;
- Inrush current of $250I_n$
- Total watt-losses: $< 0.5 \text{ W / kVAr}$
- Temperature category: -25° C to 55° C

Type of unit connection: The capacitor units shall be internally connected in delta and shall incorporate a 3-phase pressure switch dis-connector for protection against internal faults, over pressure, etc. The pressure switch dis-connector must isolate all the three phases simultaneously in the event of fault.

Discharge resistance: To be provided between all the phases. The built-in discharge resistors shall not be accessible (factory fitted) and tamper proof. The discharge resistors shall ensure reduction in capacitor voltage to less than 50 volts in 3 minute after switch off.

Series Reactor: 14% de-tuned type (135 Hz) for each capacitor stage. The de-tuning reactors shall copper wound be connected in series with each capacitor stage and shall be of iron cored type. The reactor insulation shall be Class "H" rated at 180°C . The maximum temperature of the reactor at maximum continuous RMS amperage shall be no higher than 145°C at a 50°C ambient. The de-tuning reactor shall be manufactured in full compliance with and tested to the requirements of IEC 60289 / IS 5553.

Each stage of the capacitor bank shall also have a suitably rated MCCBs (Thermal Magnetic type) with an overload & Short circuit protection. The MCCB shall be manufactured in full compliance with and tested to the requirements of IEC 60947-1, & 2.

Stage Contactor: The electromagnetic contactors shall be rated for 415 Volts and shall be 3-pole capacitor duty type with pre charging resistors and shall be employed for switching 'on' and switching 'off' operations in capacitor banks. The rated voltage of control coil shall be 415V (phase-to-phase). This voltage is subject

to a variation of (+) 10% and (-) 15%. The contactor shall be AC type. The contactor shall be of certified design confirming to IEC 60947-1 & 4-1.

Active Correction device (active power filter)

The Active power filter (APF) shall be defined as a power electronic device consisting of power semiconductors known as insulated gate bipolar transistors (IGBT) that switch into the AC lines to modulate its output to mitigate detrimental harmonic current; correct the displaced reactive current (leading or lagging); and balance the current (also known as negative sequence current) for the power source. Spectrum Cancellation: from 2nd to 49st

The APF shall employ the most efficient 2 level inverter technology.

Cooling Architecture: Segregated Cooling (Separate for heat sink and separate for PCB's)

APF shall analyze the content of the supply current for harmonics from the 2nd to the 49th harmonic and shall determine the reactive current content representing displacement power factor and supply current balancing. APF shall have a spectrum cancellation from 2nd to 49th , discrete, fully selectable per harmonic order (amplitude and on/off).

APF shall have a Closed Loop Control: Source sense (at mains) CT or Load sense CT for single unit.

APF shall include an option to achieve optimized unity PF, leading (capacitive) or lagging (inductive) power factor to target.

APF shall provide field selection as harmonic filter, reactive current correction, or supply current balancing or any combination of the three modes. All modes shall be required for this project.

APF shall be designed with a current limiting function to protect the IGBT. APF shall have automatic restart capability upon power loss return and fault resets. APF shall monitor the incoming air temperature and invoke a hard trip of the unit at 50° C.

APF shall have a door-mounted human machine interface (HMI) with touch screen display. HMI shall provide an oscilloscope feature to display specific parameters

In addition, performance trend curves shall be displayed for load - total RMS current, load RMS harmonic current per phase, APF harmonic current output per phase, AC mains voltage per phase, THDi, TDD, load RMS reactive current, and APF RMS reactive current output. Display of the mains and load harmonic current amplitudes per harmonic order. HMI shall display a flashing warning screen in the event of a fault.

DSP controller

The Hybrid Power factor correction should have a 32 bit controller which shall be

able to communicate through CAN with HMI and shall be able to control the capacitor banks.

In case of separate controller, the APFC relay shall control switching of capacitor banks.

Human Machine Interface

HMI shall provide an oscilloscope feature to display specific parameters.

- a. Minimum 7-inch, colour touch screen LCD interface.
- b. Support MODBUS TCP communication protocol with a provision of USB port and SD card.
- c. Start, stop and trip status (with trip code) on the home screen
- d. Active filters shall be with input surge suppression and forced air cooling system.
- e. Active filter shall be able to connect in both open loop and closed loop configuration
- f. Active filter should have a HMI touch screen display having the functionality of a power analyzer and should display parameters as mentioned below :
 - ↗ 3 phase Current Parameters: A_{rms} , $A1_{rms}$, $iTHD$ (%), A_{unb}
 - ↗ Voltage Parameters: V_{rms} , $V1_{rms}$, U_{rms} , $vTHD$ (%), V_{unb} , Frequency
 - ↗ Power Parameters: Active, Reactive, Apparent Power
 - ↗ Power Factor
 - ↗ Displacement Power Factor
 - ↗ Filter Parameters: A_{pk} , Filter Utilization, Stack Temperature, DC Voltage, Filter Runtime, Fan Runtime, Panel Temperature
 - ↗ Voltage and current waveforms
 - ↗ Voltage and current Harmonic spectrum
 - ↗ Alarm indications & log details.
- g. Active filter shall be isolated from the power supply when powered "off"
- h. IGBT modules shall be self-protected for maximum reliability through semiconductor fuses.

In case of separate controller for Passive and active are used, the APFC controller shall allow the following settings and readings.

The power factor controller panel shall be microprocessor based and shall be able to sense the reactive current requirement of the network and shall switch ON / OFF the required stages of a capacitor bank. The power factor controller should be able to detect and correct abnormalities in wirings such as reversed CT connection. The controllers shall be suitable for 1A or 5 A current input and shall have Display.

- a) Automatic initialization and stage rating detection
- b) Any step sequence detection
- c) Measurement of capacitance per stage
- d) Capacitor bank over load current ratio
- e) THD Voltage

f) The controller shall initiate alarms and warnings in the following events:

- Temperature limit is exceeded
- Insufficient capacitor output / Loss of capacitance
- Overload current ratio limit is exceeded
- Under voltage, Over voltage
- THDV limit is exceeded

6. EARTHING

Detailed specification of earthing shall be followed as described in specification of LT panel section. Two separate earth terminals from two independent earth pits shall be provided to the LV hybrid compensation system panel(s). The earth terminals provided on the body of the capacitor bank and the Active components shall be bonded to the main capacitor panel earth bus.

7. TEST AT MANUFACTURER WORKS

A general visual check shall be carried out. This shall cover measurement of overall dimensions, location, number and type of devices, terminal boxes, location and connection of terminals etc.

- a. Checking of bill of material as per approved drawings
- b. Checking of operation of various feeders as per approved schematic drawings
- c. Operation check shall be carried out for every control function as per schematic drawings
- d. Checking of inter changeability of identical feeders
- e. IR test and value measurement on power and control circuits before and after HV withstand test
- f. High voltage test on power and control circuit as per IS
- g. For equipment brought from other suppliers, certified test reports of tests carried out at the manufacturer works shall be submitted. Normally all routine tests as specified in the relevant standards shall be conducted at the sub supplier at its works and copies of routine test reports shall be furnished
- h. Heat run test for the active filter shall be performed
- i. Functional test for harmonic compensation shall be done at manufacturer works.
- j. Any other test as per standard asked by AAI inspecting officials.

VIII-BATTERY & BATTERY CHARGER (SMPS TYPE)

1.0 Sealed Lead –Acid Maintenance free Battery

(i) Codes & Standards

All standards, specification and codes of practice, referred to herein, shall be the latest edition including all applicable official amendments and revisions as on date of opening of bid.

In case of conflict between this specification and those (IS Codes Standards etc.) referred to herein, the former shall prevail. All works shall be carried out as per the following standards and codes:

IS:266	:	Specification for sulphuric acid
IS :1069	:	Specification for water for storage batteries
IS :1069	:	Specification for rubber & plastic containers for lead acid storage batteries
IS :1652	:	Specification for stationary cells and batteries, lead acid type(with plant positive plates)
IS :3116	:	Specification for sealing compound for lead acid batteries
IS :8320	:	General requirements and methods of tests for lead acid storage batteries
IS :6071	:	Specification for synthetic separators for lead acid batteries. IEC: 60950 - Specification for Safety

Equipment complying with other internationally accepted standards such as IEC, BS, DE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

2.0 General Technical Requirements

2.1 Scope

The Specifications give details of the Battery Charger suitable for HT/ LT Panels. The VRLA (valve regulated lead acid) Maintenance free Batteries up to 24V – 200 AH are housed in the Bottom Compartment of the Battery Charge. The Battery Charger is a composite Battery Charger cum DC Distribution Board.

2.2 General

The Battery Charger shall float cum Boost type, SMPS based. The Charger shall be user programmable using a laptop or a mobile phone or display to set the - Maximum charging Current, Boost/charge, Absorption and Float Voltages. During Auto Float - Boost Mode, Automatic Changeover shall take place from Float Mode to Boost Mode and vice-versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to Float Charge. The charger shall be capable of charging Lead Acid Batteries selected through user program.

2.3 Construction Feature

Float cum Boost Charger and DC Distribution Board with all necessary controls shall be housed in Upper Compartment whereas batteries will be placed at lower compartment of Sheet Steel Cubicle. The cubical shall be fabricated with CRCA sheet steel of 2mm thickness and shall be folded & braced as necessary to provide a rigid support for all compartments. The door & cover shall be of 1.6mm thickness. The all other details of fabrications, switches & components, painting etc shall be followed as described in LT panel section.

The D.C Output Voltage for Float/ Boost Charger shall be stabilized for A.C. Input variation up to of $230V \pm 20\%$, frequency variation of $50Hz \pm 10\%$ and D.C. Load variation of 0 – 100%. The Voltage Regulation shall be achieved by a constant voltage regulator having fast response through High Frequency PWM Control. The ripple content in output shall be within 0.5 % of D.C. Output Nominal Voltage.

No manual settings are allowed to be done. All the settings shall be done through the programming port /knob display with password protection available on the front panel of the charger. During Auto Float mode the Battery charging shall automatically changeover from Boost Mode to Float Boost and vice-versa. During Manual Float/ Boost Modes it shall be possible to set the output volts through the user settable program only. The charger shall have an LCD Display showing Set Modes, Voltage and Current Limits, Temperature, Battery voltage charging current and Load current etc. Fault indications shall also be visible on the display.

A potential free alarm shall be provided for alarm in case of mains failure, charger failure and Battery Low. Suitable arrangement shall be made for forced cooling.

D.C. Distribution Board

Incoming : 1No.63ADPMCB
Outgoing : 7 Nos. 16A DPMCB

Visual and Audible Alarm shall be provided along with a potential free electrical contact for the following conditions:

- a) A.C. Mains Fail.
- b) Charger Fail.
- c) Load/ Output Overvoltage.

Rating

AC Input	:	230v \pm 20% ac 50 Hz Single Phase.
DC Output	:	Float/ Boost Charge 24V – 200 AH
Current Rating	:	30.0 Amps.
Float Mode	:	27.0 V Nominal (Adjustable 20V – 29.0V)
Absorption Mode	:	Adjustable 27.0 V – 28.0 V
Boost Mode	:	28.0 V Nominal (Adjustable 20V – 29.0V)
Equalization Mode	:	Adjustable 20.0 V to 29.0 V
Low Voltage Trip	:	Adjustable, (Default value –22V)
Ripple	:	Less than 0.5 %
Program Options	:	Display Modes of charge and Temperature display compensation.

BATTERY & BATTERY CHARGER

1.0 Battery

For Sealed Lead Acid Maintenance free (VRLA) Battery		
a)	Battery Bank Voltage	24 V
b)	Battery type	VRLA 2V – 1.85V
c)	Capacity for ten (10) hour rate at 27 degree C as per IS	200 AH
d)	Nominal discharge voltage per cell/ Battery	1.85 V
e)	Float Voltage	2.25 V / Cell

2.0 Battery- Charger

a)	Battery Charger type	Float Cum Boost Charger
b)	Input Voltage	230V +/- 20%
c)	Output float Cum Boost charge	Levels set as per prevailing IS standards for VRLA Battery
d)	Load/ Varies	0 – 100%
e)	Battery type	VRLA Battery of Approved Makes
f)	Capacity @ five (5)hour rate at 27 degree C as per IS	160 AH
g)	Type of Enclosure	MS Powder Coated Enclosure for Charger and Battery
h)	Input and Output Terminations	Incoming – 1 No. 63A DP MCB Outgoing – 7 Nos. 16A DP MCB
i)	Efficiency	> 90% at full load
j)	Input Power Factor	> 0.9 to Unity
k)	Line Isolation Level	2500 V AC as per safety standard
l)	Ingress Protection	IP21 for indoor use

IX - HT / LT CABLE WORKS

1.0 GENERAL

HT & LT Cables shall be supplied, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drums. The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed.

2.0 Standards and Codes:

The following standards, amended up to date shall be applicable:

IS : 1753	:	Specification for Aluminium conductors for insulated cables.
IS : 2982	:	Specification for copper conductors in insulated cables.
IS : 5831	:	Specification for XLPE insulated and PVC sheath of electric cables.
IS : 6474	:	Polythene insulation and sheath of electric cables
IS : 3975	:	Specification for mild steel wires, strips and tapes for armouring of cables
IS : 694	:	PVC insulated cables
IS : 7098	:	Specification for XLPE insulated PVC sheathed cables
IS : 3961	:	Recommended current ratings of cables
IS : 5819	:	Recommended short circuit ratings for high voltage PVC cables
IS : 8130	:	Electrical purity of Aluminium

3.0 STORAGE AND HANDLING

Storage:

- i) The cable drums shall be stored on a well drained, hard surface, so that the drums do not sink in the ground causing rot and damage to the cable drums paved surface is preferred, particularly for long term storage.
- ii) The drums shall always be stored on their flanges, and not on their flat sides.
- iii) Both ends of the cables should be properly sealed to prevent ingress/absorption of moisture by the insulation during storage.
- iv) Protection from rain and sun is preferable for long-term storage for all types of cables. There should be enough ventilation between cable drums.
- v) Damaged battens of drums etc. should be replaced, as may be necessary.

Handling:

- (i) When the cable drums have to be moved over short distances, they should be rolled in the direction of the arrow marked on the drum.
- (ii) For manual transportation over long distances, the drum should be mounted on cable drum wheels, strong enough to carry the weight of the drum, and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.
- (iii) For loading into and unloading from vehicles, a crane or a suitable lifting tackle should be used. Small sized cable drums can also be rolled down carefully on a suitable ramp or rails, for unloading, provided no damage is likely to be caused to the cable or to the drum.

4.0 a) H.T. CABLES

H.T. Cables shall be of 11KV grade, 3 Core, XLPE insulated, Aluminium Conductor, Armoured Cables with electrical purity of aluminium conductor manufactured & tested in accordance with IS: 7098 (Part II). HT Cable shall be of earthed, grade and shall be of stranded construction, comply to IS 8130. The conductor screen & insulation screen shall both be of extruded semi conducting compound and shall be applied along with XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth inter-phase. The metallic screen of each core shall consist of copper wires or tape. The method of curing shall be dry / gas / steam curing. Metallic screen shall be suitable for carrying the fault current of minimum 0.6 KA (for combined 3 core) for 1 second 33KV OR 11KV. Outer sheath shall be of tough, PVC compound as per IS:5831 and shall be extruded over the armouring. Cables shall be extruded over the armouring.

Cables shall be tested for type tested & routine tested in accordance with IS:7098 (Part II).

Laying & termination of H.T. cables shall be with all required accessories. The cables shall be inspected in the OEM factory before dispatching.

b) LT CABLES

LT Power cables shall be XLPE insulated and PVC sheathed type stranded aluminium conductor armoured cable whereas control cable shall be armoured / unarmoured, conforming to IS : 7098 : 1988 (Part-I). Cables shall be of 1100volt and with ISI certification mark. Conductor of cables shall be made of electrical purity Aluminium conforming to IS : 8130- 1984. All standards shall be with upto date amendments.

All inter-connecting cables within terminal building shall be Halogen Free Flame Retardant (HFFR).

c) ARMOUR

The armouring for cables above 16 sqmm shall be galvanized steel strips and 16 sqmm & below shall be with galvanized steel round wire.

5.0 INSPECTION

The cables shall be inspected in the OEM factory before dispatching as per standard and as per contract conditions.

6.0 JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoiding of cable joints. This apportioning shall be got approved from Engineer-In-Charge before the cables are cut to lengths.

7.0 INSTALLATION OF CABLES

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as per approved layout and / or as per the direction of Engineer-In-Charge. Cable laying shall be carried out as per CPWD specifications.

7.1 CABLES LAYING IN GROUND

Cables shall be laid by skilled experienced workmen using adequate rollers. The cable drums shall be placed on jacks before unwinding the cable. With great care, it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 metres.

Cables shall be laid at depth of 750 mm below ground level & 1200 mm in case of HT, from ground level. A sand cushion of 80mm & 170 mm shall be provided below & above the cable respectively, joint boxes and other accessories. Cable shall not be laid in the same trench or along side a water main. Width of the trench shall be 350 mm (minimum) for laying single cable.

For all underground cables, route markers should be used. Separate cable route markers should be used for LT, HT and telephone cables. Cable markers should be installed at an interval not exceeding 50 M along the straight routes of cables at a distance of 0.5 M away from centre of cable with the arrow marked on the cable markers plate indicating the location of cable. Cable markers should also be used to identify change in direction of cable route and for location of every joint in underground cable.

The relative position of the cables, laid in the same trench shall be preserved. At

all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bent not less than 12 times the diameter of cables. Minimum 3 metre long loop shall be provided at both end of cable. Distinguishing marks may be made on the cable ends for identifications of phases. Insulation tapes of appropriate voltage and in red, yellow and blue colours shall be wrapped just below the sockets for phase identifications.

7.2 PROTECTION OF CABLES

The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than one cables is laid in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 50mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic, shall be protected by running them through Hume Pipes of suitable size.

7.3 EXCAVATION & BACK FILL

All excavation and back fill required for the installation of the cables shall be carried out by the contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surface, roadways, side walks, kerbs wall or the works cut by excavation to their original condition to the satisfaction of the Engineer-In-Charge.

7.4 LAYING OF CABLES ON CABLE TRAY/SURFACE OF WALL/CEILING

Cable shall be laid on perforated M.S./GI Cable tray. Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/saddles. Care shall be taken to avoid crossing of cable. Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches

7.5 CABLES ON HANGERS OR RACKS

The Contractor shall provide and install all iron hangers racks or racks with die cast cleats with all fixings, rag bolts or girder clamps or other specialist fixing as required. (Iron racks to be provided by Civil Contractor or their Sub associates). The cable racks shall be of adequate strength to carry the weight of cables with out sagging. Structural bracket grouted in the build up trenches to support the cable such supports shall be at intervals of not less than 750 mm centre. All the structural steel work shall be finished with two coats of paint over primer. Earthing flat/wire can also be laid in cable tray along with cables.

Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. These shall be designed to keep provision of some spare capacity for future development.

8.0 TERMINATION AND JOINTING OF CABLES

a) Use of Glands

All PVC cable upto 1.1 kV grade, armoured or un-armoured shall be terminated at the equipment/junction box/ isolators/push buttons/control accessories, etc. by means of suitable size compression type cable glands armour of cable shall be connected to earth point. The Contractor shall drill holes for fixing glands wherever necessary. Wherever threaded cable gland is to be screwed into threaded opening of different size, suitable galvanised threaded reducing bushing shall be used for 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.

b) Use of Lugs/Socket

All cable leads shall be terminated at the equipment terminals, by means of crimped type solder less 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:

- i) Strip off the insulation of the cable end with every precaution, not to sever or damage any strand. All insulation to be removed from the stripped portion of the conductor and ends of the insulation should be clean and square.
- ii) 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 fitted with corrosion inhibiting compound. This compound should also be applied over the stripped portion of the conductor and the palm surface of socket.
- iii) Correct size and type of socket/ferrule/lug should be selected depending on size of conductor and type of connection to be made.
- iv) Make the crimped joint by suitable crimping tool.

- v) If after crimping the conductor in socket/lug, same portion of the conductor remains without insulation the same should be covered sufficiently with PVC tape.
- c) Dressing of Cable inside the Equipment
After fixing of cable glands, the individual cores of cable shall be dressed and taken along the cableways (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 an aluminium cables, the Contractor shall modify the same without any additional cost.

- d) Identification of Cables/Wires/Cores

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

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

9.0 CABLES TAGS

Cable tags shall be made out of 2mm thick aluminium sheets of suitable size & tagged with GI wire before entry in to the panel(s)/ crossing/manholes. The cable tag shall indicate destination & origin point of cable alongwith its size.

10.0 TESTING OF CABLES

Prior to installation, burying of cables, following tests shall be carried out.
Insulation test : (between phases, phase & neutral, phase & earth for each length of cable).

- a. Before laying.
- b. After laying.
- c. After jointing.

On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer-In-Charge.

- a. Insulation Resistance Test (Sectional and overall).
- b. Continuity Resistance Test.

c. Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such tests.

11.0 GENERAL REQUIREMENTS FOR HANDLING OF CABLES

- a) Before laying cables, these shall be tested for physical damage, continuity absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500/1000 volt Insulation Resistance Tester.
- b) The cables shall be supplied at site, wound on wooden drum or steel drum 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.
- c) Sharp bending and kinking of cables shall be avoided. The bending radius for PVC insulated and sheath armoured cable shall not be less than $12 D$ Where 'D' is overall diameter of the cable.
- d) While drawing cables through GI pipes, conduits, RCC pipe, ensure that size of pipe is such that, after drawing cables, 40 % area is free. After drawing cable, the end of pipe shall be sealed with cotton/bituminous compound.
- e) High voltage (11 kV and above), medium voltage (230 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes/trays.
- f) Armoured cables shall never be concealed in walls/floors / roads without GI pipes, conduits RCC pipes.
- g) 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 type joint shall be made, without any additional cost.
- h) A minimum loop of 3 M shall be provided on both ends of the cable, or straight through cable joint or as per site conditions. This additional length shall be used for fresh termination in future.
- i) Cable shall be neatly arranged in the trenches / trays in such a manner so that

criss-crossing is avoided and final take off to the motor / switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor.

- j) 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 Engineer-in-charge before cutting of cables. While selecting cable routes, interference with structures, foundations, pipe line, future expansion of buildings, etc. should be avoided.
- k) All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.
- l) Wherever cable rises from underground/concrete trenches to motors/switchgears/push buttons, these shall be taken in GI pipes of suitable size, for mechanical protection upto 300 mm distance of concerned cable gland or as instructed by the Engineer-in-charge.
- m) Where cables pass through foundation/walls of other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the electrical Contractor shall determine their location and obtain approval of the Engineer-in-charge before cutting is done.

X - CABLE TRAY

1.0 PERFORATED TYPE

The cable tray shall be fabricated out of slotted/perforated MS (painted) / GI sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These will be galvanised as specified.

Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works Part-II-External.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surface between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cable trays and for different supported span are as per Table-IV of CPWD General specifications of Electrical Work Part-II - 1994. The sizes shall be specified considering the same.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided of same make as of cable tray & as per good engineering practice (Details are typically shown in figure-3 of CPWD General specifications of Electrical Work Part- II – 1994). The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The entire tray (except in the case of galvanised type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

2.0 LADDER TYPE

Ladder type cable tray shall be fabricated out of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a center to center spacing of 250mm. The channel sections shall be supplied in convenient lengths and assembled at side to the desired lengths. These may be galvanised or painted to the desired lengths.

Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 25% additional width for future expansion. This additional width shall be minimum 100mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part-II-1994. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

3.0 **INSTALLATION OF CABLE TRAY/ LADDER**

The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS/GI rounds or 25mm x 5mm flats at specified spacing as per of CPWD General Specification of Electrical Work Part II -1994. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer, to take the weight of the cable tray with the cables. All MS the support structure will have 2 coat of Red oxide primer followed by enamel point.

XI - EARTHING

1.0 SCOPE

This section covers the essential requirements of earthing system components and their installation. For details not covered in these specifications, IS Code of Practice on Earthing (IS : 3043-1987) CPWD General specifications for Electrical works (part-I-Internal) as amended upto date and in the regulations of the local Electrical Supply Authority shall be referred to. Installation of plate/pipe should be as per drawing available in CPWD specification.

1.1 APPLICATION:

- i) The electrical distribution system is with earthed neutral (i.e. neutral earthed at the transformer/ generator end). In addition to the neutral earthing, provision is made for double earthing the metallic body of equipments and non-current carrying metallic components in the substation, as well as in the internal/ external electrical installations.
- ii) Earthing requirements are laid down in Indian Electricity Rules, 1956 and Indian standard Specification IS:3043:1987 with latest amendment as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.

2.0 MATERIALS

The material of earth and earth conductor shall be as specified.

2.1 EARTH ELECTRODES

The earth electrode shall be as GI/CU Plate or GI pipe size of earth electrodes shall be as per specification.

2.2 EARTHING CONDUCTOR

- 2.2.1 The earthing conductor (protective conductor from earth electrode upto the main earthing terminal/ earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper and in the form of wire or strip as specified. The size of earthing conductor shall be as per specification.
- 2.2.2 Each equipment shall be connected with two independent earth conductors to earth bar located in respective area. Each earth bar shall be connected to Earth Grid by two independent earth conductors. Earthing Grid shall be directly connected by two independent earth electrodes. Earthing shall be of GI or Copper.

3.0 HARDWARE ITEMS

All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrode and forged tinned brass in case of copper plate electrodes.

3.1 PROTECTIVE (EARTH CONTINUITY/ LOOP EARTHING) CONDUCTOR

- i) The material and size of protective conductors shall be as specified.
- ii) Unless otherwise specified, GI conductor should not be ordinarily used as protective conductor within any circuit beyond a Distribution Board downstream.

3.2 LOCATION FOR EARTH ELECTRODES

Normally an earth electrodes shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases electrodes may be located further away from the building, with the prior approval of the Engineering-In-Charge.

The location of the earth electrode shall be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and roadways, shall be avoided for locating earth electrodes.

When more than one electrode (plate/ pipe) are to be installed, a separation of not less than 2m shall be maintained between adjacent electrodes.

4.0 INSTALLATION

4.1 ELECTRODES

4.1.1 PIPE ELECTRODE

Earthing electrode shall consist of a medium class GI Pipe of approved make not less than 40mm dia and 4.5 meters long. GI Pipe electrode shall be cut tapered at the bottom and provided with holes of 12mm dia drilled at not less than 75mm interval upto 2 meters length from bottom. The electrode shall be buried vertically in the ground as far as practicable below permanent moisture level with its top at not less than 20cm below ground level. The electrode shall be in one piece and no joints shall be allowed in the electrode. Wherever possible earth electrodes shall be located as near water tap, water drain or a down take pipe. Earth electrodes shall not be located in proximity to a metal fence. It shall be kept clear of the building foundations and in no case shall be nearer than 2 meters from the outer face of the wall.

The pipe earth electrode shall be kept vertically and surrounded with 150mm thick layer of charcoal dust and salt mixture upto a height of 2.0 meters from the bottom. At the top of the electrode a funnel with a mesh shall be provided for watering the earth. The main earth conductors shall be connected to the electrode just below the funnel, with proper terminal lugs and check nuts.

In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be reduced

length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-In-Charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.

4.1.2 PLATE EARTH ELECTRODE

Earthing shall be provided with GI /copper plate electrode mentioned as following.

- i. GI Plate Electrode. : 600mm x 600mm x 6mm thick
- ii. Copper Plate Electrode. : 600mm x 600mm x 3mm thick

The electrode shall be buried in ground with its faces vertical and not less than Three (3) metres below ground level. 20mm dia medium class GI pipe shall be provided and attached to the electrode. Earth electrode shall not effect the column footing or foundation of the building. In such cases electrode shall be further away from the building.

4.1.3 WATERING ARRANGEMENT

- iii) In the case of plate earth electrodes, a watering pipe of 20mm dia. medium class GI pipe shall be provided and attached to the electrodes as shown in the drawing as referred in CPWD specifications and a funnel with mesh shall be provided on the top of this pipe for watering the earth.
- iv) In the case of pipe electrodes, a 40mm x 20mm reducer shall be used for fixing the funnel with mesh.
- v) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 300 mm x 300 mm x 350 mm deep.

A MS frame with 6mm thick MS cover and having LEN Key locking arrangement shall be suitably embedded in the masonry enclosure. The top enclosure shall be provided of 50mm thick PCC.

- 4.1.4 The details of Plate/ Pipe earth electrode, a detailed drawing as referred in CPWD specification of Internal EI shall be referred.

4.2 EARTH CONDUCTOR

In the case of plate earth electrodes, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.

In the case of pipe earth electrodes, wire type earthing conductor shall be secured as using a through bolts, nuts and washers and terminating socket.

The earthing conductor from the electrode upto the building shall be protected from mechanical injury by a medium class, 15mm dia GI pipe in the case or wire, and by a minimum of 40mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be fixed on walls.

The earthing conductor shall be securely connected at the other end to the earth stud/ earth bar provided on the switch board by Soldered or preferably crimped

lug, bolt, nut and washer in the case of wire, and, Bolt nut and washer in case of strip conductor.

4.3 EARTH BUS AND MAIN EARTHING TERMINAL

In all installations, main earthing terminal shall be provided at the main switchboard. This may be in the form of earth stud or single earth bar depending on the type of the switchboard.

Following conductors shall be terminated on to the main earthing terminal.

- a) Earth connection from electric supply company (where provided)
- b) Earthing conductor from electrode.
- c) Protective conductors
- d) Equi-potential bonding conductors.

4.4 PROTECTIVE (LOOP EARTHING/ EARTH CONTINUITY) CONDUCTOR

Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/ terminal of the upstream switchboard by protective conductors.

Two protective conductors shall be provided for a switchboard carrying 3 phase switchgear thereon.

4.5 EARTH RESISTANCE

The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be upto 8 ohms.

Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode (s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-In-Charge.

4.6 MARKING

- i) Earth bars/ terminals at all switch board shall be marked permanently, as 'E'.
- ii) Main earthing terminal shall be marked 'SAFETY EARTH- DO NOT DISCONNECT'.

4.7 MEASUREMENT OF EARTH ELECTRODE RESISTANCE

- 4.7.1 Two auxiliary earth electrodes, besides the test electrode, are placed at suitable distance from the test electrode. A measured current is passed between the electrode 'A' to be tested and an auxiliary current electrode 'C' and the potential difference between the electrode 'A' and auxiliary potential 'B' is measured. The resistance of the test electrode 'a' is then given by

$$R = V/I$$

Where,

R- Resistance of the test electrode in ohms

V- Reading of the voltmeter in volts

I-Reading of the ammeter in amps

- 4.7.2 Stray currents flowing in the soil shall produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator is used.

If the frequency of the supply of hand driven generator coincides with the frequency of stray current, there shall be wandering of instrument pointer. An increase or decrease of generator speed shall cause this to disappear.

- 4.7.3 At the time of test, the test electrode shall be separated from the earthing system.
- 4.7.4 The auxiliary electrodes shall be of 13mm diameter mild steel rod driven up to 1 m into the ground.
- 4.7.5 All the three electrodes shall be so placed that they are independent of the resistance area of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode C shall be placed at least 30m away from it and the auxiliary potential electrode 'B' shall be placed mid-way between them.
- 4.7.6 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C up to 50m, and each time placing the electrode B mid-way between them.
- 4.7.7 Earthing plate/pipe earthing should be as per drawing available in CPWD specification.
- 4.7.8 Installation of plate/ pipe earthing shall be as per CPWD specification and drawing.

XII- UPS

1.0 Scope of work

- (a) The centralised UPS systems (Minimum 60 KVA more as per site requirements) as per applicable Indian Standards (IS 16242/IEC 62040) will be provided in Terminal building etc. as per site requirement & direction of EIC for different zones as per switch room location i.e. a centralised UPS system with 100% redundancy will be provided for lighting load, PAVA, FAS, FIDS, IT system, Signages emergency power points, and other installations as required.
- (b) Power Distribution Panel (PDP) - The power distribution panels shall be provided to meet the system requirement along with UPS. The power distribution panel shall provide MCBs with proper ratings for all equipment/ installations/ rooms as mentioned above sufficient numbers of Loops are required to be made to avoid high current passing in single loop – one MCB for each loop and one Mains Control Switch.

2.0 Specifications:

The detailed technical specification for UPS system will be as following.

- The acoustic noise should be less than 80 dB at one meter distance.
- All system parameters and monitoring of rectifier battery charging and inverter functions should be carried out digitally. (i.e. by using microprocessor)
- The system should use high frequency IGBT Based rectifier with PWM based system.
- Galvanic isolation transformer at output within UPS is required.
- The system should provide in-built static as well as manual by-pass.
- Programmable battery testing facility should be provided to know the battery status. By using the battery test mode the system should disconnect input power supply at set time period and battery should discharge through the load. Programmed battery testing should be selectable through the front panel of the system.
- The system should provide “EVENT RECORDING” facility. It means the system should store last 100 events. i.e. input voltage variation or out of tolerance operating condition of the system at any time and should also include cause of the fault should also give the name of the faulty component in terms of rectifier controller card, inverter controller card, snubber circuit fault etc., all events should be readable from front panel LCD of the system and it should be able to take print out through RS 232 interface port.
- The system should provide battery-monitoring facility. This system should check battery capacity in regular intervals during normal operation of the UPS. The front panel LCD should show the capacity of the battery and calculate for how long the load can be supplied.

- Front panel of the system should have LCD display for displaying of input voltage, input frequency, input voltage and frequency of the supply connected in by pass line, battery remaining time, output voltage out frequency and load connected to the system. It should also display event occurred by using event recorder. It should also provide facility to switch UPS ON /OFF, Emergency OFF and manual by-pass ON/OFF.
- Mimic diagram should provide to know the status of the rectifier, inverter, battery and output bus bar.
- Emergency switching OFF of the UPS system (remotely).
- In case of Input supply phase reversal the system should not trip and should not go to battery. It should work on mains alarm indication. It should be inbuilt feature of the system.

TECHNICAL DATA:

INPUT:

1. Input phase voltage : 400 V +/- 20 % (operating Range: 320-480V)
3 - phase
2. Supply frequency : 50 Hz
3. Frequency Tolerance : $\pm 10\%$ at 50 Hz (without UPS tripping)
4. In put power factor : >0.99
5. Input current distortion/harmonics : $<3\%$
6. Rectifier Technologies : IGBT with PWM technologies.

BY-PASS LINE:

1. Three phase voltage : 400 V +/- 15 %
2. Over load capacity for 1 min. : 150 %
3. Over load capacity for 10 min. : 125%

OUTPUT:

1. Inverter technologies : IGBT with PWM Technologies.
2. Voltage three phase : 415 V and should be selected to 380 or 400 V
3. Voltage stability : +/- 1 % static, +/- 5% dynamic.
4. Wave form : sinusoidal with 1% total harmonic distortion
(Linear)
5% total harmonic distortion (Non-Linear)
5. Frequency : 50 Hz
6. Frequency stability : +/- 0.05%
7. Crest factor : 3:1
8. Accepted over load : 110% for 10 min. 125 % for 1 min.
9. Load power factor : 0.9
10. Rated power : KVA
11. Active power : KW

SYSTEM:

1. Total efficiency of the UPS : more than 93% at 50% of load.
2. Standard RS 232 interface facility should be provided.
3. Battery should be SMF VRLA type.
4. Battery Ah calculation should be submitted along with technical submittal.

ADDITIONAL TECHNICAL PARTICULAR FOR UPS & BATTERIES

1.	Power walk in	0-120 Sec (settable)
2.	Output voltage	380/400/415 V (selectable in steps)
3.	Frequency slew rate	1 Hz / sec
4.	Voltage recovery time within +/- 1%	20 ms
5.	Short circuit current	
	Phase to phase	180% for 1 sec
	Phase to neutral	300% for 1 sec
6.	Overall efficiency at rated load (ECO mode efficiency)	≥ 95 % (ECO mode ≥ 98%)
7.	Heat dissipation @ 10% load at nominal PF & charge batteries	As per OEM Standards
8.	Battery type	SMF VRLA Type
9.	Designed life of battery	5 Years
10.	Battery backup	30 Min.
11.	Phase reversal protection Feature	Inbuilt
12.	UPS dimension	As per OEM standard
13.	Battery bank dimension	As per OEM standard
14.	Protection	
	Over load	Yes
	Short circuit	Yes
	Input low voltage	Yes
	Input high voltage	Yes
	Output over voltage	Yes
15.	Control & indication	
	Alarm	Yes
	UPS fault	Yes
	Battery discharge	Yes
	Inverter OFF/ failed	Yes
	Rectifier OFF/ failed	Yes
	Over temperature	Yes
	Over load	Yes
	Emergency stop	Yes
16.	Indication/display	
	Input voltage	Yes
	Input current /phase	Yes
	Input frequency	Yes
	By pass input voltage	Yes
	Bypass input frequency	Yes

Inverter output voltage	Yes
Inverter output current /phase	Yes
Inverter output KVA and KW	Yes
Battery voltage	Yes
Battery charging voltage	Yes
Battery discharging voltage	Yes
Battery backup remaining time.	Yes
Overall system temperature	Yes
Inverter temperature	Yes
Rectifier temperature	Yes

MINIMUM TESTS TO BE CHECKED DURING FACTORY ACCEPTANCE TEST OF UPS

S. No.	Description of Test	Test Method / Procedure	Acceptance Criteria (as per CPWD / IS)	Measured Value	Pass/Fail	Remarks
1	Physical & Visual Inspection	Inspect enclosure, labels, wiring, nameplates,	No physical damage; Correct rating;			
2	Insulation Resistance Test	IR test at 500V/1000V as applicable	> 1 MΩ or as per OEM			
3	Functional Test	Power ON UPS; run self- test; check inverter, bypass, alarms	All modules operate normally; No abnormal alarms			
4	Input Supply Voltage & Frequency Check	Measure using calibrated meter	Within specified tolerance (±10% V, ±3% F)			
5	Output Voltage (No Load)	Measure output phase - neutral/phase-phase	Within ±1-2% of rated			
6	Load Test - 25% Load	Apply resistive load, record V/F/Waveform	Till thermal steady state or as per tender specification			
7	Load Test - 50% Load	Apply 50% resistive load	Till thermal steady state or as per tender specification			
8	Load Test - 100% Load	Apply full load using load bank	Till thermal steady state or as per tender specification			
9	Overload Test	110%-125% for 10 Min 126%-150% for 1 Min	UPS shall withstand 110%-125% for 10 min & 126%-150% for 1 Min			
10	Unbalanced Load Test	Apply unbalance load up to 30-60 minutes as per tender requirement	Voltage Within ±2% to ±3% of rated value			
11	Voltage Regulation Test	Vary load from 0-100%	Regulation within ±1%			
12	Output Frequency Stability	Measure frequency at all load levels	±0.1 Hz inverter mode			
13	Output THD (Linear Load)	Use power analyser	As per tender specification			
14	Efficiency Test	Measure Pin & Pout at rated load	As per tender specification			
15	Power Factor (Input/Output)	Measure using analyser	As per tender specification			

Note : The above test parameters are minimum, however any other test may also be consider for FAT as per requirement.

PACKAGE - C

LPS

LIGHTNING PROTECTION SYSTEM

1.0 GENERAL:

1.1 This section covers works out detailed risk analysis and provide Lightning Protection System (LPS) for terminal building, & its structure etc. as per latest Indian (IS) and IEC standard.

1.2 Qualification criteria for supplier of the lightning protection system:

The supplier of the lightning protection system should be OEM / authorized specialized agency of the OEM. The OEM of the lightning protection system should have authorized service setup in India. The makes should be an approved make of the LPS enclosed.

Standard & Code:

Part I	:	General Principles	IS/IEC 62305-1:2010
Part II	:	Risk Management	IS/IEC 62305-2:2010
Part III	:	Physical damage to structures and life hazard	IS/IEC 62305-3:2010
Part IV	:	Electrical and electronic systems in structures.	IS/IEC 62305-4:2010
Wind velocity			IS 875 – 1987
Design of lightning protection system			NBC 2016
Lightning current capability test for special cable HVI			IEC/TS 62561-2 (ed.1.0), 81/457/CD:2013-11 Clause 5.4.7.1 –
Material test standard			IEC / EN 62561
Surge Protection Device for Power Supply			EN 61643-11:2012 / IEC 61643-11:2011 OR latest
Surge Protection Device for Power Supply			IEC 61643-21:2009 and EN 61643-21: 2010 OR latest
Copper Bonded Earthing Rods			UL 467&IEC- 62561-2
Testing Ground / Earth enhancement Chemical			IEC 62561-7 & IEEE 80



1.3 Scope of work:

The detailed requirement of installation of lightning conductor system for protection of following structures / building against lightning shall be worked out and executed as per IS/IEC:62305 (Part-I to IV) & NBC 2016 and as per enclosed layout drawings for the following location/ installations :

1.3.1 Terminal Building

The roof of terminal building shall be provided with minimum level-I protection complying IS/IEC: 62305 (part-I to IV). Horizontal terminal shall be installed with approved holder / clamps with roofing sheet. If holder / clamps are not feasible as per sheet profile then it shall be planned with base block by fixing special glue. This will be subject to approval of Engineer-in-charge. There shall be close co-ordination with the roofing sheet vendor. The life of glue shall be life long at any atmospheric conditions of the site proposed. No drilling is allowed on the roof top of the terminal building.

While determining the position of the air-termination systems, a special attention must be paid to the corners and edges of the structure to be protected.

Steel work within reinforced concrete structures can be considered as down conductors for LPS as described in para 1.3.2 above.

1.3.2 ESS Building (Sub-Station):

The above building(s) and its extended roof shall be provided with minimum level- I protection complying IS/IEC: 62305 (part-I to IV). The air termination shall directly be installed on the roof of the building with cement concrete base. Drilling shall be avoided on roof top.

While determining the position of the air-termination systems, a special attention must be paid to the corners and edges of the structure to be protected.

1.3.3 Structural Earthing / Bounding: Inter connecting steel reinforcement / metal frame structure shall be considered in designing the lightning protection systems and equipotential bounding of the conducting part shall be maintained properly w.r.t. the ground complying standard.

1.4 Works to be done by the contractor:

Unless otherwise mentioned in the tender documents, the following works shall be executed by the EPC contractor within their scope of work:

- a. Lightning protection system shall be worked out at climatic condition of proposed site and submitted with all supporting documents for approval of AAI.
- b. All supporting holders, universal connectors, upper & lower termination & fixing/ holding clamp for High voltage insulated (HVI) cable etc. shall be used



as per recommendation of the OEM for lightning protection system. The design of the pole structures & foundation for installation of complete lightning protection system shall be submitted duly certified / vetted by a recognized Govt. Engineering College viz. IIT / NIT etc. or by structural consultant of AAI for approval by Engineer-In-Charge.

- c. Submission of test certificate of OEM for life time guarantee for glue being used for fixing block with roof of structures.
- d. Bidder should submit certificate from manufacturer of LPS for complete support towards design & selection, supply of all parts, inspection at site etc. along with submission of shop drawings supported with risk calculation sheets, design etc. for approval of Engineer – In- charge.
- e. Making good all damages caused to the structure during installation and restoring the same to their original finish.
- f. Minor building works necessary for installation of equipments including its required foundation, making of opening in walls or in floors and restoring them to their original condition / finish and necessary grouting etc., as required.
- g. Supports for horizontal & vertical terminals including fittings, assemblies, accessories, hardware items complete as required.
- h. All electrical works including interconnections, bonding etc. as required.
- i. All tools and tackles required for unloading / handling of equipments and materials at site, their assembly, erection, testing and commissioning.
- j. Painting of all exposed metal surfaces of equipments and components with appropriate colour as directed & approved by Engineer-In-Charge.

2.0 System Design:

The level of protection – LPL – I shall be considered as per NBC – 2016, however detail Risk assessment shall be submitted as per IS / IEC 62305 (with upto date amendments) for above building/ structure. Considering airport installations, the rolling sphere method of protection shall preferably be adopted.

While designing the External Lightning Protection (ELP), the separation distance shall be considered by maintaining the physical separation distance between the down conductor for buildings and HVI cables for down conductor to compensate the need of separation distance and to avoid creepage flashover.

The system design and layout shall be done in accordance with IS-IEC: 62305 – 2015 (with up-to-date amendments) and as specified in the tender documents. The design, shop drawing and bill of materials etc. shall be prepared/ worked out by the bidder as per standards for the lightning protection system and submitted to AAI for approval after getting vetted from the manufacturer of LPS.

The work can be taken at site only after approval of technical submittal and shop drawing approval by AAI. The test certificate of the materials to be used as per IEC, attested in original by the manufacturer shall also be submitted by the bidder before being incorporated for the works to be executed.



3.0 All components shall meet the requirement of IEC 62305 (part I - IV) standard. The materials supplied like - air terminations, down conductors, earth termination etc. of the protective system shall be reliably resistant to corrosion, or be adequately protected against corrosion. Aluminium should not be used underground, or in direct contact with walls.

3.1 External Lightning Protection (ELP) components shall comply with the specification as under :

Sl. No.	Components	Specifications
i)	Air terminal vertical as well as horizontal	<p>a) Vertical air terminal rod shall be copper coated / <u>copper</u> / Aluminium of required dia & length and blunt point at top.</p> <p>b) The horizontal <u>conductors shall be round conductor</u> made of Aluminium / Copper coated steel or its alloy (long length & minimum joints). The clamp support shall be provided with necessary base block with clamp / glue on concrete block(s) <u>for the support of roof conductor.</u> No drilling is allowed on roof top.</p>
ii)	Down conductor from Air-termination upto test point / earth point	<p>Round conductor (long length & minimum joints) made of Aluminium / Copper coated steel or its alloy, dia 8 mm (min) for buildings and High voltage isolated (HVI) cables of area of cross section shall not be less than 50 mm² shall be used as per site conditions. The HVI cable should meet the requirements according to EN 62561-2 and test certificate from approved lab up to 200KA (lightening impulse current) to be submitted.</p>



iii)	Clamp for support to conductor	<p>All support / clamps/ universal connectors at crossing of round conductors/ holder for vertical conductor etc. shall be provided complying IS/IEC 62305 as per site requirement.</p> <p>All Clamps and connectors shall be tested as per IEC / EN 62561 from accredited test lab only.</p>
iv)	Test Joint (with box to be provided at substation side)	<p>It shall be used for every down conductor at 1 Meter (approx.) above ground level (for connection /disconnection purpose). For buildings, the down conductor from test box to earth pit shall be protected with HDPE pipe which shall withstand min 6 kg pressure test.</p>
v)	Earthing system	<p>Each down conductor shall be terminated to either earth electrode or ring earth, Earth electrode shall be not less than 17mm dia, 10 feet long, UL listed, copper coating over mild steel. Each earth electrode shall be supported with RoHS certified, low resistivity (≤ 0.12 ohm Mtr.) ground enhancement material (min 20Kg) which performs in all soil condition, increases the contact area with earth electrode. Suitable clamps shall be used for termination of down conductors to earth electrode.</p> <p>Ground enhancement material shall be tested from NABL test labs only for all the parameters (i.e. resistivity, pH value, thermal stability, water solubility, Sulphur content, moisture retention, corrosive prevention etc).</p>
vi)	Equi-potential bonding	<p>All metal (natural conductor) components shall be bonded together with roof/down conductor for equi-potential bonding, (Except - HVI as down conductor)</p>



vii)	Interconnection of earthing system	All earth pits shall be connected together, incase different earthing system cannot be connected directly and same shall be interconnected using Isolating Spark Gap.
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3.2 **Air-termination systems:-**

The function of the air-termination of lightning protection system is to prevent direct lightning strikes to damage the volume to be protected. They must be designed to avoid uncontrolled lightning strikes to the building / structure to be protected.

Correct dimensioning of the air-termination systems allows to reduce the effects of a lightning strike to a structure in a controlled way.

Air-termination systems shall consist of -

- i) Air termination networks may consist of vertical or horizontal conductors, or combinations of both.
- ii) For a flat roof, horizontal air termination along the outer perimeter of the roof shall be used. For a roof of larger area a network of parallel horizontal conductors shall be installed.
- iii) Horizontal air terminations should be carried along the contours such as ridges, parapets and edges of flat roofs, and, where necessary, over flat surfaces, in such a way as to join each air termination to the rest, and should themselves form a closed network.
- iv) All metallic projections including reinforcement, on or above the main surface of the roof which are connected to the general mass of the earth, should be bonded and form a part of the air termination network.
- v) If portions of a structure vary considerably in height, any necessary air terminations or air termination network for the lower portions should be bonded to the down conductors of the taller portions, in addition to their own down conductors.

3.3 **Down Conductors:**

The down conductor is the electrically conductive connection between the air-termination system and the earth-termination system. The function of a down conductor is to conduct the intercepted lightning current to the earth-termination system without damaging the building e.g. due to intolerable temperature rises. To avoid damage caused during the lightning current discharge to the earth-termination system, the down conductors must be mounted to ensure that from the point of strike to the earth -

- Several parallel current paths exist,
- The length of the current paths is kept as short as possible (straight, vertical, no loops),
- The connections to conductive parts of the structure are made wherever required.



3.3.1 Routing of down conductors:

- a) A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged as evenly as practicable around the outside walls of the structures.
- b) The down conductor bending shall be as per IS/IEC 62305-3. It shall have minimum bending radius of 8". The sharp bending shall be avoided.
- c) The walls of lift wells may be used for fixing down conductors, but lift shafts should not be used for this purpose.
- d) Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors, but cannot replace them, such connections should have disconnecting joints.
- e) In deciding on the routing of the down conductor, its accessibility for inspection, testing and maintenance should be taken into consideration.

f) **Provision when External Route is Not Available**

Where the provision of external routes for down conductors is impracticable, for example, in buildings of cantilever construction from the first floor upwards, down conductors should not follow the outside contours of the building. To do so would create a hazard to persons standing under the overhang. In such cases, the down conductors may be housed in an air space provided by a non-metallic and non-combustible internal duct and taken straight down to the ground.

Any suitable covered recess, not smaller than 76 mm x 13 mm, or any suitable vertical service duct running the full height of the building may be used for this purpose, provided it does not contain an unarmoured or a non-metal sheathed cable.

In cases where an unrestricted duct is used, seals at each floor level may be required for fire protection. As far as possible, access to the interior of the duct should be available.

- g) The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the building.

3.3.2 Determination of the number of down conductors:

Depending on the structural conditions (e.g. gates, precast components), the distances between the various down conductors can be different. In each case, there must be at least the total number of down conductors required for the respective class of LPS. The IEC 62305-3 Table 5.2.1.1 specifies the typical



standard distances between down conductors and ring conductors for each class of LPS to be followed.

3.4 SPECIFICATION FOR POLE

3.4.1 Design & approval

The thickness and dia of steel / FRP pole shall be workout by the bidders as per system design requirement. Successful bidder to examine the same and its foundation taken into account seismic activity at proposed site and also the Basic wind speed of 47 Mtr/sec. as per clause 5.2 of IS:875 (Part-3) 1987 with up to date amendment.

The design shall be such that wind excited oscillation shall be dampened as much as possible and an adequate allowance shall be made to resist stresses due to these oscillations. On award of work, the bidder shall furnish full calculations of the forces involved for approval after getting vetted from the manufacturer of pole(s)/specialized agency.

3.4.2 Pole Construction

The steel / FRP pole manufacturing unit shall be ISO 9001:2000 certified & preferably ISO 14001 certified to ensure consistent quality & environmental protection.

The sections of FRP pipes of suitable thickness shall be inter-connected with tapped adapter of suitable dia& length. The upper part of tapped adapter shall be positioned such that it should not accumulate any dust and bottom part should be secured with SS nut & bolt to the FRP poles. All pipes shall be internally threaded for connection and smooth finish from outside.

The bottom section of steel pole shall be hot dip galvanized internally and externally having uniform thickness of minimum 65 microns. To enable clear access to the test point with cable connections, inside the bottom steel pole, a vandal resistant weather proof door opening has to be provided with a secured heavy duty lock. The lock should not be easily accessible and special arrangements are to be made to open the door for undertaking test check / maintenance. This opening has to be adequately reinforced with welded steel section, thereby restoring the section modules and preventing trickle.

The mast shall be delivered in sections and to be assembled at site by using FRP adapter for FRP poles and slip stress fit in steel pipe (if supply in two sections). The top and bottom dia of the pole shall be not less than 50mm & 100mm A/F respectively. There shall not be any site welding in the pole. The connection between steel pole and FRP mast (above counterpoise structure) shall be with frangible coupling.

The vent shall be provided in all pipes to prevent pressurization due to seasonal variations. The vent provided shall have IP 66 protection.



The air terminal rod shall be inserted into the TOP FRP pole with HDPE adapter. The adapter shall have tapered outer end.

3.4.3 Pole Foundations

Concrete foundation required for the pole shall be designed as per IS: 875 (Part-3) -1987/ IS: 456/78 / IS: 4091-79 and with due consideration to the seismic activities of site. Foundation shall be designed for safe bearing capacity of 10.0 tones per sq.mtr available at a depth of 1.50 m below ground level. Footing can be taken deeper if required from structural considerations.

The foundation design of pole(s) structure shall be certified / vetted by a recognized Govt. Engineering College viz. IIT / NIT etc. or by structural consultant of AAI and submitted for approval. The cost for the same shall be borne by the contractor. The pole foundation shall be 300 mm above finish surface.

3.4.4 Casting of Foundation:

Reinforced cement concrete (RCC) foundation shall be casted as per approved drawing. The curing shall be done for two weeks before loading the pole. The foundation shall project above ground by 300 mm which shall be neatly finished with sand cement plaster.

3.4.5 Cable Guard pipe:

50mm (OD) as per list of approved makes for electrical works & ISI marked DWC HDPE pipe as required shall be laid for easy laying & relaying of HVI cable in concrete foundation without any change to the RCC foundation work. The end of the pipe shall be sealed after cable is laid & tested.

3.4.6 Installation of Pole

The steel/ FRP poles shall be installed in a workman like manner so that it is leveled, properly aligned and oriented.

Care shall be taken in handling the pole to avoid any distortion to the supporting structure or damage to any other parts.

After erection of pole(s) with overlapping at joints, and flexible coupling at joint between steel & FRP sections, the pole should be numbered as per the direction of Engineer-in-charge and the exposed portion of concrete foundation shall be painted.

On erection of poles, all sections of poles including all fixing accessories shall be coated with polyurethane corrosion resistance paint. The outer colour of pole paint shall be white or as approved by architect of the project.

3.5 Specifications of Down Conductor :

The down conductor to be used shall be PVC insulated & PVC Sheathed



unarmoured flexible High voltage insulated (HVI) cables. The cable shall be pure Electrolytic type. The size of cable shall not be less than 50 sq.mm.

3.6 Earthing & Grounding

- a) Earth pits must be made using chemically earth enhancing compounds and must be maintenance free.
- b) The earth resistance of the individual earth pit must not exceed 2 ohms static impedance.
- c) Earth electrode shall be minimum of 17mm dia, 10 feet long, UL listed, min 254 micron copper coating over mild steel, - Each earth electrode shall be supported with RoHS certified, low resistivity (≤ 0.2 ohm Mtr) Ground enhancement Material, at least 3 meter depth and back filled with Chemically earth enhancing compound including excavation & back filling (if required) of pit complete.
- d) A minimum quantity of 20Kg of Earth enhancing compound must be used per earth pit.
- e) Earth pit chamber shall be of polymer materials or approved equivalent with locking arrangement of size not less than 300 x 300 x 200mm and suitable to withstand load of 5T.

OR

An earth pit chamber shall be casted with PCC. The top cover shall be made of 6mm thick MS sheet with MS angle frame embedded in PCC of chamber & Allen Key lockable arrangement as inspection chamber shall be provided.

After completion of the work the OEM authorised representative shall check and attest the test certificate of the materials used in the work and certify that the installation along with the materials used are complying IS –IEC-62305 (Part I - IV) standards on his letter head.

- 4.0** The quoted rate by the bidder is deemed to be inclusive of all cost pertaining to the design, manufacture, supply, installation, testing and commissioning of Lightning protection as described in the previous pages as a complete job and nothing extra shall be paid on this account.

5.0 Testing:-

On completion of the installation the following measurements checks have to be made and the results to be recorded:

- i) The resistance to earth of each local earth electrode and resistance to earth of complete earth termination system.
- ii) Each local earth electrode has to be measured in isolation and the test point between the down conductor and the earth electrode in the disconnected position (isolated measurement).
- iii) A further measurement has to be taken with the test point in the connected position (combined measurement).



- iv) The result of visual check of all conductors, bonds and joints and their measured electrical continuity.

If the resistance to earth of a lightning protection system exceeds 10 ohms, the value must be reduced. Necessary remedial action needs to be taken to reduce the value below or equal to 10 ohms.

All connections of air termination systems, down conductors, equipotential bonding conductors, shielding measures etc. should have low-impedance continuity. The recommended value is $< 1 \Omega$.

The contact resistance to the earth-termination system at all test joints must be measured to establish the continuity of the lines and connections (recommended value $< 1 \Omega$).

An inspection report shall be prepared & submitted to AAI along with the technical documents & drawings. The report should contain the following information:

- i) **General:** Firm's name and address, Name & address of the OEM of lightning protection system, year of construction.
- ii) **Information on the structure:** Location, use, type of construction, type of roofing, lightning protection level (LPL).
- iii) Information on the lightning protection system.
- iv) Material and cross-section of the conductors.
- v) Number of down conductors, e.g. test joints (designation according to the information in the drawing); separation distance calculated.
- vi) Type of earth-termination system (e.g. ring earth electrode, earth rod, foundation earth electrode), material and cross-section of the connecting lines between the single earth electrodes.
- vii) Connection of the lightning equipotential bonding system to metal installations, electrical installations and existing equipotential bonding bars.
- viii) Description and drawings of the lightning protection system.
- ix) Lightning protection standards and provisions at the time of installation
- x) Deviations from the applicable standards, regulations, requirements and application guidelines applicable at the time of installation.
- xi) Defects found if any.
- xii) Earth resistance or loop resistance at the individual test joints with information on the measuring method and the type of measuring device
- xiii) Total earth resistance (measurement with or without protective conductor and metal building installation).



PACKAGE - D
VRF/VRV/AC SYSTEM



1.0 General

This section covers the provision of Variable Refrigerant Flow (VRF)/ Volume (VRV) System (Cooling) and various other types of air-conditioning & ventilations systems (With Eco-friendly CFC free refrigerant only) for the proposed Terminal Building, & its allied structures.

Design, scope of work and specifications indicated in succeeding paras are minimum guidelines to enable the contractor to carry out detailed engineering and execute entire works to meet the indicative design / employer's functional requirement.

If EPC contractor provide superior techno- commercial solution to mitigate above parameters complying latest standard; can also be accepted subject to approval of Engineer-In-Charge.

The Air-Conditioning load is estimated as minimum 91 TR or more through VRF/VRV are proposed in the Terminal building as per site requirements. Split AC's system are proposed in the buildings as per site requirements.

Air – conditioning & ventilation system design shall be well equipped with energy conservation features to reduce energy consumption and operating costs where economically feasible.

Indoor design conditions In Terminal Building etc. shall be adopted as per: Table - "Annexure-EB"

1.1 Scope of Work:

1.1.1 The scope of work of Variable Refrigerant Flow (VRF)/ Volume (VRV) systems comprising of design, engineering, manufacture, supply, transportation, loading, unloading, delivery, storage, installation, balancing, testing, commissioning, coordination, interfacing, integrating, handover & training, for the following installations: -

I) Terminal Building area:

- a) VRF/ VRV units shall be planned & designed area wise as per operational requirements of Terminal Building.
- b) Outdoor Unit(s) shall be sectionalized in such a way that each area is provided with two circuits, and one circuit shall be designed / selected to meet minimum 30%-50% of that total area so that minimum Air- conditioning of area is maintained of common area (except areas mentioned under para S. No. d & e below). All outdoor units of VRF system should be planned and installed at green area. The small capacity outdoor unit shall be accepted nearer/ with facia of proposed Terminal Building without obstructing facia. However, EPC contractor has to take the prior approval of the location (s) & its covering etc. from AAI before installation.
- c) In double / single height area, the indoor unit(s) shall be designed with Cassette /ductable/Hi-wall or superior unit as approved by Engineer-in-charge matching with surrounding interior of the area.
- d) Server room, VIP ROOM, CCTV shall be planned & designed with standby split Air-conditioning unit(s)(N+1).



- e) Exhaust ventilations shall be planned & designed with in line/centrifugal fans system & centrifugal fans with ducting, grills, diffusers, etc. for Toilets, Switch Rooms, Pantry, Kitchen areas, smoking room etc. If Inline system is not feasible as per site conditions, then exhaust fan(s) can be accepted with the approval of Engineer-in-charge.
- f) UPS & battery rooms will have separate standby AC system with split Air-conditioning unit(s) (N+1). In addition to Air-conditioning unit, the equipment areas shall be provided with standby unit as standby(N+1).
- g) The areas like -VIP Lounge / Reserved Lounge, shall be provided with standby unit with split Air-conditioning unit(s) to meet the operational/ functional requirements. Child care rooms shall also provided with split AC system.
- h) With the exterior facia of terminal building, suitable size & shape Bird screen /cowl/ louver shall be provided for all design of system including exhaust system/ fans etc. The materials shall be superior grade suitable for outdoor applications& matching with facia.
- i) Scrubber for Restaurant kitchen shall be designed & planned.
- j) Touch Manager_– Intelligent Control & monitor unit for complete VRF/ VRV system shall be provided at one point control as per location approved by Engineer-in-charge. The loop control cable shall be fire survival copper of size not less than 1.5 sq. mm and shall be protected if laid on surface. Specification for fire survival cables to be followed as given in separate section.

1.1.2 In addition to supply, installation, testing and commissioning of all equipment's as brought in Para above installation-wise, design parameters and as per specifications, the following works deemed to be included within the scope of work, to be executed by the contractor.

- a) Supply, Installation, Testing and commissioning of indoor & outdoor VRV/VRF system as required including first charge of refrigerant etc.
- b) Necessary foundation with MS frame work duly painted for installation of outdoor AC units, Split AC etc.
- c) All cassettes / Ductables unit should come with inbuilt drain pump. Only high wall units should be fitted with additional pump if slope for drain pipe is not available.
- d) Supply, Installation, Testing and Commissioning of Inter-connecting copper refrigerant piping of different sizes with closed Nitrile Rubber Insulation, supports and protections complete.
- e) Supply, Installation, Testing and Commissioning of Drain pipe of different sizes with closed Nitrile Rubber insulation, supports and protections complete.
- f) Every item of machinery, likely to produce vibration or sound must be isolated from structure so as to eliminate any possibility of vibration and sound travelling to the structure and other parts of the building with best quality of isolation



materials.

- g) For extending 3 phase power to outdoor VRF units, the EPC contractor shall make necessary provision in feeder panel with rated capacity of MCCB / MCB & protection of earth leakage / phase reversal and isolation switch at outdoor unit site as required for system.

Single phase Power supply for indoor units shall be extended by making necessary provision in feeder panel / separate DB as per site requirement.

- h) Control & power cable—As per system and load requirement. Earthing to be extended / provided to all requirements as per standard
- i) Protection pipe for refrigerant, drain and raceway / cable tray for cabling, wiring, etc. as per site conditions shall be planned, designed & provided
- s) The cost for the Maintenance / Service during DLP period of 24 months is covered under the scope of work and quoted rates shall be deemed to cover regular examination of the installations by the trained technician of the contractor including necessary adjustments, greasing, oiling cleaning including replacement of parts etc. to keep the equipments in excellent operational state.
- t) The contractor shall also provide 24 hour emergency repair service to attend the system provided at any time of the day or night including Sundays and Holidays.

1.2 Outdoor & Indoor design condition

The entire system has been based and designed on climatologically data available as given under Basis of Design and Scheme. EPC contractor to follow the data for finalising the design.

Outdoor design parameters

Location – Udampur, J & K to be followed.

Indoor Design Conditions to achieve—

- a) Shall be followed as per standards of ASHRAE
- b) All the conditioned space shall be maintained at

Inside design conditions:

Summer and Monsoon		
Dry Bulb Temperature	:	22 ± 1.1°C (71.6±2°F)
Relative Humidity	:	Not exceeding 60%



1.3 Noise criteria

It is recommended to maintain acoustic conditions for all the space NC (Noise criteria) / NR (Noise Rating) as per ASHRAE.

1.4 Mechanical Ventilation & Exhaust

All the intake/extract will have 5 meter distance maintained amongst each other to avoid short circuiting.

1.5 Materials and Equipment

All materials and equipment shall conform to the relevant Indian Standards or international and shall be of the approved make and design. Makes shall conform to list of approved makes. All equipment shall operate under all conditions of load without any sound or vibration which is objectionable as per specification in the opinion of AAI. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed or annoyingly noticeable inside its own room, shall be considered objectionable.

1.6 Manufacturer's Instruction

Where the manufacturer has furnished specific instructions, relating to the material and equipment used in this project, covering points not specifically mentioned in these documents, manufacturer's instructions shall be followed in that case.

1.7 Technical Data and Proposed Equipment

All the technical data, design basis and proposed equipment included in this document are only guidelines and these shall be assessed, verified and validated by the Contractor.

1.8 Codes and Standards

The codes, regulations and standard applicable for design of various equipment's, selection of materials, installation, testing and commissioning are covered in this section. The international standards shall be applicable, wherever relevant national Standards/code is not available.

- National Building Code of India - 2016 (NBC)
- Relevant Bureau of Indian Standards (BIS) codes
- Indian Society of Heating, Refrigeration, and Air Conditioning Engineers (ISHRAE) Hand Book
- American Society of Heating, Refrigeration, and Air Conditioning Engineers(ASHRAE)
- Air filters as per ASHRAE Standard 52.2 – 2007
- NFPA 92B for Standard for Smoke Management Systems in Malls, Atria, and Large Spaces
- Duct construction standard as per SMACNA
- National Electrical Manufacturers' Association (NEMA)
- Air Conditioning and Refrigeration Institute (ARI)
- Air Diffusion Council (ADC)
- Air Movement and Control Association, Inc. (AMCA)
- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)



- American Society for Testing and Materials (ASTM)
- American Water Works Association (AWWA)
- Underwriters Laboratories, Inc. (UL)
- British Standard European Norm (BSEN)

1.9 Drawings and Technical Documents

The contractor shall prepare and supply the following four (4) sets drawings to AAI within 30 days from the date of award of work:

Contractor has to submit calculation for the entire VRV/VRF system along with selected equipment schedule based on the final architecture layout. This shall also include complete capacity calculation for indoor and outdoor units for all areas complete.

- (a) Outdoor units.
- (b) Indoor units.
- (c) Refrigerant piping
- (d) Power & Control Cables between Outdoor units & Indoor units.
- Foundation / Mounting Arrangement Drawing for all equipment's.
- Fixing details for indoor units.
- Single Line diagram for refrigerant circulation system
- Single Line diagram for electrical distribution system
- Fabrication Drawings for all electrical panels
- Control wiring details
- ii) Drawings shall include layouts for VRF systems, Ventilation system, detailed Ducting drawings showing exact location of supports, flanges, bends, tee connections, reducers, silencers, distribution grids, volume control dampers, collars, grilles, diffusers; detailed piping drawings showing exact location and type of supports, valves, fittings etc; acoustic lining and external insulation details for ducts, pipe insulation etc; electrical panels inside / outside views, power and control wiring schematics, cable trays, supports and terminations.
- iii) These drawings shall contain all information required to complete the Design and execute the works and shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work.
- iv) All the drawings shall be prepared on computer through AutoCAD System.
- v) Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer from the list of approved makes.
- vi) Manufacturer's drawings, catalogues, pamphlets and other documents shall be maintained in the Records Office. Each item in each set shall be properly labelled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying the items and the operating characteristics.
- vii) Samples of all materials like grilles, diffusers, controls, insulation, pre- molded pipe section, control wires etc. shall be maintained at site in a dedicated samples



room provided by the Contractor and submitted for approval to Engineer-in-charge.

- viii) All HVAC drawings shall be coordinated with all other services drawings.
Any impact or change due to co-ordination will be absorbed by the EPC contractor.
- ix) Final handover documents shall include O&M manual along with as built drawing.



Equipment Specifications

2.0 VARIABLE REFRIGERANT FLOW (VRF) / VOLUME (VRV) SYSTEM

2.1 Outdoor Unit

- (i) The system selected is a modular with number of indoors connected to centrally located outdoor units. The outdoor units for all the system shall be air cooled type.
- (ii) All the VRF air conditioners shall be fully factory assembled, wired, internally piped & tested. The outdoor unit shall be pre-charged with first charge of refrigerant. Additional charge shall be added as per refrigerant piping at site. All the units shall be suitable for operation with 415 V +/- 10%, 50 Hz + 3%, 3 Phase supply for outdoor units; & 220 V +/- 10%, 50 Hz +/- 3%, 1 Phase supply for indoor units.
- (iii) The outdoor unit should comprise of Inverter controlled Twin Rotary Compressor / Scroll Compressor. The PCB shall be refrigerant cooled or as per OEM standard for stable temperature of electronics even at varying ambient temperatures for higher reliability.
- (iv) Each module of outdoor unit must have at all inverter Compressor which can work on part load suitable to operate at heat load proportional to indoor requirement. ODUs above 16 HP shall be with dual compressor.
- (v) The ODU must deliver COP of minimum 3.25 at 100% load and minimum 4.7 at 50% load at ambient Condition 35 Deg C DBT and Indoor condition: 27 deg C DBT and 19 Deg C WBT and evaporating temperature of refrigerant at 6 deg C.
- (vi) The outdoor unit shall have VRT/ VET feature to automatically modulate the evaporative temperature between 6 Deg. C to 11 Deg. C with respect to load for better comfort and energy efficiency.
- (vii) The inverter technology based VRV/ VRF equipment should be capable of refrigerant piping between outdoor unit and farthest indoor units which shall be Extendable up to 225 m. Allowable level difference between outdoor unit & indoor units shall be 50 m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom.



- (viii) Allowable level difference between various indoor units connected to one outdoor shall be upto 15m.
- (ix) The outdoor units shall be suitable to operate within an ambient temperature range of "5 Deg C to 43 Deg C" in cooling mode.
- (x) The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.
- (xi) Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested.
- (xii) Outdoor unit shall have function of automatic refrigerant amount check periodically to confirm leakages.
- (xiii) It should also be provided with duty cycling for inverter capable of changing the rotating speed of inverter controller to follow variation in cooling & heating loads & switching starting sequence for better stability and prolonging equipment life. The EPC contractor shall submit the copy of proof in support of standard mentioned by the manufacturer for their Outdoor unit.
- (xiv) Inverter compressor of the unit shall start first & at the minimum frequency, to reduce the inrush current during starting.
- (xv) Water proof termination box (IP-65) shall be provided with each outdoor unit to accommodate isolation switch (of suitable rating MCCB/MCB) for terminating incoming cable, earthing, etc.
- (xvi) The outdoor unit shall be suitable for mix match connection of types of indoor units.
- (xvii) It should be provided with duty cycling for switching the starting sequence of multiple outdoor units.
- (xviii) The unit shall be provided with its own system architecture with provision for integration with the Touch-Manager for Air-conditioning system.
- (xix) The outdoor units should have anti-corrosion paint free plate for easy mounting of unit.
- (xx) The machine must have a sub cool feature to use coil surface more effectively through proper circuit/ bridge so that it prevents the flushing of refrigerant from long piping due to this effect thereby achieving energy savings.



- (xxi) The outdoor unit should be fitted with low noise level and should not be more than 67db (A) at normal operation when measured at 1.5m distance from ground level.
- (xxii) The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss and should be fixed with DC/ AC fan motor for better efficiency.
- (xxiii) The outdoor units are connected to multiple indoor units of various types as such the combined operating loads of indoor units may touch 120 to 125% of the nominal capacity. The outdoor unit shall be able to perform at the combined loads demands as indicated above.
- (xxiv) VRF units shall have auto bypass i.e. if any one IDU have any electric or PCB failure, rest of the system should continue to operate.
- (xxv) Top discharge ODU shall be provided with cowl complete with grill and bird screen to dispatch heat and to avoid making hot pocket if provided in covered area of terminal. The cowl should be painted to match with the ODU's color / outdoor facia. The fan static pressure of the outdoor unit shall be minimum 75 Pa to avoid hot air recirculation.

2.2 Indoor Units

- (i) All indoor units as specified shall have in general; noise levels less than 48 db. For critical applications noise levels below these limits may, however, be specified during design stage.
- (ii) Each unit shall have electronic control valve to control refrigerant flow rate respond to load variation of the room.
- (iii) All indoor Units should have force shut option to connect with fire alarm adaptor, so that the unit can be integrated with other systems to stop automatically such as in case of fire.
- (iv) The address of the indoor unit shall be set automatically in case of individual and it shall be possible to control individual indoor unit as well as group control by the centralized control system (Touch- Manager).
- (v) The fan shall be dual suction, aerodynamically designed, Turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having support from housing.
- (vi) The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance



with fins. Each coil shall be factory tested at min. 21 kg/sq.m air pressure under water.

- (vii) Indoor unit shall have cleanable type filter fixed to an integrally molded/ molded plastic frame. The filter shall be slide in and neatly insert able type. It shall be possible to clean the filters either with compressed air or water.
- (viii) Each unit shall have computerized PID control for maintaining designed room temperature. Each unit shall be provided with microprocessor thermostat for cooling/ heating.
- (ix) Each indoor unit shall be with Cordless remote controller as per standard design of manufacturers.

2.2.1 Ductable:

The unit shall be ceiling mounted/ suspended ductable type. The unit shall include pre-filters, fan section and DX- coil section. The casing of unit shall be standard as per OEM & shall be powder coated/ heat treated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. All indoor shall be suitable to operate from 230±10% & have sufficient static pressure as per requirement.

The unit shall complete with all fittings & accessories required.

2.2.2 Cassette type:

- (i) The unit shall be ceiling mounted cassette type. The unit shall include pre-filters, fan section and DX-coil section. The plastic body shall be light in weight and shall be able to suspend. The fan shall be aerodynamically designed diffuser turbo fan type. Unit shall have an external attractive panel for supply and return air.
 - (ii) These units shall be installed between the bottom of finished slab & top of false ceiling.
 - (iii) Unit shall have provision of connecting TFA unit for fresh air without any heat recovery unit, special chamber & increasing the total height of the unit (320 mm maximum). TFA unit shall be connected with separate outdoor unit as a system.
 - (iv) The unit must have in built drain pump, suitable for vertical lift of 750 mm.
 - (v) Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The sound pressure level of unit at the higher operating level shall not exceed 46 dB (A).
 - (vi) The cassettes units shall have sensor which detect the presence of people (zone occupancy sensor) and floor temperature to provide comfortable air-conditioning and energy saving. The sensor should detects human presence and adjust the airflow direction automatically to prevent drafts. Room temperature should be increased upto 4 deg C when no people are detected. The sensor should detect the floor temperature and automatically adjusts the operation of the indoor unit to reduce the temperature difference between the ceiling and the floor.
- All



4 louvers of the unit shall be independently adjustable for position as per user preference.

2.2.3 Wall Mounted /Hi-wall:-

- (i) Wall mounted units must be compact & stylish design that does not detract from the décor of the room.
- (ii) Each indoor unit must have electronic expansion valve operated by microprocessor thermostat based temperature control to deliver cooling/ heating as per the heat load of the room.
- (iii) The unit must have provision of adding drain pump kit if required & specified. The drain pump must be suitable to lift drain up to 1000 mm from the bottom of the unit.
- (iv) The sound pressure level of unit at the highest operating level shall not exceed 46 dB(A).
- (v) Refrigerant control in the indoor unit shall be through Electronic Expansion Valve.

2.2.4 Floor / Ceiling mounted Unit :

The unit shall include pre filter, fan section & DX coil section. The EPC contractor may provide these units as per site requirement and to meet the interior decor duly approved by the Engineer-in-charge.

2.3 Refrigerant Circuit

The refrigerant circuit shall include liquid and gas shut-off valves and a solenoid valves at condenser end.

The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

All necessary safety devices shall be provided to ensure the safe operation of the system.

2.4 Heat Exchanger

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil.

The aluminum fins shall be covered by anti-corrosion resin film/paint/treatment. The unit should be with by-pass/ e-pass heat exchanger to optimize the path of heat exchanger and for better efficiency of condenser.

The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.



2.5 Safety Devices

All necessary safety devices shall be provided to ensure safe operation of the system. Following safety devices shall be part of outdoor unit:- high pressure switch, fuse, fan drive overload protector, fusible plug, crankcase heater, over load relay, overload protection for inverter.

The outdoor roof mounted units shall be provided in such a fashion that these do not affect the overall aesthetics and ambience of the building. If required these units shall be suitably camouflaged to give good aesthetic look.

Noise levels for outdoor units shall not be more than 67 db (measured at a point 1 meter in front of the unit at a height of 1.5 meters).

3.0 DX UNITS

3.1 Air Cooled Invertor Type Split Ac

3.1.1 Hi-wall split indoor unit

Indoor unit shall remove moisture at least 1.5 liters/hour. The unit shall adjust its performance automatically depending on the room temperature and heat generated. It shall have 24 hour programmable on/off timer. The unit shall work on dry mode to remove extra moisture in high humid situation. The unit shall have features like sleep mode, in built time delay, auto restart after power interruption, memory back up to retain setting even after power interruption, oscillating louvers etc.

Each Indoor unit shall be complete with cooling coil, Fan. Filter and control accessories. The unit shall be plastic body light in weight. It shall have electronic control valve which control refrigerant flow rate in respond to load variations of the room. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation. Indoor unit shall be fitted with high purity filtration to eliminate dust, odour of all indoor smells and shall trap fine dust and smoke particles to ensure healthy indoor air quality.

Compressor

All compressors shall be hermetically sealed rotary/ scroll type of suitable capacities. Compressor shall be suitable for R-427a / R-410A / R-407C /R-134a / R-404a / R-507a refrigerant. The compressor shall be electrically interlocked with indoor and outdoor fan motors, HP/LP cutouts and thermostat in the evaporator. The compressor shall be housed inside the Condenser.

Condenser (Air cooled)

The coils shall be made of copper hydraulically bonded with aluminium fins. The tubes shall have a minimum of 9.5 mm outer diameter, firmly bonded with aluminium fins spaced at 12-14 fins/inch. The air velocity across the face of the coil shall not exceed 200 m/min. The coils shall be designed for a maximum working pressure of 35 kg./sq.cm. The condenser coil shall be protected on the open end by a wire mesh duly powder coated/plastic coated.

Evaporator coil

The coils shall be made of copper tubes hydraulically bonded with aluminium fins. The coils shall be hydrophilic in nature. The tubes shall have a minimum of



9.5 mm outer diameter, firmly bonded with aluminium fins spaced at 12-14 fins/inch. The air velocity across the face of the coil shall not exceed 170 m/min. The coils shall be designed for a maximum working pressure of 35 kg/sq.cm. The circuit should include a thermostatic expansion valve/capillary tube, distributor, liquid strainer, suction line shut off valve and liquid line shut off valve.

Condenser motor

The condenser motor shall be of IP-55 rating.

The unit shall complete with all fittings & accessories required.

Star rating—The unit shall be 5 star rating

3.1.2 Ceiling Mounted Cassette Units:

The units shall be ceiling mounted type. The housing of the unit shall be of powder coated galvanized steel and shall include pre filter, fan section, coil section, etc. The casing of unit shall be standard as per OEM & shall be powder coated/ heat treated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo fan type. The fan shall be mounted directly on motor shaft having supported from housing. The fan shaft shall be statically and dynamically balanced. The fan shall be direct driven type. The cooling coil shall be of seamless copper tubes, and shall have continuous aluminium fins. The tubes shall be staggered in the direction of airflow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coils shall be tested against leaks. Unit shall have filter cleanable type of resin net (with mold resistant) fixed to an integrally molded plastic frame. The filter should be slid away type but neatly inserted. All visible Units shall have an external attractive panel for supply and return air. Ceiling Mounted Cassette Unit shall have four way supply air grilles on sides and return air grille in center. Each unit shall have high lift drain pump, fresh air intake provision and low gas level detection system. Each unit shall have an electronic expansion valve which control refrigerant flow rate in respond to load variations of room. Each unit shall also have a pressure sensor. The computerized PID control shall be used to maintain a correct room temperature. Each unit shall be provided with microprocessor thermostat for cooling & heating. Each unit shall be with wired remote controller LCD type. The LCD remote controller shall memorize the latest malfunction code for easy maintenance. The unit shall have provision to connect fresh air.

Control

Computerized PID control shall be used to maintain a correct room temperature. Unit shall be equipped with a self-diagnosis for easy and quick maintenance and service. The LCD (Liquid Crystal Display) remote controller shall memorize the latest malfunction code for easy maintenance. Remote control (Cordless) shall be provided with one On/Off timer, selecting fan speed (Three speeds), angle of swing flap and setting up of temperature.

Compressor

All compressors shall be hermetically sealed scroll type of suitable capacities. Compressor shall be suitable for R410a/R407c refrigerant. The compressor shall be electrically interlocked with indoor and outdoor fan motors, HP/LP cutouts and thermostat in the evaporator. The compressor shall be housed inside the Condenser.

Condenser (Air cooled)

The coils shall be made of copper hydraulically bonded with aluminum fins. The tubes



shall have a minimum of 9.5 mm outer diameter, firmly bonded with aluminum fins spaced at 12-14 fins/inch. The air velocity across the face of the coil shall not exceed 200 m/min. The coils shall be designed for a maximum working pressure of 35 kg./sq.cm. The condenser coil shall be protected on the open end by a wire mesh duly powder coated/plastic coated.

Evaporator coil

The coils shall be made of copper hydraulically bonded with aluminum fins. The coils shall be hydrophilic in nature. The tubes shall have a minimum of 9.5 mm outer diameter, firmly bonded with aluminum fins spaced at 12-14 fins/inch. The air velocity across the face of the coil shall not exceed 170 m/min. The coils shall be designed for a maximum working pressure of 35 kg/sq.cm. The circuit should include a thermostatic expansion valve/capillary tube, distributor, liquid strainer, suction line shut off valve and liquid line shut off valve.

Condenser motor

The condenser motor shall be of IP-55 rating.

The unit shall complete with all fittings & accessories required.

Star rating – unit shall be 5 star rating

3.2 Refrigeration piping and accessories

The following specifications shall be followed for Hi-wall split indoor unit & Ceiling Mounted Cassette Units.

(a) Refrigeration piping

Soft drawn copper shall be used in piping with brass fittings wherever required. Brazing shall be with silver copper phosphorous alloy. Horizontal lines shall have a grading of at least 1:250 away from the compressor and towards condenser to prevent gravity draining of oil to compressor. Liquid lines shall be sized to ensure that flashing of liquid refrigerant does not occur. The circuit should include a thermostatic expansion valve, distributors, liquid strainer, de- hydrator and liquid lines shut off valve and suction line shut off valve.

All refrigerant pipes shall be insulated with flexible elastomeric closed cell insulation having a built-in Vapour barrier. It shall be of pre-formed tubes of appropriate thickness.

All refrigerant piping shall have minimum 19mm thick insulation.

Leaks shall be tested with nitrogen gas and soap solution at a minimum pressure of 21 kg/sq.cm. After all leaks have been repaired, system shall be tested with nitrogen gas at a test pressure maintained for a period of not less than 24 hours. No measurable drop in pressure should be detected after the pressure readings are adjusted for temperature changes. After satisfactory completion of the pressure test, the system shall be evacuated to reduce the pressure to 0.1 Kg/Sq.cm. for a period of 6 hours and vacuum broken. A vacuum pump connected to the refrigeration system shall be used to create the vacuum and the installed compressor shall not be used to create the purpose. The system shall again be evacuated and a vacuum of 0.01 Kg/Sq.cm maintain for

24 hours before charging with correct quantity of refrigerant and oil. The system shall be operated for 12 hours and then again tested for leaks.

(b) Fan

Fan section including wheel and housing shall be of heavy gauge steel/aluminium. Fans



shall be centrifugal, forward curved multi-blade type. Fan housing shall have inlets and guide vanes for smooth air flow. Fans shall be complete with drive motor. The fans should be statically and dynamically balanced. The fan motor should be resilient mounted. The fan should deliver a static pressure of 20 mm.

(c) Electric motor

The electric motor driving the compressor shall be as per manufacturer's standard for this compressor and motor shall be suitable for operation on A.C. supply. The motor shall be continuous duty rated for the application. The motor shall be selected in such a way that the motor rating is for actual requirement. The motor shall be provided with suitable bearing to take care of loads / thrust. Necessary lubricators shall be provided to enable the bearings to be correctly greased as required.

(d) Filters

All evaporator units shall be provided with air filters capable for filtration up to 20 microns. The filters shall be of washable synthetic fibre type.

(e) Control Panel

All units shall have independent electrical control panels housing contactors, overload relays, voltage cutouts, time delays, interlocks, strip connectors, indication lamps, and control fuse. All these have to be housed inside the Outdoor unit of each circuit.

(f) Thermostat

The indoor blower motor shall have 3 speeds and indoor units noise shall not exceed 41/38/35 dBA .The unit shall be provided with cordless remote microprocessor control.

(g) Drain Piping

Drain pipe shall be of suitable dia UPVC pipes. All Split units shall be provided with independent drain lines. The drain shall be taken to the drain main line. All drain pipe shall be insulated with 12mm thick insulation of closed cell elastomeric nitrile rubber with density not less than 80kg/m³ finished with an 8 Oz canvas cloth covering adhered between two coats of fungicidal protective coating suitably supported on trays, clamps etc.

(h) Installation

Adequate vibration isolation using rubber/neoprene pads/vibration springs in order to reduce transmission of vibrations to the floor shall be provided for all condensing units.

(i) Testing

Air-conditioning units after installation shall be tested for its conformity to specifications. Units shall also be tested for the rated capacity and power consumption.

5.0 VENTILATION & EXHAUST SYSTEM :

5.1 General :

The scope of this section comprises the design, supply, erection, testing and commissioning of various types of fans for ventilations & exhaust system conforming to the Specifications and in accordance with the site feasibility & functional requirements.

The requirement and brief scope of work for ceiling & exhaust fans are given in para-VI



(C) of Internal and External EI package. The exhaust fan shall be industrial type with louver / grill as explained in this HVAC section are to be provided.

Further detailed scope of inline fan (duct type, cabinet type, etc.) shall be provided as detailed below. The ventilations & exhaust system better than as explained above, offer by EPC contract to meet the functional & site condition shall also be accepted on its techno-commercial beneficial to AAI.

5.2 In-Line Fans

Duct mounted supply, exhaust or return fans shall be of centrifugal or Plug or mixed flow /direct driven in- line type. The fan housing shall be of the square / Circular design constructed of heavy gauge galvanized steel and shall include square / Circular duct mounting collars.

Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.

The fan wheel shall be centrifugal backward inclined / Forward curved or Plug or mixed flow, constructed of steel / abs plastic / aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure.

Motors for fans shall be suitable for 230V, 1-ph or 415V,3-Ph; 50Hz power supply.

All Inline fans shall be AMCA Certified for Sound and air performance in accordance to AMCA 210 and AMCA 300.

Note : To meet the functional requirement, any other fans are required to be provided by the EPC contractor with the approval of Engineer-in-charge.

6.0 SCRUBBER (DRY TYPE)

6.1 General

The kitchen Scrubber will be self-contained and will consist of the following component parts listed in the following paragraph. The entire unit shall be weatherproofed and corrosion protected as herein after specified. The unit shall be factory fabricated and will include the following parts.

6.2 Construction:

6.2.1 Evaporative/ Scrubber Section:

The wet section will have 16GGI tank and body with folded construction with the bolted openable sides also in 18G SS sheet/FRP. The wet section will contain 50mm thick rigid media to act as the first stage of scrubber to be sprayed by water through WIDE ANGLE NOZZLES to wet, scrub and clean the media installed at the inlet. These nozzles will be provided on a pipe grid such that the total face of the first bank of rigid media is kept fully wet and also gets pressure cleaning.



The wet section will also have another subsequent layer of 150mm thick rigid media which will act as the cleaning media for the smoke and smell, these media banks will be designed @ 2.5 m/s to give 90%adiabatic efficiency. For the second bank 2 mm thick FRP specially fabricated header will be provided for the water distribution using perforated PVC piping 15 mm brass bleed off cock along with 20 mm heavy duty brass float. PVC drain/overflow and bleed off outlet are to be provided on all wet sections.

The section shall include Centrifugal SISW fan wheel of totally GI construction with inlet cones and shall be complete with individual motor (IE:3), shall have bearing out of the Air stream and shall be mounted with C Channel frame and Cushy Foot or Spring Mounts. The fan rated based on delivery against the rated static pressure with the media and filters in place. The fan wheel will be of the multi-blade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of groove drives as per the recommendation of the drive supplier. The blower housing will of the Pittsburgh joint construction and the drive will be provided by a motor of adequate capacity. The motor plate will be constructed out of 1.6 mm MS or heavier metal with slotted holes, which permit belt adjustment in both the direction. The outlet velocity of the blowers will be kept low.

6.2.2 Filter Section

All sections will include 5 layer 30 micron aluminium wire mesh filters of 50 mm thickness including the mounting channels in 1.6mm GI for ease of removal and renewal of filter cells. The filters to be designed at 2.5 m/s to give 90% efficiency down to 30 microns.

6.2.3 Pumps

The unit will have a horizontal single phase 220 Volts + 6%, 50 c/s single phase power supply mono block self priming pump assembly to provide re-circulated tank water and a pressurized flow via a piping system for proper pad and media water distribution. The pump capacity will be such that it can take care of the bank of nozzles provided for cleaning the first bank and also feed water to wet the second bank.

6.2.4 Cabinet Fans

The construction of the cabinet fans shall not have filters and humidifiers.

6.2.5 Ionizer:

Stainless steel spiked ionizers to create high voltage DC field.

6.2.6 Collector Plate:

Aluminum collector plates which should be alternatively charged positive & negative with large collecting area with 14" deep cell, to work as magnet for charged smoke & oil particles.



6.2.7 Electrostatic Section:

Electrostatic precipitation technology based dry type air cleaner to remove Oil, Smoke & fumes from the Kitchen exhaust air. Electrostatic Precipitator should be able to charge particles from 0.01 micron to 10 micron through solid state power supply. Collector cell should be of permanent type and slide out facility for easy removal for cleaning.

6.3 Average efficiency of 90-95% in single pass as per ASHRAE test method.

6.4 Power Supply

Power supplies shall be 100% solid state and operate on 230 VAC, 50 Hz, 1 Phase input and provide a dual high voltage output of (+) 12 to 13 KVDC for the ionizer and (+) 6.0 to 6.5 KVDC for the collector. Module of capacity above 3000 CFM shall be equipped with Pulse width modulating (PWM) to maintain the specified collection efficiency by maintaining a constant charge in the event of Low/High Voltage from source thus ensuring that the unit functionality is not affected with these voltage fluctuations. Power Consumption should not be more than 50 watts per cell.

System should be fitted with interlock switch for safety.

The system should be able connected to a fan section to achieve airflow of 500 FPM across the air cleaner and should be interlocked with the fan to prevent dry run of the units.



Annexure- EB (For Temperature)

Departure and SHA Area

S. NO.	Area Description	Inside Condition (Summer/ Monsoon)	
		TEMP (°C)	RH %
1	Office Area	22±1 (71.6± 2°F)	< 60%
2	CCTV Room/ Security Room		
3	F&B and Retail		
4	Passage area		
5	Check -In-Area		
6	VIP Lounge		
7	Airlines & Check-In-Counters		
8	Smoking Room		
9	Security Hold Area		
10	Child Care Room		
11	Switch Room & Maint. Room		
12	IT Server Room	20±1 (68± 2°F)	50±5%
13	UPS & Battery Room	22±1°C (71.6± 2°F)	< 60%

Arrival Side Area

S.NO	Area Description	Inside Condition (Summer/ Monsoon)	
		TEMP (°C)	RH %
1	Fire Ctrl Room	22±1 (71.6± 2°F)	< 60%
2	Airport Mgr. Room/Child care room		
3	F&B and Retail		
4	First Aid & MI Room		
5	Arrival Hall/Baggage claim area		

Office and Conference room Area

S.No.	Area Description	Inside Condition (Summer/ Monsoon)	
		TEMP (°C)	RH %
1	Office Area	22±1 (71.6± 2°F)	< 60%
2	A.P.D Office and PA Office		
3	Conference Room		
4	Lobby/Corridor		

In Arrival Side Area, Security Hold area, Departure Hall, Check-in-area & other offices/rooms etc. in Terminal Building not mentioned in above tables shall be maintained as per the direction of EIC & as per approval.



PACKAGE-E

FIRE PROTECTION SYSTEM



Fire Protection System

1. GENERAL

The Fire Protection System (FPS) design criteria & construction specifications for proposed Airport is covered under this section.

The design specification indicated is minimum guidelines to enable the contractor to carry out engineering and execute entire FPS works to meet the design intent/ employer's functional requirement.

The types of fire protection systems considered in this section are as listed below:

- a) Fire Hydrant System, Hose reel, down comer etc.
- b) Pumps & Panels.
- c) Portable fire Extinguishers.

The Fire protection system shall be generally designed based on the requirements of National Building Code of India (NBC), relevant Indian standard codes CPWD, NFPA, UL/FM specifications and as per local fire authority.

CODES & STANDARDS

IS:5- 2004	Colors for ready mixed paints and enamels (Fifth revision)
IS: 444 – 1987	General purposes rubber water hose (Fourth revision)
IS: 636	RRL hose pipe-Non-percolating flexible firefighting delivery hose (Third revision)
IS: 694	PVC insulated cables (light duty) for working voltage upto 1100 volts.
IS: 780	Cast iron sluice valve
IS: 823	Welding procedure
IS: 884	Specification for first-aid hose reel for firefighting (First revision)
IS 901 - 1988	Specification for couplings, double male and double female, instantaneous pattern for firefighting (Third revision)
IS 902 - 1992	Specification for suction hose coupling for firefighting purposes(Third revision)
IS: 903 -1993	Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner (Fourth revision)
IS: 907 - 1984	Specification for Suction Strainer cylindrical type for firefighting purposes (Second revision)
IS: 908 -1975	Specification for Fire Hydrant, Stand Post Type (Second revision)
IS: 909 - 1992	Specification for underground fire hydrant, sluice valve type (Third revision)



IS: 1239	Mild steel, black ERW pipes up to 150 mm dia, with fittings. (Part 1)-2004 Specification for steel tubes, tubular and other wrought steel fittings Part 1: steel tubes (Sixth revision). (Part 2) -1992 MS tubes, tubular and other wrought steel fittings (Fourth revision).
IS: 1255	Code of practice for installation and maintenance of power cables.
IS: 1554	PVC insulated cables (heavy duty) for voltage up to 1100 volts.
IS: 2062	Steel for General Structural Purposes
IS: 2379 - 1990	Color code for identification of pipe lines (First revision).
IS: 3844 - 1989	Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises (First revision)
IS 4984	HDPE pipes
IS 4985	PVC pipes
IS: 5216	Guide for safety procedures and practices in electrical work.
IS: 5290-1983	Specification for Landing Valves (Third revision)
IS: 5312	Non return valve (Part I) - 1984 Specification for Swing check type reflex valves (Non return) for water works purposes: Part I single door pattern. (Part 2) -1986 Specification for Non-Return Valves for water works purposes: Part 2 multi door pattern
IS: 5714 - 1981	Specification for Hydrant Stand-Pipe for Fire Fighting (First revision)
IS: 7673 - 2004	Fire Fighting Equipment - Glossary of Terms
IS: 8757 - 1999	Glossary of terms Associated with Fire Safety
IS: 9972 - 2002	Specification for Automatic Sprinkler Heads for Fire Protection Service (First revision)
IS: 10221	Code of practice-coating & wrapping of underground mild steel pipelines
IS: 11101 - 1984	Specification for Extended Branch Pipe for Fire Brigade Use
IS: 12349 - 1988	Fire protection-safety signs
IS: 12407 - 1988	Graphic symbols for fire protection plans
IS: 12469 - 1988	Specification for Pumps for Fire Fighting System
IS 13095	Butterfly valve
IS: 14846 - 2000	Sluice Valve for water works purposes (50 to 1200 mm size)
IS:14933 - 2001	High Pressure Fire Fighting Hose – Specification
IS:15051 - 2001	High Pressure Fire Hose Delivery Couplings – Specification
IS:15105 - 2002	Code of Practice for Design and Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems
IS:15301 - 2003	Code of Practice for Installation and Maintenance of Fire Fighting Pumps



IS 15683	Manufacture & Performance of Portable fire extinguisher.
CPWD General Specifications For Electrical Works- Part 5-2020	
National Building Code of India – 2016.	

In case of any discrepancy in specifications between the State Act / Rule and the relevant IS specifications, the superior specifications shall be accepted.

For all materials and equipment, IS specifications shall be applicable. Where IS specifications are not available, British / European standard specifications shall become applicable. All specifications, standards, publications specified mean the latest editions of such publications with upto date amendments.

2.. SCOPE OF WORK:

The scope of work broadly covers design supply erection coordination among different traders liaison/ coordination with relevant local government departments, Testing and commissioning of fire protection system for the proposed Interim Terminal Building with external & internal hydrant system, Hose reel, down comer, Fire Pump & panel, portable fire extinguishers etc. with the following:

- a) All associated piping valves and accessories shall be as per system requirement.
- b) A Fire water tank is proposed. The fire pumping system for the proposed buildings shall be planned, designed, constructed from this fire water tank. The filling of the fire water tank should be automatic, water level indicator shall be provided along with auxiliary alarm output in case of empty tank.
- c) Fire Hydrant System with piping network, landing valves, Hose Reels, Hose box and Hose Cabinets.
- d) Internal and External yard Hydrants with associated piping and valves. Location of the yard hydrant & Hydrant Cabinets shall be coordinated with Civil other services & shall comply with the applicable codes & standards.
- e) Portable Fire Extinguishers to fight fire at incipient stage. Fire Extinguishers shall be provided as per travel distance and area coverage throughout the building, as per the codes as specified.
- f) Sealing of cut-outs / openings with Fire sealants. The fire rating of the sealant shall be compatible with the structure (Floor/Wall), as the case may be.
- g) Interface with various other disciplines as per the Specifications. FPS piping shall not run inside the water sensitive areas like Control room / Equipment room, Electrical room, Substations, Generators rooms, battery / UPS rooms, etc.
- i) To develop System Schematic diagrams, detail working drawings showing hydrant pipe network, fire hose stations, pump room layout, portable Fire Extinguisher locations etc. complete.



- j) Excavation works (Mechanical or Manual depending upon the site conditions) for laying the fire protection pipes, making of trenches, road cutting if required, excavating any type of soil including rocky strata, refilling the trench or pit, disposal of surplus earth at the approved location by AAI.
- k) Minor civil works related to fire protection system such as penetrating through walls, floors and filling up all these holes with fire sealant (Fire Stop Mortar), thrust block and anchor block for supporting underground pipes. Providing all the valve chambers, along with the manhole covers, designed for appropriate loading.
- l) Obtaining clearances before start of work and Completion Certificate (Fire Approval and occupancy certificate) on completion of works from the Local Fire Officer.
- m) The Contractor shall be responsible for the Supply & Installation of all the above mentioned Fire Protection Systems in accordance with the Specifications, Standards and the contract drawings/documents. The entire work shall be carried out strictly in accordance with the true intent and meaning of the specifications and drawings taken together, regardless of whether the same may or may not be shown particularly on the drawings or described in the specification, provided that the same can be reasonably inferred from there.
- n) **APPROVAL BY LOCAL FIRE SERVICE :** It shall be the responsibility of the EPC contractor to get the approval in stages from the Local Fire Service as required. This shall be without any liability to the AAI/Engineer-in-charge. On successful completion of work, the contractor shall incorporate all changes as approved by the fire service department that might have been effected during execution of the work in as built drawings.
On completion of work, the contractor has to obtain necessary approval from Local Fire Services as required by submitting necessary completion certificates, drawings, equipment details, test results, etc. before energization.
- o) All associated civil works like excavation for pipe laying underground with pedestal supports or chase cutting in the wall/ceiling or making hole in the RCC floor/ceiling or in brick wall for piping, grouting etc. including making good the same after completion, small size pedestals, foundation for pumps, panels and other installations as required or any other minor civil works required in connection with the installation of the system are should be done in coordination with Civil division.

3. DESIGN CRITERIA

The objective of this report is to design & provide fire protection system that shall be based on the standards and code as specified:

- Life safety of occupants
- Property protection - Building and Contents.
- Compliance with all relevant statutory requirements.

Classification: The building classification shall be as per NBC, IS standard, NFPA, UL/FM to be followed.



4.1 Storage Tanks and Pumping System

The capacity of the fire water tank shall be as per requirements in NBC, relevant IS codes and local fire regulations. The storage capacity shall be adequate to meet the FPS requirements for the proposed terminal building. Water tank shall be complete with compartments, overflow arrangements and digital water indicator. Inlet to the tank will be fed from the raw water line(s). The overflow for the fire water tank shall be connected to the inlet of domestic water tank.

Pumping system including pumps, pipes, Air valves, isolation valves, etc. shall be installed in accordance with the system requirements for Fire protection and relevant codes. All necessary control & Power cabling required from pumps & pressure switches, sensors to their panels shall be in the scope of contractor. All cablings/ wiring shall be HHFR.

4.2 Fire Hydrant System (Internal)

The water to the Internal Hydrant system shall be fed through vertical risers located at common area.

The Building shall be equipped with a Hydrant and Fire Hose Reel System. The Hydrant Stations with Fire Hose Reel shall be provided to meet the requirements as per NBC, relevant IS codes and local fire regulations.

- a) Locations of Internal Fire Hydrant Stations shall be in the recessed wall openings and the same shall be coordinated with Architectural drawings. The door frame shall be made 2mm thick SS sheet with hinged double front door partially glaze (6mm glass panel) with locking arrangement with "Fire Hose" written on it prominently.
- b) Each internal hydrant station shall consist of one single headed 53mm SS hydrant valve 02 nos. 15 m long RRL-Type A fire hoses, 01 no. wall mounted hose reel with 30mm long hose tubing, complete with shut off nozzle & clamps, 01 no. SS branch nozzle and 01 no. fire man axe. All fixtures shall be as per list of approved makes for electrical works.
- c) To reduce excess pressure, Orifice plates of suitable design shall be provided.
- d) The hydrant risers shall be terminated with automatic air release valve at the highest points (on top of each wet riser) to release the trapped air in the pipe work along with necessary accessories.

4.3 Fire Hydrant (External)

- a) The External hydrants shall be provided around building. The maximum spacing between two external hydrants, number & type of hydrant valve, hoses and branch nozzle shall be as per NBC, relevant IS codes and local fire regulations.
- b) Each external hydrant station shall consist of hydrant valve along with two nos. C.P hoses and one branch nozzle housed in weatherproof MS cabinet with glass front door. All the equipment's housed inside shall be as per list of approved makes



for electrical works.

- c) Fire brigade inlets for pumping water into hydrant lines shall be provided. Fire brigade inlet shall be located and arranged so that hose lines can be readily and conveniently attached to the inlets without external interference.
- e) Underground piping shall be laid at least 1m below and at road crossing where heavy vehicles are expected to pass, shall be protected with RCC pipe for additional protection.

4.5 Portable Fire Extinguishers

- i. The portable fire extinguishers to handle small fires shall be provided as per IS 2190 with references made to NFPA 10 wherever applicable. However, additional fire extinguishers shall be provided as per requirement of the local Fire Service authorities.
- ii. The capacity of the extinguishers shall be based on the hazard classification and per the provisions indicated in IS -15683.
- iii. Fire Extinguisher shall be installed in Passenger terminal building, electrical room, UPS/ battery room, IT sever Rooms, External Canopies, room, ESS(Sub-station), service block etc. as per fire norms.

5.0 Fire Fighting Accessories

A) Piping

- (i) Pipes shall be GI confirming to IS: 1239 with upto date amendments, ISI marked (Heavy grade) (for pipes of sizes 150 mm NB & below) suitably treated on the outside to prevent soil corrosion as per IS:10221.
- (ii) For GI pipe upto 50mm dia screwed jointing shall be adopted, while for pipes above 50 mm dia welded or flanged connections shall be used. Only Electro galvanized nuts/ bolt shall be used. Pipe thread and flanges shall be as per IS.
- (iii) All Fittings shall be from list of preferred makes, Fittings shall be of malleable castings of pressure ratings suitable for the piping system. Fittings used on welded piping shall be of the weld-able type.
- (iv) Flanges shall be from list of approved makes and as per I.S.6392-1971, Table 17 with appropriate number of G.I. Washers, Nuts and Bolts, with minimum 3mm insertion neoprene gasket complete. Flange thickness shall be as under:

Pipe dia	Flange Thickness
200 mm	24 mm
150 mm and 125 mm	22 mm
100 mm and 80 mm	20 mm
65 mm	18 mm
40 mm and below	16 mm



- (v) Tee off connection shall be through reducing tees, wherever possible. Otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- (vi) All equipment and valve connections shall be through flanges (Welded or screwed for galvanized steel).
- (vii) All welded piping is subject to the approval of the Engineer in charge. Sufficient number of flanges and unions shall be provided.

B) PIPING INSTALLATION

- (i) Piping shall be properly supported on or suspended from stands, clamps, hangers etc. as specified and as required. The EPC Contractor shall adequately design all the brackets, saddles, clamps, hangers etc. and be responsible for their structural integrity. Shop Drawings of all proposed supports to be submitted for approval before execution of work.
- (ii) The pipe support or hangers shall be designed to withstand combined weight of pipe, pipes fittings, fluid in pipe and insulation.
Pipe supports shall be of steel fully galvanized, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamp are of dissimilar material, a gasket shall be provided in between. Spacing of pipe supports on main headers shall not exceed 3.0 meters in any case, and additional supports shall be provided on all bends, tees, and valves etc as per requirements.
Pipe hangers shall be fixed on walls and ceiling as per standard design and as per approved by EIC.

Pipe supports shall not be more than that specified below: -

Nominal Pipe Size (mm)	Spacing (m.)
20 and 25	2.00
32 to 125	2.50
150 and above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress, on the pipes.

- (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 attached to pipe and with a 12mm thick rubber pad or any other approved resilient material. Where pipes pass through the terrace floor, suitable curbing shall be provided to prevent water leakage. Risers shall also have a suitable concrete pipe support at the lowest point.
- (iv) Pipe sleeves of diameter larger than the pipe by least 50mm shall be provided wherever pipes pass through walls and the annular spaces shall be filled with felt lead wool and finished with retaining rings.
- (v) In pipe above ground level, expansion loops or joints shall be provided to take care of



expansion or contraction of pipes due to temperature changes.

- (vi) All pipes using screwed fittings shall be accurately cut to the required sizes and threaded in accordance with IS: 554 and burrs removed before laying. Open ends of the piping shall be locked as the pipe is installed to avoid entrance of foreign matter. Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.
- (vii) To facilitate detection of leak and isolation of defective portion of pipe, valves shall be provided in underground pipe at suitable locations. As far as possible such valves shall be provided over ground. If the valves are to be provided below ground, suitable masonry chamber with cover plate shall be provided. Locations where vehicles can pass shall be avoided for provision of valve below ground.
- (viii) EPC Contractor shall provide suitable cement concrete, anchor blocks of adequate dimensions as per spacing mentioned above & at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes wherever pipes are installed underground. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate) 20 mm nominal size.

C) PIPE PROTECTION

- (i) All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer immediately after bringing the pipes to site and shall be painted with one coat of red oxide primer after erection & proper hydraulic testing and two or more coats of Synthetic Enamel Paint of approved shade on finishing.

All pipes & fittings under floors or below ground shall be provided with protection against corrosion after proper hydraulic testing by application of 100mm wide and 4mm thick layer of anti-corrosive protection tape over the pipe, with overlap of 25mm minimum as per manufacturers specifications.

- (ii) Where pipes are buried under ground, after treated, the same shall be back filled with the excavated soil. The top of the pipes shall not be less than 100cms below the ground level. Where this is not possible, the permission of Engineer -In – charge shall be obtained for burying the pipes at lesser depth. Underground pipe shall be laid at least 2M away from the face of the building preferably along the roads and footpaths.

D) VALVES & ACCESSORIES

Sluice valve conforming to IS: 780 or butterfly valve conforming to IS:13095 shall be provided. All valves shall be suitable to with-stand the pressure in the system and rating shall be PN 1.6. All valves shall be right handed (i.e. handle or key shall be rotated clock wise to close the valve), the direction of opening and closing shall be marked and an open / shunt indicator fitted.

(i) SLUICE / GATE VALVES

Sluice Valves above 65 mm (inside screw and non raising screw type) shall be of Cast Iron body and Gunmetal seat with double flanged ends and valve wheel. They shall conform to



type PN 1.6 of IS 14686. Sluice valves upto 65mm (outside screw raising spindle type) shall be of Gunmetal Full way Valve with wheel tested to 20 Kg /cm² class-II as per IS: 778 with female screwed ends. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and close.

(ii) **BUTTERFLY VALVES**

- (a) The Butterfly Valve shall be suitable for waterworks. (b)

The material of valves shall be as under: -

Body	-	Cast iron
Disc	-	Cast bronze or Stainless Steel
Seat	-	Either integral or nitrile rubber
O-Ring	-	Nitrile / Silicon

- (c) 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.

(iii) **NON-RETURN VALVE**

Non-return valves shall be of Cast Iron body and SS seat. They shall conform to IS 5312 and have companion flanges. They shall be Dual Plate Type suitable for both horizontal and vertical installation. An arrow mark in the direction of flow shall be marked on the body of the valve.

(iv) **PRESSURE GAUGES**

Pressure gauges shall be of 150mm dia. dial with Bourdon tube element of SS 316 and of appropriate range and scale division shall be in metric unit marked in black on white dial etc. complete with all accessories including shut off gauge valve etc. duly calibrated before installation. Care shall be taken to protect pressure gauges during pressure testing.

(vi) **ORFICE PLATE**

The pressure in a firefighting system varies from point to point. The pressure will be maximum in the pump house and minimum at the farthest hydrant at terrace level. To reduce pressure to safe operating pressure at every internal/external hydrant, orifice plates are provide before connection of landing valve between the flanges of the landing valve and pipe flange.

Orifice plate shall be made of 6mm thick stainless steel and shall have an identification tag projecting beyond any flange between which it is clamped. The orifice shall be plain central hole without burs and diameter not less than one-half of the internal diameter of the pipe to which it is fitted.

E) EXTERNAL YARD HYDRANTS

- (i) The EPC Contractor shall provide External Fire Hydrant in the Ring or on External Fire Line as per requirement. The spacing of the hydrants and the distance from the building shall be maintained as per latest relevant codes, unless specified.



Yard hydrants shall be located at a minimum distance of 2 m. but not more than 15 m from the building face. They yard hydrants shall be accessible and should normally be provided near boundary wall / along road. While locating yard hydrants it should be ensured that same do not become hindrance in vehicular movement or entrance to the building. Yard hydrants, should be located around the building in such a way that it should be possible to fight fire on any face of the building from the nearest hydrant. A distance of 45m from hydrant to hydrant will be adequate.

- (ii) Fire Hose Cabinet (FHC) shall be fabricated of 2 mm thick M.S. sheet of minimum Size of 0.9 M x 0.6M x 0.5M. The fire hose cabinet shall have glass (min 6 mm thickness) front double door with common lock & keys and break glass recess for keys, all complete.

Yard Hydrant will include the following accessories:

- | | |
|--|---------|
| (a) Connection from ring main with 80 mm dia MS Pipe. | |
| (b) 63 mm dia single head landing valve | - 1 No. |
| (c) Butterfly / Sluice Valve 80 mm dia | - 1 No. |
| (d) Hose pipe 63 mm dia 15m. long with male and female coupling at both ends | - 2 No. |
| (e) Branch pipe 63 mm dia with 20 mm (nominal internal diameter) nozzle and suitable for instantaneous connection. | - 1 N |



The FHC shall be painted with post office red colour or as per requirement of stove enameled finished after given two coats of highly corrosive resistance primer. The words “yard hydrant” or “hydrant” shall be lettered on the glass of 75mm high in white or red paint. Top surfaces shall be slopped for water discharge. Vents shall also be located on sides of the Hose Box.

Pedestal shall be made of brick masonry or MS Channel bracket with hydrant pipe of standard height.

Pedestal shall be protected with MS channel(in non-passenger area)/SS 304 graded tube (in passenger movement area) duly approved by Engineer-In-charge.

F) **INTERNAL HYDRANTS**

(i) Every Riser will be provided with the following at every floor including terrace:

(a)	Single Headed Outlet	- 2 Nos.
(b)	First Aid Hose Reel (Length of pipe shall be such that nozzle of the hose can be taken into every room and within 6 Mtrs. of any part of the rooms keeping in view layout and obstruction).	- 1 No.
(c)	Hose pipe 63 mm dia 15m long with male and female coupling at both ends.	- 2 Nos.
(d)	Branch pipe 63 mm dia with 20 mm (nominal internal diameter) nozzle and suitable for instantaneous connection.	- 1 No.
(e)	Fireman Axe	- 1 No.

(ii) **FIRST-AID HOSE REEL EQUIPMENT**

- First-Aid hose reel equipment shall comprise reel, drum which can swing upto 180 degrees with hose, guide fixing wall bracket, hose tubing, globe valve, stopcock and nozzle. The water inlet is connected to the riser pipe by means of 37 mm socket and valve. The hose tube can be pulled out easily for the purpose of discharge of water on fire. The length of hose tube shall be such that the nozzle of the hose can be taken into every room and within a range of 6 M from any part of the room. This shall conform to IS: 884 - 1969. The hose tubing shall confirm to IS: 12585 (Thermoplastic textile reinforced) type - 2. The drum shall be fabricated from MS sheet.
- The hose tubing shall be 20 mm (nominal internal) dia. and 30 m long (Min). The G.M nozzle and shut off valve shall be as per standard to shut off the water supply to the Hose Reel.
- The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS: 884 - 1969. The first-aid hose reel shall be connected directly to the M.S. pipe riser through a 25mm dia pipe.



- A MS bracket shall be fixed on the wall to which the first aid hose reel shall be bolted. The bracket shall be of 40x40x5mm thick MS angle to form a square of 400x400 mm (approx). The units shall be fabricated in factory and all joints shall be finished with grinder and shall be spray painted after single coat of primer.
- The water flow rate shall be not less than 24 lpm and the range of jet shall be not less than 6m.

(iii) **HOSE PIPES, BRANCH PIPES AND NOZZLES**

HOSE PIPES

- (a) Two nos. hose pipes for External and 2 Nos hose pipes for Internal hydrants shall be provided. The hose pipe shall be rubber lined woven jacketed (RRL) and 63mm in dia. & 15m long, (non percolating Reinforced rubber lined) conforming to IS:636 (Type B). The hose shall be sufficiently flexible and capable of being rolled.

Each run of hose shall be complete with necessary male & female SS coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903.

(b) **BRANCH PIPES**

Standard short sized Branch pipe shall be constructed from Gun Metal(GM) material of 63 dia and be complete with male instantaneous spring lock type coupling for connection to the end of hose pipe. The branch pipe shall be externally threaded to receive the nozzle conforming to IS:903. The branch pipe shall be tested to 20 kg/ cm² pressure.

(c) **NOZZLES**

- The nozzle shall be of GM of 20 mm nominal internal diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.
- End Couplings, Branch pipe, and Nozzles shall conform to IS:903-1985.

(iv) **PAINTING**

All Hydrant pipes & fittings (above ground) shall be painted with Fire red color paint (Shade No. 536 of IS: 5). The pipes shall be painted with one coat of Zinc Chromate primer and after hydraulic test two or more coats of synthetic enamel paints.



H) **FIRE BRIGADE INLET CONNECTIONS**

- (i) Fire Brigade Inlet connection shall be provided near the terminal building as decided & approved by EIC and with a view that these are easily accessible to the fire brigade, without any hindrances. Fire brigade inlet connection to the external ring main. Each connection shall be with similar dia. of sluice valve and non-return valve.

- ii) **VALVE CHAMBERS**

Masonry Chamber 0.9 m x 0.9 m x 1.0 m inside with 75 class designation brick work in cement mortar 1:5 (1 cement: 5 fine sand) for sluice valve with C.I. medium duty circular cover with frame of 560mm internal dia. for valve chamber. The weight of the cover not to be less than 20 kg and frame not less than 38 kg as per standard design and RCC top slab 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) necessary excavation, foundation concrete 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3(1 cement: 3 coarse sand), 12 mm thick finished with a floating coat of near cement complete as per standard design.

7.0 **Portable Fire Extinguishers**

Portable fire extinguishers shall be Carbon dioxide etc. as per the requirement. The capacities shall be worked out based on the type of hazard. These extinguishers shall be suitably distributed in the entire areas of all the concerned buildings based on the hazard classifications. These shall be placed or hanged on wall in a group on several suitable places or placed inside the extinguisher cabinet in coordination with architectural requirements. The number of extinguishers shall be calculated in accordance with NBC and IS 15683.

The portable fire extinguishers to handle small fires shall be provided as per IS 2190 with references made to NFPA 10 wherever applicable. However, additional fire extinguishers shall be provided as per requirement of the local Fire Service authorities.

Fire Extinguishers shall be provided in all entire public and services areas based on the coverage area & travel distance for the particular type of extinguishers and hazard Classification.

Extinguishers shall be mounted inside the wall mounted Cabinets. Fire Extinguishers shall be provided in all public areas, near each exit doors, inside the recessed openings in coordination with the Architect.

The capacity of the extinguishers shall be based on the hazard classification and per the provisions indicated in IS -15683.

Sand Buckets shall be installed in transformer room, near DG, outside the Substation as per fire norms.

Typical location for different type of fire extinguishers includes, but not limited to, the following:

All the extinguishers suggested above should be with ISI markings and should be located at an easily accessible position without obstructing the normal passage and maintained periodically.



CO₂ TYPE FIRE EXTINGUISHER

CO₂ type fire extinguisher of minimum 4.5 KG or higher capacity as per site requirements assembled out of seamless steel cylinder (conforming to IS:7285 latest) having CCE approval and ISI mark complete with wheel type valve (conforming to IS: 3224 latest), high pressure wire braided discharge hose with horn and carrying handle. The cylinder should be fully charged with CO₂ Gas. All other components, design, performance, anticorrosive treatment should be as per IS: 15683 and IS:15222 latest CO₂ fire extinguisher in Terminal building, ESS (Sub station) etc. of minimum Qty. 28 nos or more quantity as per norms.

7.0 INSPECTION AND TESTING-Hydrant System

(I) Inspection – General

All site fabricated work / material shall be subject to inspection in cleaned condition, prior to erection. At no event, site fabricated work/material shall be installed in position without inspection and approval by AAI. The Contractor shall ensure that each stage of fabrication is carried out in compliance with the procedures specified in the IS / NBC standards as applicable and / or specified in this document.

The contractor shall conduct sample tests of all the materials supplied at reputed laboratories / agencies as directed by AAI at his own cost and test reports are to be submitted. Inspecting officials of AAI and Local Authorities shall have the right to access the premises of the work at any time with or without giving prior notice. All the formalities or procedures for conducting the inspections by the authorities as required by them shall be arranged by the contractor free of cost.

All testing shall be carried out in the presence of AAI / statutory authorities and test registers shall be maintained by the contractor. The EPC contractor shall provide all material, tools, equipment, instruments, services and personnel required to perform the tests and remove debris / water resulting from cleaning and after testing free of cost

The original test certificates of all tests conducted are to be submitted to AAI.

After conducting the tests, any defects found on materials, equipment, piping, etc. shall be got rectified / repaired by the EPC contractor without any extra cost.

Before energizing electrically operated equipment, care shall be taken to meet the local electrical rules and regulations, earthing of the body, verifying availability of safe insulation resistance value, etc. Also confirm the motor enclosure to the level of protection required for the particular application.

(II) Piping

All piping shall be tested by filling water, removing air locks, foreign materials, etc. and applying pressure at 1.5 times of the maximum working pressure and see that the pressure drop is within 0.5 Kg per Sq. cm over a period of 2 hours. The testing shall be carried in sections by blocking both ends or closing the valves provided. After completion of the installation and connecting to the mains of pumping system the installation shall once again tested and rectify breakage if any or replace the defective material, free of cost.

At least 10% of the total weld joints on pipes shall be tested by radiography. Holiday tests shall



preferably be carried out by flexible and detachable ring probe, which shall enable the entire 360 deg. of the surface of the pipe to be scanned.

(III) Hydrant system

The entire hydrant system shall be tested in the presence of AAI to ascertain the functioning of each system, equipment, etc. as desired by AAI. The contractor shall hand over the system only if it is proved that the system performs as per the specifications.



PACKAGE – F

ADDRESSABLE FIRE DETECTION & ALARM SYSTEM



ADDRESSABLE FIRE DETECTION & ALARM SYSTEM

1.0 GENERAL DESCRIPTION AND SCOPE OF WORK

1.1 This section covers the requirement of automatic intelligent analog addressable fire alarm system as per specification laid down below and as per the design intent/ AAI requirements and shall fit for the purpose.

1.2 The EPC contractor shall furnish and install complete and ready for intended use and operation an intelligent addressable fire detection & alarm system including fire alarm panel(s) initiating devices (manual call stations, addressable multi sensor detectors, etc.) indicating devices (sounders, bells, visual warning signals etc.) and supervisory devices wiring apparatus and accessories.

1.3 The installation and locations of equipment and devices in the Terminal building, ESS(Sub-station) shall be governed by the relevant codes / standards with due regard to actual site conditions, manufacturers' recommendations, ambient factors affecting the equipment and other operations in the vicinity. If any deviation from the specifications is necessary, approval shall be obtained from AAI before work is started thereon.

The fire protection system shall be generally designed based on the requirement of National building code of India (NBC), relevant Indian standard codes, CPWD, NFPA, UL/FM specifications and as per local fire authority.

1.4 Materials and equipment supplied shall be new, updated standard with current models of the manufacturer and shall be suitable for this system as per approved make of list and shall be suitable for the system.

1.5 All materials, devices, and equipment shall be compatible with the circuits or systems in which they are utilized.

2.0 In addition to SITC of Fire detection and alarm system, the following work shall also be deemed to have included in the scope of work to be executed by the EPC Contractor within his quoted amount.

- i) It includes obtaining approvals from Chief Fire Officer / Fire Department concerned and all other statutory authorities for complete scope of work as per the prevailing rules & regulations etc.
- ii) The Fire Detection and Alarm System of the building shall be integrated with respective to the zoning of PA system so that, in case of fire, the PA system shall automatically come in announcement mode of that particular zone and play pre-recorded evacuation messages from PA system.
- iii) Providing repeater panel at Main Terminal Manager Room and interconnecting the same with main FACP installed in the building.

3.0 REQUIREMENTS

a. This installation shall be made in accordance with the specifications i/c local codes and local fire authorities having jurisdiction over this project.

b. Fire Detection & Alarm System Installation work shall be carried out in accordance with Indian Standard Code of Practice for Electrical Wiring Installation IS: 732 - 1989, IS: 2274-1963 and IS 2189-2008 with upto date amendment. The control cable used shall be of Fire Retardant, Low



Smoke, Halogen Free type.

- c. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Fire Authority. Proposed Intelligent Addressable Fire Detection & Alarm system in general shall be carried out as per following Specifications-

Reference Standards

All equipment and installation shall be installed in compliance with the following codes and listing with update amendments:

CODES & STANDARDS

Following Indian/international standard specifications, code of practice etc. updated shall apply to the equipment and the work covered by the scope of this contract:

IS: 2175	:	Specification for Heat Sensitive Fire Detectors for
		use in Automatic Fire Alarm System.
IS : 2189	:	Code of practice for Selection, Installation and Maintenance of automatic fire detection and alarm system.
IS: 11360	:	Specification for smoke detectors for use in
		automatic electrical fire alarm system.
NFPA 71 & 72	:	National Fire Alarm code
NFPA 71 & 72	:	National Fire Alarm Code
UL 464	:	Audible Signaling Appliances
UL 38	:	Manually Actuated Signaling Boxes

National Building Code-2016 for Fire & Life safety.

CPWD-General Specifications for Electrical Work-Part-VI: Fire Alarm & Detection System-2018.

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentioned regulations and specification then the specification here under shall take precedence over the said regulations and standards.



4.0 SCOPE OF WORK:

To provide the automatic addressable fire alarm system in entire Interim Terminal Building, & Sub-station as per latest design & requirement. The system shall be provide with addressable & analog fire alarm initiating, annunciating & control devices.

The addressable shall be such that smoke sensors, thermal sensors, manual call point etc. can be identify with point address.

The brief scope of work of SITC is under but not limited to:

- a) Multi detector
- b) Manual Call point
- c) Wall sounder cum strobe
- d) Beam detector
- e) Isolator module
- f) Control Module
- g) Response Indicator
- h) Addressable main fire alarm panel
- i) Fire survival cable

In addition to above brief scope of work contractor has to provide any other services required for complete installation.

- 5.0 In addition to SITC of fire detection & alarm system, the following work shall also be deemed to have included in the scope of work to be executed by the contractor within his quoted amount:

- i) It includes obtaining approvals from Chief Fire Officer/Fire Department concerned and all other statutory authority for complete scope of work as per the prevailing rules & regulations etc.
- ii) The fire detection & alarm system of the building shall be integrated with respective to the zoning of PA system so that, in case of fire, the PA system shall automatically come in announcement mode of that particular zone and paly pre-recorded evacuation messages from PA system.

6.0 Test at Site and Tests Certificates

- i) All commissioning tests at site will be in line with NFPA / EN (Latest).
- ii) Following test shall be conducted: -
 - Loop Checking.
 - Checking of multi sensor detectors etc. by simulation/functional test by Aerosol Spray or as recommended by the manufacturer.
 - Functional tests for fire alarm panel.
 - The Mock trial of the complete Fire Detection and Alarm system.

Tests certificates will be furnished for all Fire alarm system devices by the manufacturer.

7.0 SHOP DRAWINGS

Technical submittals and shop drawings for all equipments/ materials are to be submitted by EPC Contractor as per functional / site requirement to the Engineer-in-Charge in 3 sets and be approved by him before procurement and commencement of work. All such drawings shall show the dimensions of all equipment and installation. Drawings include the following not limited to:

- i. Block Diagram showing all detectors and devices area wise, their connectivity to the panel including wire description.



- ii. Point-to-point wiring diagrams showing the points of connection and terminals used for all electrical field connections in each system, all equipment or systems which are supervised and controlled by the fire alarm system. Diagrams shall show all connections from field devices to the control panel initiating modules, output modules, switches, relays and terminals. Diagrams shall show interconnection of all devices, modules, output modules, switches, relays and terminals.
- iii. The Contractor shall submit specific catalogue for each of the item specified in Specifications for approval from AAI before procurement.

A further set (4 copies) of all approved shop drawings shall be supplied by the EPC Contractor for use of the Engineer-in-Charge for execution of work.

8.0 **POWER SUPPLY**

- 8.1 The control panel shall drive from 230 Volts main power supply. In case of failure of main power supply, the panel shall be automatically switched over to standby power supply i.e. battery. The standby battery as secondary supply shall be such that when charged by associated battery charging equipment it can operate independently for a period of **24** hours normal working and then be capable of operating the system for 30 minutes during an emergency / fault conditions. Batteries shall be of Lead Acid type sealed Maintenance free / Li-ion.
- 8.2 In addition to the batteries, an automatic battery charger suitable for operation on the auxiliary power available in the plant as specified above. The capacity of the charger shall be such that the same can charge the battery (within **12hrs**) while supplying the rated load of the fire detection system. Facilities shall be provided to limit the voltage supplied to fire detection and alarm system to their rated values during the time of charging. The charger shall normally supply the battery trickle charging current and the DC load of the fire detection and alarm system. In case the AC supply on the input side of the charger fails the necessary power for the complete fire detection and alarm system shall be supplied by the battery.
- 8.3 Visible and audible annunciation for troubles or failure in the power supply system like "charger Failure", "Battery Low Voltage", etc. shall be provided.
- 8.4 Battery fault indication/annunciation shall be included in the panel.

9.0 **DESIGN REQUIREMENT**

- a) The system shall be provided with multiple loops and distributed as per GFC drawing issued by the department on award of work. All devices shall be connected directly to the loop with 2x1.5 sq. mm Armored copper fire survival cable. The system shall be compatible to integrate with the PA system.
- b) Addressable Multi-Sensor Detectors (smoke + heat), Addressable smoke Detectors Addressable Heat Detectors, Addressable Beam Detectors Addressable Manual Pull Station, Fault Isolators, Control Modules, Monitor Module, Response Indicators, Addressable Hooters cum strobe etc.
- c) The Panel shall have necessary Logic Software and Hardware built into it for time delay starting of strobe.
- d) Suitable racks shall be provided for housing control equipment's etc.

10.0 **SPECIFICATION**



The design, supply, installation testing & commissioning of entire fire alarm system shall conform to BS/NFPA 72. All devices including Main Fire Alarm Panel shall be UL /EN listed and FM approved.

11.1 **ADDRESSABLE MAIN FIRE ALARM PANEL**

- The Fire Alarm Control Panel shall be **Modular Microprocessor based expandable fully intelligent Addressable Control Unit** which shall control all intelligent addressable detectors, manual call stations Control / Monitor module etc.
- All Addressable Units shall be connected to the Panel through the Loop Cards and shall be addressed through individualized numbers. The Panel shall be able to obtain intelligent value for all detectors in the circuit through a pulsed digitalized current data. The panel shall be able to analyze all intelligent inputs from all addressable units and through its own software and ambient level screening the panel shall be able to identify fire, possible fire or fault conditions. The unit supervision shall be dynamic and continuous.
- The Fire Alarm Panel itself shall have all loop cards in it. No isolated mother board or transponder is allowed. Each loop shall be able to access a minimum of 250 addressable detectors / devices (in any combination) per loop. Panel shall be expandable.
- The Panel shall also give adequate warning signal whenever there is Dust Accumulation in Detectors, and up to the point of its replacement it should be possible to change the level of ambient alarm calibration condition either by the use of software programme operable by the Owner or by resetting the detector.
- Short circuiting, loose wiring or missing units shall also be reported at the panel with pin point or segment-wise location. In such cases, the system through the use of Fault Isolators shall be able to isolate that segment between the two Fault Isolators.
- The panel shall have a liquid crystal display type on it to indicate immediately all conditions. In case of testing of the system from the panel, the display shall be able to give readouts of intelligent value of all detectors being tested. The panel shall also be able to carry out continuous self monitoring when in normal condition.
- Number of detectors / devices per loop should not be exceeding 90 percent of the full capacity of each loop as per IS code.
- The panel shall have either an in-built or external printer coupled to the panel which shall log all events with time. The printer shall be suitable for printing panel's event logs or as per the configuration to print automatically any of the events such as Fire, Fault, Alarm or Test, the unit address, time along with option for printing the Inputs, Outputs, Disablements, Network Faults etc.
- The panel shall also be able to discriminate between false alarms and fire conditions, as well as priority selection of alarm address in case alarm activates in two or more remotely located units simultaneously. In such cases, the manual call box shall be reported first, group of sequentially laid detectors (in one room for example) second and a detector with the greatest obscuration over a period of time third.



- Any time, the operator shall have following manual capacities at fire alarm panel under password control:
 - Operator privileges & ID number of up to four digits shall be assignable only by the main operator or designated official.
 - Action taken by operator shall be automatically printed on FAP printer with operator initial, date and time.
- The panel shall also be able to actuate switches automatically in case of fire condition that of AHUs and power supply or other systems. The EPC Contractor will be required to design and install the system in operation in coordination with the associate contractor for air conditioning / other work. The EPC Contractor will not be allowed to charge extra on this account, and such charges shall be included in his package.
- The system shall be fail safe and adequate safe guards should be under taken that in the event of a failure of a part of the system it shall not handicap the complete system. The mother board shall be of modular construction.
- The EPC Contractor will be responsibility of the complete installation, commissioning, user trials, training and maintenance of the system as required. The software shall be such so as to be easily operated by the departmental Personnel, is secured against Software errors, ability to be upgradable so as to incorporate more detector units or replacement / changing of detector units, can incorporate more features at a later date such as illumination control, security etc.
- The voltage rating shall be from as per OEM, though the voltage may be changed depending upon the working voltages of a proprietary fire alarm panel.
- The panel shall be totally enclosed dust and vermin proof type made of suitable gauge dust inhibited sheet with finish. The panel shall be of completely solid state design.
- The logic circuitry shall be based on high noise immunity solid state hardware employing modular construction. Logic cards shall be of epoxy fiber glass construction.
- The system shall meet the BS/NFPA 71 & 72 standards and shall be listed with UL/EN (Latest Versions).
- The panel shall have facility to connect printer to printout log and facility to have seamless integration with analog/digital voice evacuation system (PA- System), fire fighter telephone system and shall be complete with all accessories. The panel shall be compatible for IBMS system with open protocol BACnet/ Modbus over IP complete as required. Programming software for the system, Automatic system test activates, Detector sensitivity adjustments, Alarm verification, Alpha / numerical display.
- The design of the panel hardware and software shall incorporate the capability to accept additional input from fire protection system such as water flow switch etc.
- The fire alarm panels shall have a possibility of being interlinked by direct connectivity or an optical cable link between the various locations and should further have connectivity to the main control center.



- There shall be minimum 20% spare capacity in the looping system for future expansions. The Contractor has to intimate the maximum number of devices/ detectors can be connected in one loop based on the manufacturer design.

11.2 INTELLIGENT ADDRESSABLE MULTI SENSOR DETECTOR

- a) The detector shall have both optical and thermal sensor and shall be capable of working in combined mode (Optical + Thermal) or heat mode (only Thermal) or smoke mode with inbuilt fault isolator / isolator base or to provide fault isolator at every 20 nos. complying NFPA guidelines.
- b) The combined modes of operation both the inputs from the optical and thermal sensors are processed using special algorithms before an alarm decision are made. If the presence of smoke is detected above a threshold value for a period of time or if heat sensor temperatures rise above certain fixed temp or rate of rise, than an alarm condition will be generated. In "heat only" mode only temperature above certain fixed level will generate an alarm conditions.
- c) The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, kitchen etc.) and then have the ability to automatically change the setting as the environment changes in order to avoid nuisance alarm.
- d) The multi sensor detector shall be a combination of smoke & heat and it can be used as a smoke detector, as a heat detector or as a combined smoke/heat detector upon demand and is programmed and set-up specifically for the environmental conditions that it is part of. It should detect smoldering and open fires at an initial stage by being able to detect and evaluate the characteristics of fire and smoke (Tyndall or relevant applicable principle) as well as heat (NTC sensor / thermistor principle). The sensitivity of the detector can be adjusted, if required as per site conditions.
- e) The multi sensor detector shall activate on receiving smoke particles in the 0.5 to 10 micro meter range or as manufactured specified. The detector shall be completely solid state with LED indication.
- f) The detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion. The detector shall be suitable for low voltage two wire supply as per OEM. The sensitivity of the detector shall not vary with change in ambient temperature, humidity, pressure and voltage variation.
- g) The coverage per detector shall be as listed with UL & FM approved This coverage area will reduce depending upon structural configurations or partitions etc. The sensitivity of detector shall be set adjusted by the supplier to suit the site requirement.
- h) The multi sensor detector shall be intelligent addressable detector with electronic addressing or manually-set digital code and be able to give intelligent output to the fire alarm panel regarding its condition.



- i) The Base of the detector shall be interchangeable with other detectors and the construction shall be of polycarbonate or any approved flame retardant material.
- j) Signals from detectors that are normally not visible shall be extended in the shape of Response Indicators to a suitable location, which is easily visible. The response Indicator shall be lit by means of twin LED"s in red colour and shall be housed in MS box / Aluminium die cast box. For detectors above false ceiling, the Response Indicators shall be installed either right below on the false ceiling or on the nearby wall/column with bottom 300 mm below false ceiling Alternatively all Response Indicators shall be located at convenient places as approved. The cover plate of the Response Indicators shall also boldly display the detector number to which they correspond.

11.3 ADDRESSABLE MANUAL CALL POINT

As per IS manual call point shall be so located that to give an alarm, no person in the premises has to travel distance of more than 30 m to reach them. It shall be fixed at height from surrounding floor level.

Manual Call Station shall be of Pull / Push down Resettable type units and inbuilt fault isolator or isolator module, completely encased in a cast aluminium housing or in 16 gauge MS / LEXAN / Polycarbonate, with provision for cable or conduit coupling. The Manual call station shall have the word prescribed in clear bold letters on facia window **"In Case of Fire/ Push In / Pull Down / as per OEM"**. Its casing shall be of red color.

The Manual Call Box Station shall be fully addressable with its own set code and operated by digitized signals sent from the Panel. The Voltage range shall be as per OEM. It shall have protection as per IP 54 for indoors & IP 65 enclosure for outdoor applications. The operating temperature range shall be from 0 degree C to 50 degree C. Relative Humidity (non condensing) range for performance parameters shall be between 0 to 93%.

11.4 ADDRESSABLE HOOTER CUM STROBE

The wall mounted Hooters cum Strobe and inbuilt fault isolator or isolator module, shall be suitable for indoor and outdoor application with adjustable sound level of 90 db to 120 db at 1M distance. Strobe shall be of red colour. It shall flash at 1Hz over the strobe's entire operating voltage. The Hooters cum Strobe shall be addressable and loop powered.

11.5 ADDRESSABLE MOTORISED AUTO ALIGN BEAM DETECTOR

- a) Addressable motorised auto align type linear optical beam smoke beam detector having control panel at low height designed to operate as components of fire alarm systems. It should be the combination of transmitter/receiver units that can be connected to a detector loop.
- b) The Infra-Red transmitter generates a beam of light towards a high efficiency reflector. The reflector returns the beam to the receiver where an analysis of the received signal is made. The change in the strength of the received signal is used to determine the alarm condition.



- c) The sensitivity of the detector can be set to between 25% and 60% obscuration, providing application flexibility to suit the environment in which the detector will be installed. In addition to four fixed value alarm thresholds, there are two variable thresholds that automatically compensate for changes in the environment which could otherwise result in unwanted alarms while remaining within a known sensitivity range.
- d) The detector incorporates automatic drift compensation, whereby the detector will adjust its detection thresholds in line with any long term signal reduction of the beam caused by contamination of the optical surfaces.
- e) Different alert for Fault and Fire condition.
- f) The detector can be adjusted up to 10 degrees vertically and horizontally for alignment. Where greater angular adjustment is required, the multi-mount accessory will be provided.
- g) The detectors have a range of 9 m to 50m, extending to 100m with a long-range reflector kit.
 - (i) Tested and approved to FM & UL
 - (ii) Voltage Range As per OEM
 - (iii) Temperature Range (Nominal Range) 0 deg C to (+) 50 deg C
 - (iv) Humidity (Nominal Range) 10 to 93% RH (non-condensing)

11.6 **RESPONSE INDICATOR:**

The response indicator should have to be of approved quality. Dual LED should be there & should get actuate at the time of fire detected in the detector. Compatibility with all detectors dual LED, Lamp ABS plastic, Indoor use only wall mounted & ceiling mount. Response indicator shall be of same make as make of panel.

11.7 **MODULES**

A. MONITOR MODULE (FOR INPUT TO FIRE ALARM PANEL)

The Input Device shall provide an addressable input for N.O. or N.C. contact devices such as manual water flow switches, pressure switches, etc. The input device shall provide a supervised initiating circuit.

An open-circuit fault shall be annunciated at the Fire Alarm panel (Subsequent alarm shall be reported.) The device shall contain an LED which blinks upon being scanned by the Fire Alarm panel. Upon determination of an alarm condition, the LED shall be latched on.

B. CONTROL MODULE

The control module shall provide an addressable output for a separately powered alarm indicating circuit or for a control relay. The control module shall provide a supervised indicating circuit where indicated on the plans. An open circuit fault shall be annunciated at the Fire Alarm panel.



The Output Device shall provide a control relay where indicated on the plans. The relay contacts shall be SPDT rated at one amps / as per OEM, 24 V DC. The device module shall contain an LED which blinks upon being scanned by the Fire Alarm panel. Upon activation of the device, the LED shall be lit on.

12.0 **Fire Survival Circuit Integrity Cables**

Fire survival cable for detectors and other will be executed as per enclosed specifications at sub head **"Fire Survival Cables"**

13.0 **TESTING**

13.1 **RANDOM SAMPLE TESTING:**

About 5% of all fire alarm components shall be subjected to random testing by connecting to the panels. All smoke detectors shall be tested as given above and later cleaned with a vacuum cleaner. Hooters shall also be tested through direct 24V supply for 10 minutes.

13.2 **TESTING OF EARTHING SYSTEM:**

The earth continuity conductor including metallic parts of the equipments shall be tested for earth to electrical continuity. All tests shall be carried out as per IS 3043-2018 and resistance of complete installation shall not be more than one ohm.

13.3 **TESTING AT SITE:**

Following testing shall be conducted: -

- Loop Checking
- Checking of multi sensor detectors etc. by simulation/functional test by
 - Aerosol Spray or as recommended by the manufacturer.
- Functional tests for fire alarm panel.
- The Mock trial of the complete Fire Detection and Alarm system.

13.4 **TESTS CERTIFICATES**

Tests certificates will be furnished for all Fire alarm system devices by the manufacturer.

14.0 **COMMISSIONING AND ACCEPTANCE TESTS**

The commissioning and acceptance tests shall be apart from the standard or routine tests prescribed and normally conducted by the manufacturer / Design-Build Contractor and will be irrespective of the fact whether the same are covered by such tests or not. All commissioning tests at site will be in line with NFPA 71 and 72.

- a. Each sounder circuit shall be energized separately and the sound level reading taken to check for conformity with the minimum standards.
- b. Mains failure performance.



- c. Battery disconnection test.
- d. Open circuit of each sounder circuit to be tested.
- e. Short circuit of each sounder circuit to be tested.

The result of the above tests either by fault warning or the fire alarm shall be recorded in the log books which will be signed both by contractor and the AAI representative.

Gas Suppression System:

The room flooding system shall be provided in Server room and UPS/Battery room as per FM/UL standard.

Technical Specifications of Aerosol Extinguishing System

1. Scope: Scope includes supply, installation, testing and commissioning of Aerosol fire extinguishing system for Room Flooding using Tor - 2800 & Electrical equipment using 8 gram and 20-gram aerosol fire extinguishers. The 8 gram and 20 gram aerosol fire extinguishers shall be fitted in Electrical LT panel as per the direction of EIC. The 2.8 kg aerosol fire extinguishers shall be installed in sufficient qty to cover server room and UPS/ battery room

The 2.8 kg aerosol fire extinguisher shall be connected to gas release panel and shall operate when electrical command from the gas release panel is given to the aerosol extinguisher. Gas release panels shall also be connected to conventional smoke detectors in appropriate area and shall operate when smoke detectors of combined 2 zones senses smoke. A hooter shall also ring indicating operation.

2. General Requirement: The Aerosol Fire extinguishing system shall be confirming to GOST R53284/ISO 15779/NFPA- 2010/UL listed. The electrical LT panel shall be provided by fitting aerosol-based safety generators (ASG) with thermo cord sensors into same as above conditions which shall be able to react automatically to the rise of temperature in case of initiation of fire without human intervention. To avoid any delay in preventing fire propagation from the instance of actual initiation of fire and saves the installation from damage. The room flooding aerosol fire extinguisher shall be fitted on the wall in sufficient qty and shall operate when signal from the gas release panel is received by it

3. Technical Characteristics of Room Flooding aerosol Fire extinguisher

- i. Activation Mechanism: Electrical impulse from gas release panel.
- ii. Gross Weight: 5.3 kg± 0.2 kg
- iii. Net Weight of Extinguishing Agent: 2.8 kg
- iv. Discharge Time: < 18 seconds
- v. Size: The dimensions shall not exceed 120 mm x 245 mm diameter
- vi. Protected Volume: 127 cubic meter (with approx. Panel size 7 meter X 6meter X 3 meter
- vii. Self-Activation Temperature: In case thermo cord fails to active at 172° C, then each Aerosol, Generator self-Activities at 300°C.
- viii. Fire Class: Suitable for Class A, B, C & E Fire.
- ix. Related Standard: GOST R53284/ ISO 15779/ NFPA- 2010/UL Listed



- x- Applications: Should be suitable for Rooms & Electrical equipment's
- xi. Environment Protection: (a) Zero Global Warming Potential, (b) Zero Ozone depletion
- xii. Safety requirement:
 - (a) shall not cause any damage to humans, equipment and environment.
 - (b) Nontoxic and non-corrosive.
 - (c) The extinguishing must not be Pressurize
- xiii. Suppliers/manufacturer: reputed suppliers /Manufacturer of fire protection system in India. The bidder must be a manufacturer of such system or their local authorized dealer/distributor. Manufacturer's authorization certificate to dealer/distributed shall be submitted as the case may be.
- xiv. Operation range: Operation Range: 0°C to+ 60°C
- xv. Maintenance requirement: Preferably maintenance free system

4. Technical Characteristics of 8 gm Aerosol for Electrical LT panel

- i. Activation Mechanism: Thermal Activation by thermo-cord at 172°C Aerosol generator should be self-activated at 172°C by thermo cord which in turn actuates aerosol generator.
- ii. Gross Weight: 22 gm
- iii. Net Weight of Extinguishing Agent: 8 gm
- iv. Discharge Time: < 13 seconds
- v. Size :The dimensions shall not be exceed 15 mm x 52 nun diameter approx. with 5% variation
- vi. Protected Volume: 0.1 cubic meter (with approx. DB/ panel size) 3 Feet X 2 Feet X ½ Feet
- vii. Self-Activation Temperature: In case thermos cord fails to active at 172° C, then each Aerosol, Generator self-Activities at 300°C.
- viii. Fire Class: Suitable for Class A, B, C & E Fire.
- ix. Related Standard: GOST RS3284/ ISO 15779/ NFPA- 2010/UL listed
- x. Applications: Should be suitable for Electrical DBs & Panels and Equipment's
- xi. Environment Protection: (a) Zero Global Warming Potential, (b) Zero Ozone depletion
- xii. Safety requirement: (a) shall not cause any damage to
 - (a) human, equipment and environment.
 - (b) Nontoxic and non-corrosive.
 - (c)The extinguishing must not be Pressurized
- xiii. Supplies/manufacturer: Reputed suppliers / Manufacturer of Fire Protection System in India. The bidder must be a manufacturer of such system or their local authorized dealer/distributor. Manufacturer's authorization certificate to dealer/distributed shall be submitted as the case may be.
- xiv. Operation range: Operation Range: 0°C to + 60°C
- xv. Maintenance requirement: Preferably maintenance free system



5. Technical Characteristics of 20gm Aerosol for Electrical LT panel

- i. Activation Mechanism: Thermal Activation by thermo-cord at 172° C Aerosol generator should be self-activated at 172°C by thermo cord which in turn actuates aerosol generator.
- ii. Gross Weight: 140 gm
- iii. Net Weight of Extinguishing Agent: 20 gm
- iv. Discharge Time: < 10 seconds
- v. Size: The dimensions shall not exceed 65 mm x 65 mm x 38 mm approx. with 5% variation
- vi. Protected Volume: 0.2 cubic meter (with approx. panel size) 3 Feet X 2 Feet X 1 Feet
- vii. Self-Activation Temperature: In case thermo cord fails to active at 172° C, then each Aerosol, Generator self-Activates at 300°C.
- viii. Fire Class: Suitable for Class A, B, C & E Fire.
- ix. Related Standard: GOST RS3284/ ISO 15779/ NFPA- 2010/UL Listed
- x. Applications: Should be suitable for Electrical Panel & Equipment's
- xi. Environment Protection: (a) Zero Global Warming Potential (b) Zero Ozone depletion
- xii. Safety requirement: shall not cause any damage to
 - (a) humans, equipment and environment.
 - (b) Nontoxic and non-corrosive.
 - (c) The extinguishing must not be Pressurized.
- xiii. Supplies/manufacturer: Reputed suppliers / Manufacturer of Fire Protection System in India. The bidder must be a manufacturer of such system or their local authorized dealer/distributor. Manufacturer's authorization certificate to dealer/distributed shall be submitted as the case may be.
- xiv. Operation range: Operation Range: 0°C to + 60°C
- xv. Maintenance requirement: Preferably maintenance free system



PACKAGE – G

SIGNAGES



SIGNAGES WORKS

- 1 **General** This section covers the detailed requirements of provision of Signage and Graphics for Passenger Terminal Building. EPC Contractor will procure materials, fabricate, finish, print, assemble, and execute the illuminated as well as non – illuminated signages, installation complete at the proposed airport site on designs, complying specifications and details provided hereunder.

1.1 Introduction

This document outlines the material specifications and performance / technical requirements for execution and installation of signages at Airport i/c car park area. The material specifications are given for the key materials used in manufacture of the signage and performance criteria serves as a guideline for the detailing and implementation of the various details of the signage. This document shall be the key reference to be read in conjunction with the sign drawings, sign schedules, and sign design guidelines enclosed.

1.2 Outline Scope of the EPC Contract:

It is to be noted that the various sign types are specified and agreed for their design, visual appearance, dimensions, orientations, form, colour, suggestive fixing and placements at the airport and will be binding on to the EPC Contractor. However, the actual detailing and design of the structure, at times material specification, detailing for fixing, joineries, integration with the built architectural elements, connection and coordination with electrical and data cabling, installation, stability, accuracy and correctness of design implementation as per the performance criteria is the responsibility of the EPC Contractor.

This document gives the technical specification for the specified materials and notes on best practice, workmanship which shall be guideline for the EPC Contractor to accomplish the job. It is EPC Contractor responsibility to detail for fabrication by creating shop drawing/ working drawing which shall be presented to the Engineer in Charge for approval. The integration and coordination of the signage for their fixing with architectural element like walls, floor, ceiling and structural member shall be detailed and worked out by EPC Contractor based on performance and design criteria given in the document.



1.3 List of materials

Following materials are mentioned in the document which cover the majority of the work for sign fabrication but is not limited and newer options/advanced materials can be explored basis their meeting the performance criteria of signing. Components and accessories like hardware shall be procured of the best quality confirming to the Indian standards for matching life expectancy to the materials they are used in combination with.

No	Material	Format
1	Acrylic	Sheets
2	Retro-Reflective Vinyl	Roll
3	Vinyl films	Films and laminates
4	Aluminium	Extrusions, Profiles, sheets
5	Stainless steel	Sheets, Rolled sections
6	Mild Steel	Sheets, Rolled sections
7	Illumination and electrical	Lamps and electronics (LED)
8	Powder coating	
9	Polyurethane painting	Litre
10	Photo-luminescent signs	Sheet
11	Aluminium Composite Panel	Sheet
12	Flex	Roll
13	Power Supply (driver)	
14	Digital Print	Roll

2.0 Common notes

2.1 Sign detailing and construction

Fabrication quality must be of a high standard and all illuminated signs will need to meet general electrical safety standards as determined by Indian Standards. It is envisaged that all illuminated signs will also need to offer an IP54 rating to prevent water and dust ingress. There should be no dangerously sharp corners or raw edges and all burrs must be removed. All graphics must be sealed to resist the abrasive action of weather or washing. All graphics and construction materials must be able to withstand the effects of heat and cold within the range of -5°C and 65°C.

Sign faces must be fairly easy to remove and replace if necessary with hidden/flush screw heads in the top of the frame. The hanging rods/poles must allow an adjustment in height and also allow some lateral adjustment.

All signs must be able to be cleaned back to a visual standard equal to that when first installed.

In addition to design the sign structure for dead loads and imposed or live loads -



structure must be able to withstand accidental damage or knocks without becoming dangerous. Graphic surfaces or panels must be easy to replace in case of damage or change in text. Replacement of complete signs must be straight forward and not need to be achieved by the use of any specialized equipment. Ideally, graphic panels should be removable without any adjustment to any fixing bracket, rod or support to the extent possible.

2.2 Warranty/Guarantee

All sign structures should be provided with a 5-year warranty/Guarantee for the graphics and sign panels. All warranties from the manufactures shall be transferred to AAI.

2.3 Typical sign details: Illuminated signs

A lot of the directional signs are in matched pairs with information where information signs aligned at bottom of directions signs panel on the same structure.

The illuminated sign units have been designed so that only the text and graphics is illuminated.

The Illumination levels in the signs shall give uniform spread and brightness to stand out in the ambient lighting conditions during day and night of Terminal interior. Burning out due to placement of lamps close to the sign face and dark spots shall be avoided but carefully fixing the LED inside the sign frame. A light diffuser film shall be used on the inside of white acrylic for even light distribution and achieving the desired results.

All internal illumination shall be using Power LED Lights with electronic controllers /drivers.

Adequate ventilation to dissipate the heat from inside the sign shall be provided, in not visible areas, and locations & detail to ensure meeting the IP rating requirements.

2.4 Typical sign details: Non-illuminated signs

Some location signs are non-illuminated. They shall manufacture to look identical to the illuminated signs but with vinyl graphics sign faces. They do not need to be as deep as the illuminated sign units but fixing requirements and details will remain the same.

Some signs in the schedule may require only graphics to be changed on the faces of existing signs. These signs have been manufactured using vinyl graphics which can be removed and replaced with new vinyl where the type, thickness and colour of vinyl must be as per the new artwork provided.

Information, prohibition and some safety signs faces can be manufactured as shallow trays. Around the outside the sign is framed with either a stainless steel



profile or an aluminium extrusion. Sign fixing brackets and hinges can be the same as used earlier but allowance must be made for height adjustment and leveling.

2.5 Typical sign details: Emergency escape signs

Emergency escape signs shall be executed using all fire resistant materials namely MS CRCA powder coated sheet sign frames and boxes, Acrylic for the sign face with vinyl graphics applied from the inside to protect them against heating in case exposed to fire. The sign shall have internal illumination from a UPS with a min 1.5-hour backup. In general materials shall in Emergency signs comply with flame spread Index of '0'.

All fire life safety plans shall be Powder Coated Aluminum Sheets mounted on wall.

2.6 Typical sign details: Vinyl signs/graphics

At some places application of vinyl graphics is required to provide counter numbers, gate numbers, signing text, door signs and statutory signing labels. Full artwork, layout guides and detailed schedule information is available for this vinyl application.

2.7 Drawings

- i) The Engineer In-charge will issue reference drawing to the EPC Contractor. Structural drawing and detailing has to be worked out by EPC Contractor & submitted to the Engineer In-charge.
- ii) Should there be any discrepancy in the reference drawings, the EPC Contractor is to refer the matter to the Engineer In-charge. EPC Contractor shall further provide a design drawing showing the accurate setting out to line and level of all the anchor bolts intended for the work in sufficient time for their inclusion in the work so as to maintain the building program.
- iii) The EPC Contractor is to prepare all the necessary fabrication shop drawings as per functional requirement along with each submittal of materials and these shall be submitted to the Engineer In-charge in duplicate and be approved by him before fabrication is commenced. All such drawings shall show the dimensions of all parts, method of construction, assembly, installation complete.
- iv) Further, four set of all approved fabrication drawings shall be supplied by the EPC Contractor for use of the works to Engineer In-charge as required.

The drawings for illuminated signs shall cover the placements and layout of luminaires inside the sign panel.

Approval by the Engineer In-charge of drawings or any other particulars



submitted by the EPC Contractor shall not relieve the EPC Contractor of full responsibility for any discrepancies, errors or omissions therein. The EPC Contractor shall at his own expense supply such additional copies of his working drawings as are required for the use of the interested parties.

The EPC Contractor shall also create as built drawings for all the sign types for the documentation requirements for the project management and operations.

2.8 Quality check and inspection

Each material to be used in the fabrication of signs shall be approved by presenting 2 copies of samples prior to its purchase and use.

The EPC Contractor shall inform the Engineer of the progress in fabrication and as to when individual pieces are ready for inspection. All gauge templates, sample materials, sizing templates, colour swatches, necessary to satisfy the Engineer – In-charge shall be supplied by the EPC Contractor. The Engineer In-charge may at his discretion check the results obtained at the EPC Contractor's works by independent tests and should the material so tested be found unsatisfactory, the cost of such tests shall be borne by the EPC Contractor. During Inspection, the component/member shall not have any load or external restraint.

3.0 Colours

All the Signage shall use the following colour specifications.

S. No.	Application	Colour	Colour reference
1	Sign Framing		RAL 9006
2	Background (Exterior-Road)	Blue	Retro-reflective
3	Primary Message (Exterior-Road)	White	Retro-reflective
4	Background (Exterior-Curb Side)	Yellow	PANTONE YELLOW C
5	Primary Message (Exterior-Curb Side)	Black	PANTONE BLACK 6C
6	Background (Interior)	Black	RAL 9011/ PANTONE BLACK 6C
7	Primary Message (Interior)	Yellow	PANTONE YELLOW C
8	Secondary Message (Interior)	Cyan	PANTONE 311C
9	Fire Signs	Green	PANTONE 3405C
10	Fire Signs	Red	PANTONE 032C
11	Statutory Signs (Background)	Blue	PANTONE BLUE 541C



12	Statutory Signs (Message) - backlit	White	040 acrylic
13	Statutory Signs (Message) - Non-lit	White	White block out vinyl

The Above specified colours will be used through various materials like Vinyl Films, Powder Coating, Painting, Printing.

All the above materials shall be presented as samples in multiple copies for approval of engineer-in-charge before commencing any work.

In case of special colour to be developed it will be EPC Contractor's responsibility to coordinate with the manufacturer and present the various swatches to the engineer in charge for approval. All materials specific to the colour are important for the visual appearance of signs and execution of these shall confirm to the technical specifications and notes for quality of workmanship given in this document.

4.0 Materials

For all other material required for the works, the approval of the Engineer In-charge shall be obtained by the EPC Contractor prior to the use of the material in the works

EPC Contractors are expected to provide the standard warranty and the invoices from the manufacturers covering all the materials used.

4.1 Acrylic

White Cast acrylic sheets with 40% light transmission shall be used as face of all illuminated signs.

The acrylic should have excellent weather-ability and UV stability for min 5 years.

Acrylics made from virgin polymers shall be used for the sign faces

A 5mm or 8 mm thick Acrylic sheet is proposed for illuminated sign faces with a +/- 10% tolerance for the thickness. For larger sign faces more than 700mm height and 1600mm long shall use a 6mm thick acrylic. The sign face should not bulge or cave in normal conditions

4.2 Workmanship for Acrylic

The surfaces of Acrylic come covered with a masking film on both surfaces for protection during transport, storage and fabrication. The masking film should be left in place during fabrication work and all marking-out drawn on the film. It is recommended not to remove the marking film until necessary to prevent dust collection and accidental surface scoring or scratching. However, care should be taken not to have the surface scratched during handling.

Before pasting the vinyl graphics, it is advised to wash the sheet surfaces to be decorated with clean, fresh water using a soft cloth. This has the advantage of



removing all traces of static charge from the sheet after removal of the film which might otherwise attract dust. For all general purpose cleaning operations, acrylic should be washed simply with clean cold water to which a little detergent has been added. The use of any solvents such as methylated spirits, turpentine, white spirit or proprietary window cleaning products is neither necessary nor recommended.

Flatness of the sheets is very important for the signs to appear neat.

The cutting shall be done using powered saw to a tolerance of ± 1 mm. The edges shall be cleaned of any bur and chamfered to make the acrylic comfortably sit inside the frame.

4.3 Vinyl Films Block out vinyl films

- Cast films should to provide complete light blocking characteristics with less than 0.001% light transmission.
- A luster / matt finish colour matching to specified Pantone colours on the outside and uniformly white on the adhesive side.
- A cast vinyl face film of thickness between 0.1mm to 0.13mm, with clear acrylic based permanent pressure sensitive adhesive.
- The film shall provide strong adhesion to a wide variety of substrates with perfect dimensional stability and perform well as second surface media.
- The films should have self-extinguishable property and have a performance guarantee against colour fading, peeling, cracking.

Opaque vinyl films

- Cast opaque films of thickness between .063mm to .09mm, with clear acrylic based permanent pressure sensitive adhesive.
- The film shall provide strong adhesion to a wide variety of substrates with perfect dimensional stability and perform well as second surface media.
- The films should have self-extinguishable property and have a performance guarantee against colour fading, peeling, cracking.

Translucent Vinyl film

- Translucent Graphic Film to allow light transmission.
- Cast vinyl film of thickness (0.05 mm) with clear pressure sensitive adhesive.
- A cast vinyl film with a clear, permanent, pressure-sensitive adhesive and a translucent synthetic liner that does not split if wet.



- The films should have self-extinguishable property.
- Should have a performance guarantee against colour fading, peeling, cracking.
- Should be able to withstand temperatures in the range -5° to +65°C.

Protective over laminate for digital prints

- Shall be a luster / semi-matt cast films resistant to chemicals and abrasion while cleaning.
- All other following listed below products, will have to be used with maximum standard life specified within the range manufactured by supplier and all warranties for the above products shall apply.

Other films

- **Printable vinyl / Opaque vinyl / Printable floor application / Floor laminate**
- All vinyl has to have exact match with the color specified for each sign. Sample shall be approved by Engineer-in-charge before exclusion.

4.4 Workmanship for Vinyl pasting (Plotter cut Vinyl sheet graphics/text)

Vinyl shall be pasted on Acrylic sheets or on glass/metal panel after removing the masking film/cleaning the surface.

Proper preparation of application surface is essential to obtain high quality and long lasting markings.

Application:

- Clean the substrate as per recommendation of vinyl manufacturer.
- Remove entire liner from adhesive side of film.
- Align the film and press one edge to surface with finger.
- With a squeeze, apply remaining film using overlapping strokes. Hold the film away from surface to avoid pre adhesion.
- The plotted vinyl sheet should be applied to the substrates with the use of approved application tape to insure correct placement and accuracy. Vinyl application should be done in a dust free environment.

Remove pre-mask:

- Remove application film from the face of the film by pulling tape back upon itself at a 180-degree angle. Application film should be removed after 24 hours of application.



- Re-squeeze all edges to prevent edge lifting. This must be done after application of film removal. Use firm even pressure. If not thoroughly re-squeezed after pre mask removal, the adhesion at edges of film loosened by pre mask removal may start peeling off due to dirt or moisture and subsequently lift or be susceptible to damage from pressure washing.

Remove entrapped air:

- All film pasting on the surface including the over laminate should be free from air bubbles. Inspect the film in flat areas for bubbles. To eliminate the bubbles, puncture the film at one end of the bubble with a pin and press the entrapped air with the thumb or squeeze or moving towards the puncture.
- Self-matching and complementing films should be used for all situations involving layers of films laminated in a single sign.
- The graphics for the Block out vinyl sheet should be plotted in accordance with specified artwork accurately on a computerized plotter cutter. The edges of the plotter cut vinyl sheet should be clean and smooth. Vinyl sheet should be plotted in a dust free environment.
- The final applied graphics shall be free from any kinds of wrinkles, air bubbles and placement/orientation problems.

EPC Contractors are expected to provide the standard warranty and the invoices from the vinyl manufacturers covering all the vinyl used.

5.0 Printing

The graphics and text of the signage system shall be printed with inkjet /Eco solvent printers Ink type: solvent ink, designed for 2 years' outdoor application Provide a hard lamination film to resist scuffing, scratching printing shall be done in cyan, magenta, yellow, black or spot color as specified.

Same colours of the signages shall be uniform as specified and shall not vary from sign to sign.

6.0 Alluminium Sections:

Alluminium plates and sections shall conform to Alluminium alloy of grade 63400 WP/AL-6063 of IS-733.

For all illuminated signs - The sign framing section shall be approved basis a presented sample finished as sign prototype. Aluminum section has to be of minimum dimension not less than not less than 10mm for non-lit signs and not less than 25 mm for illuminated signs with a maximum face holding of 3mm. Section shall be strong enough to take load of the signage and shall not distort on application of dead of live load.

Section shall be easily openable for maintenance/cleaning/changing laminate.



All sections shall be perfectly straight free from surface damages, bends and twists. Bent profiles shall not be forcefully straightened. Straightness tolerance shall not exceed of 1.5mm per 1000 mm.

7.0 Stainless steel

Stainless steel types 304 shall be used for sheets for paneling and cladding while 304L shall be used in heavy gauge components for example pipe, plate and fixing to improve weld ability.

Tools to be used only for fabrication of stainless steel and components shall be stored separately to avoid accidental switching with tools previously used on carbon steel fabrication work. For stainless steel pipe, plasma cutting and grinding back to bright sound metal is required if the pipe ends cannot be machined. Flame cutting is not allowed. All weld end preparations and adjacent single continuous straight lengths of pipe should be used instead of joints.

Use of hot or cold hammering as a means for repair is prohibited.

Misalignment Tolerance

All piping fit-ups shall be subjected to the following bore misalignment tolerance.

Components with Equal and Unequal inside Dimensions

<u>Nominal Pipe Size</u>	<u>Misalignment</u>
DN 150 and smaller	1mm
DN 200-300	2mm
DN 350 and larger	2.5mm

NOTE: Misalignment should be minimized wherever possible by rotating the pipe/fitting for best fit and/or by grinding the bore as required.

All fabrication/joint should be at true right angle or mentioned otherwise.

Surfaces of piping components/fabricated units/signs shall be kept free of foreign materials such as grease, paint, oil and the like.

Steel wire slings shall not be used for handling and transportation of stainless steel pipes. Canvas or nylon slings shall be used.

All parts assembled for bolting shall be in close contact over the whole surface and all bearing stiffeners shall bear tightly at top and bottom without being drawn or caulked. The component parts shall be so assembled that they are neither twisted nor otherwise damaged as specified cambers if any shall be provided. Drilling done during assembling shall not distort the metal or enlarge holes. The butting surfaces at all joints shall be so cut and milled so as to butt in close contact throughout the finished joints.

The edges and ends of all cut/sheared flange plates, web plates of plate girders, and all cover plates shall be planed/grind to make it free from any burr.



Final finish has to be done in the workshop itself after fabrication is complete. Sign has to be bubble wrapped/packed safe to transport is to the site without any distortion/damage.

8.0 CRCA M.S. Sheets

The CRCA mild M.S sheets to be used in the work shall conform to IS 513 - normal D-grade type mild steel.

9.0 Sheet Metal fabrication

The Metal handling and Fabrication work for CRCA Mild Steel sheets shall be got executed from a specialized agency.

CRCA mild Steel Sheets Fabrication shall be executed with CNC bending, CNC Laser and punching machines with precise work control and quality generation. Besides the specified machines, the Metal handling and Fabrication must have in-house CO₂ welding and skilled CAD/CAM facilities, engineers and skilled and trained personnel and adequate storage facilities.

Sheet metal blanking shall be preferably done using laser cutting to save on material, reduce wastage, have fewer burrs on cut blanks, speed of execution and achieve accuracy

All surfaces exposed to view shall be clean and free from dirt, stains, grease, scratches, distortion, waves, dents, buckles, tool marks, burrs and other defects which mark the appearance of finished work. Cutting edges shall be smooth and free from all defects.

All surfaces exposed to view shall be straight and true to lines or curves. Arises and angles shall be as sharp as practicable. Miter joints shall be formed in true alignment with profiles accurately intersecting and all joints carefully eased to a radius of approximately 1 mm unless otherwise shown. Metal corners shall be bent to the smallest radius possible without causing grain separation or otherwise impairing the work.

All exposed connections shall be formed with hairline joints flush and smooth. All face panels must be flat, true and free from weld stud witness or other surface imperfections/blemishes. Edges shall be machined and finished free from cutter marks (not guillotined). All fabrication should have dressed welds, bend radii, finish, permitted texture levels, squareness of construction, no twist or warp or sagging of shape.

The Tolerances in the fabrication work shall be as under:

Linear dimensions	:	+/- 0.5 mm
Hole and Slot Punches	:	0.3 mm



Finished edge radius : 0.3 mm – 0.5 mm
Finish for sheet metal 0.062" (1.6 mm) CRCA

10.0 Structural Steel Fabrication

The EPC Contractor shall supply to the Engineer copies of the manufacturer certificate that the steel brought to the site for incorporation in the works is of a quality fully complying with the specification. If required by the Engineer, the EPC Contractor shall arrange for testing of the steel samples.

10.1 Workmanship and Fabrication for metal work

For all the works, workmanship shall be of first class quality, throughout, and true to line, level and dimension as shown in the drawings or instructed by the Engineer.

All parts assembled for bolting shall be in close contact over the whole surface and all bearing stiffeners shall bear tightly at top and bottom without being drawn or caulked. The component parts shall be so assembled that they are neither twisted nor otherwise damaged as specified cambers if any shall be provided. Drilling done during assembling shall not distort the metal or enlarge holes. The butting surfaces at all joints shall be so cut and milled so as to butt in close contact throughout the finished joints. Hand flame cutting will not be permitted.

The edges and ends of all cut/sheared flange plates, web plates of plate girders, and all cover plates, and the ends of all angles, tees, channels and other sections forming the flanges of plate girders, shall be planed/ground.

Punching of holes will not be permitted. All drilling shall be free from burrs. No holes shall be made by gas cutting process.

The Engineer in charge may at his discretion order periodic tests of the welder and/or of the welds produced by them. All such tests shall be carried out by the EPC Contractor at his cost.

All the welding shall be done as possible shops except some site work. The pieces shall be manipulated to ensure down hand welding for all shop joints as far as possible. All parts to be welded shall be arranged so as to fit properly on assembly. After assembly and before the general welding is to commence the parts are to be tack welded with small fillet or butt welds as the case may be. The welding procedure shall be so arranged that the distortion and shrinkage stresses are reduce to a minimum.

All joints required in structure to facilitate transport or erection shall be shown on the drawings or as specified by the Engineer. Should the EPC Contractor need to provide joints in locations other than those specified by the Engineer he shall submit his proposals and obtain the prior sanction of the Engineer for such joints.



Each piece of steel work shall be marked distinctly before delivery, indicating the position and direction in which it is to be fixed. Three copies of a complete marking plan are to be supplied to the Engineer before erection commences.

In the case of welded fabrication any distortion remaining in the member after welding operations are completed shall be rectified by and/or at the expense of the EPC Contractor to the approval of the Engineer.

Templates and jigs used throughout the work shall be all steel. In cases where actual materials have been used as templates for drilling similar pieces, the Engineer shall decide whether they are fit to be used as parts of the finished structure.

Apart from the requirements of welding specified under the above sub clauses, sections above, the EPC Contractor shall ensure the following requirements in the welded joints.

- Strength-quality with parent metal.
- Absence of defects
- Corrosion resistance of the weld shall not be less than that of parent material in an aggressive environment.

No gasket or other flexible material shall be placed between the holes. The holes in parts to be joined shall be sufficiently well aligned to permit bolts to be freely placed in position. Driving of bolts is not permitted. The nuts shall be placed so that the identification marks are clearly visible after tightening. Nuts and bolts shall always be tightened in a staggered pattern and, where there are more than four bolts in any one joint, they shall be tightened from the center of the joint outwards.

10.2. Protection of Steel Works

Painting shall be applied under the temperature requirement specified by the manufacturer.

The steel work, prior to delivery, shall be cleaned from scale, rust, dirt and grease etc., by means of chipping, scraping and wire brushing using skilled operators as described in the painting systems below. The cleaning shall proceed each day over the extent of surfaces which can be painted on that day. The paint shall be applied by brushing or spraying as per approval of the Engineer.

The spraying equipment shall be compatible with the paint material, fitted with necessary gauges and controls and approved by the Engineer.

Site weld locations shall be left free from paint within 50mm of the weld position, and contact surfaces in connection using High Strength Friction Grip Bolts shall



not be painted. Immediately after completion of erection all damaged paint shall be scraped off and made good to the approval of the Engineer.

The Steelwork specialist shall also clean down and apply one coat of primer to all site bolts, site bolted connections and site weld locations and the paint work generally shall be left in sound condition for any subsequent painting.

All paints and primers shall be of best quality and to be stored and applied strictly in accordance with the manufacturer's instructions.

In addition, the following specification shall apply to the shop painting of contact and inaccessible surfaces:

- Surfaces to be painted shall be thoroughly cleaned from scale, rust, dirt, grease etc. by means of sand/grit/shot blasting or other equivalent means.
- Surfaces which are to be brought permanently into close contact or made inaccessible either in the shops or upon erection shall, after cleaning, be given two coats of Red Lead Priming Paint. The surfaces shall be brought into contact while the paint is still wet.
- All enclosed surfaces of box members shall be completely sealed by oiling or by coating with approved bitumen paint and all such members and tubes shall have their ends closed by suitable plates welded in position.

Surfaces in contact during shop assembly shall not be painted. Surfaces which cannot be painted, but require protection, shall be given a rust inhibitive grease.

The EPC Contractor shall take all precautions to prevent dust and dirt coming in contact with freshly painted surfaces or with surface being painted. The second coat of paint shall only be applied when the first coat has dried.

Exposed machined surfaces shall be adequately protected.

A uniform film thickness of paint is to be ensured throughout the work.

Surfaces, which have not been shop coated, but require surface treatment shall be given necessary surface preparation and coats at site as specified in the painting system.

10.3. Erection & Site Work

The EPC Contractor shall be responsible for checking the alignment and level of foundation and correctness of foundation bolt centers, well in advance of starting erection work, and shall be responsible for any consequences for non-compliance thereof. Discrepancies if any shall immediately be brought to the notice of the Engineer for his advice.

Following the completion of the straightening, the surface of the member shall



carefully be inspected for damage and got approved by the Engineer before further use.

All equipment used by the EPC Contractor shall be sufficient for the purpose and for the erection of the steel work, in the time specified in the EPC contract. Any lifting or erecting machinery shall be to the approval of the Engineer and shall be removed from the site if he considers such appliances dangerous or unsuitable for their functions. Adequate arrangement shall be made to resist wind loads and lateral forces arising at the time of erection.

The EPC Contractor is entirely responsible for the stability of the structure during erection and shall arrange that sufficient tack bolts, braces or guy ropes are used to ensure that work will remain rigid until final bolting, riveting or welding is completed. The EPC Contractor shall supply and fix, without extra charge, any temporary bracing which may be necessary.

At stanchion splices and at other positions where concrete cover to the steel is liable to be restricted, bolts will be placed with their heads on the outside of the members.

All field assembly bolting and welding shall be executed in accordance with the requirements for shop fabrication excepting such as manifestly apply to shop conditions only. Where steel has been delivered painted the paint shall be removed before field welding for a distance of at least 50mm on either side of the joints. The number of washers on permanent bolts shall not be more than two for the nut and one for the bolt head.

11.0 Lamps and fixtures

- a) Power LEDs shall be used in all the illuminated signs. LED modules (and not strips) shall be used.
- b) IP category – IP20 or more for indoor & IP65 or more for outdoor use
- c) All lamps shall be supported using clips to ensure no damage and facility to easily replace them when required.
- d) Colour - 5700 \pm 300K
- e) Type of drivers - Non potted for indoor & potted for outdoor use, complying serviceability class B.
- f) Warranty - 5 year warranty from actual date of completion of work on complete luminaire molding driver/control gear / LED modules, etc.

EPC Contractors are expected to provide the standard warranty and the invoices from the manufacturers covering all the lights used.



11.1. Recommended contrast between Light output and background.

Types of Areas	Range of Service illuminance in Lux for Signs in given area.
Curbside area	400-1000
Interior Area	240-1000
Exterior Area	240-420
Parking area	80-320
Emergency Sign (Exterior)	80-240

12.0 Wiring for Outdoor Signs:

Illuminated signs

The EPC Contractor shall also ensure that all the connections inside the sign are made through Bakelite connectors and thimbles & screws are used for end terminations of wires. Thimbles wherever installed shall be properly covered with insulated sleeves and no temporary taping is done at any point. All the connectors shall be ISI marked.

All connectors and joints shall be mounted or fixed to the internal structures of signs with insulating fixtures

The interconnecting wiring between light fixtures within the sign shall not be less than 1.5 Sq.mm and shall be FRLS/HHFR, PVC insulated 1.1 KV grade, with multi-stranded copper conductor.

If specified - An earth terminal shall be provided on each of the lit sign which shall be connected with the earthing conductor laid along with incoming circuit wiring.

All wiring within the sign enclosure shall be covered with flexible PVC conduit which shall be properly fixed with clamps, saddles etc. in such a way that no shadow is cast on the illuminated surfaces. In no case any loose wiring shall be left inside the sign enclosure.

Wiring for all type of sign needs to be concealed and out of public reach and sight. No conduit shall have joint in the floor where it is exposing to humidity or water seepage.

Important: All Suitable protecting MCBs are to be provided at the tap off or incoming point of power supply at all signage boards.

13.0 Powder Coating:

13.1. Powder coating on Aluminium Plates/sections



Wherever specified the aluminium plates shall be coated in approved colour and shade with pure polyester powder to a minimum thickness of 75 microns.

The pure polyester powder coating shall be got executed from specialized agency.

The pure polyester powder shall have following properties: -

- Free Flow-ability : Satisfactory
- Particle size : <50-70 microns suitable for electrostatic spray.
- Specific gravity: 1.1 to 1.5 depending on the colour.
- Self-life : 6 months.
- Stoving Schedule: 200⁰ C for 10 mins. (metal temp.)

Test Certificates from approved laboratory for the representative samples shall be submitted by the EPC Contractor. Testing will be done in presence of Employer's representatives at the cost of EPC Contractor.

The curing schedule shall be as specified by the manufacturer of pure polyester powder.

The surface of aluminum shall be prepared and pretreated as follows before powder coating: -

- Removal of all foreign matter.
- Chromatisation of aluminum surface as specified by the manufacturer of pure polyester powder by at least a five stage process consisting of alkali degrease, rinse and chromate conversion followed by two rinses.
- Proper curing at required temperature shall be done for specified time period so as to achieve the desired properties.
- The pure polyester coated surface shall be of uniform texture, colour and gloss and shall be free from cracks, warps and other imperfections.

13.2 Powder coating on Mild Steel:

Wherever specified the Aluminium sections, plates M.S and CRCA mild Steel plates and sections shall be powder coated in approved colour and shade with pure polyester powder of Berger / Interpon / Asian Paints / Nerolec coat to a minimum thickness of 75 microns.

The surface of steel shall be prepared and pre-treated as follows before powder coating:

- Removal of all foreign matter.
- Low weight Zinc Phosphate conversion treatment of M.S and CRCA
- mild Steel surface as specified by the manufacturer of pure polyester powder by at least a seven stage process consisting of oxide and scale removal, alkali degrease, rinse twice and Zinc Phosphate conversion treatment followed by two rinses. Last wash shall be from diluted acid and immediately after that powder coating process shall be started without wasting much time.
- Proper curing at required temperature shall be done for specified time period so as to achieve the desired properties.



- The pure polyester coated surface shall be of uniform texture, colour and gloss and shall be free from cracks, warps and other imperfections.

14.0 Polyurethane Painting:

PU paints matched to shades as per colour specifications shall be having good recognize make to ensure the quality and life of the product. PU paint applications shall be done in following steps or as instructed by the each manufacturer.

- **Surface cleaning:** Remove grease, oil and other contaminants by using a degreasing solvent using mechanical tools. Ensure that all the dust particles are removed by suction or air blast and surface is fully dry and cleaned.
- **Application of primer:** Stir the components thoroughly and then mix base and catalyst in proportions by volume as instructed in the product specifications to uniform consistency. Avoid agitation of mixing. Add 10 % thinner immediately before application. However additional thinner may be added if required to achieve a good workability. For Airless spray use any standard equipment having pump ratio 45:1. This requires an over coating interval of minimum one overnight and a dust free environment.
- **Application of the final finish:** Stir the base thoroughly and then mix base and catalyst by volume as instructed in the product specifications to uniform consistency. Allow the mixture to mature for 30 minutes and stir again before use and application. Apply using a conventional spray. Add 10 % thinner depending on conditions. Use any standard equipment at an atomizing pressure of 3.5 – 4.9 kg/cmsq. Two coats could be applied for a good result.
- **EPC Contractors are expected to provide the standard warranty and the invoices from the manufacturers.**

15.0 Photoluminescent signs:

All Photoluminiscent signs shall be procured from specialized agency providing signs with following specifications but not limited to:

Water proof Non corrosive

Withstand temperatures from -5°C up to 65°C .

Non-reactive to Dilute Alkalis and Acids.

Glow time in excess of 2 mcd/m² after 60 minutes

UV-stable and weather-resistant for outdoor applications.

Ability to absorb energy from almost any light source (sunlight, fluorescent, incandescent) and then to emit light when ambient darkness occurs.

The light produced is yellow-green in color and is highly visible, lasting up to 10 hours.



16.0 Retroreflective signs

High Intensity grade sheeting: A very-high-intensity retro-reflective sheeting having highest retro reflectivity characteristics at short road distances should be used. It should be weather resistant and exhibit colour-fastness. The sheeting should be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent waterproof plastic has a smooth surface.

Sheet of good quality manufacturers should be used.

16.1. Acceptable Minimum Co-Efficient of Retro-Reflection for High Intensity Grade Sheetting (Candelas per Lux per Square Meter)

Observation angle in degrees	Entrance angle in degrees	White	Yellow
0.2	-4	250	170
0.2	+30	150	100
0.5	-4	95	62
0.5	+30	65	45

When totally wet, the sheeting shall not show less than 90 percent of the value of retro-reluctance indicated in the table above 16.1. At the end of 7 years, the sheeting shall remain at least 75 percent of its original retro-reflectance.

Adhesives: The sheeting should have two types of adhesives.

1. Pressure sensitive adhesive of the aggressive tack type requiring no heat, solvent or other preparation for adhesive to a smooth clean surface.
2. Tack free Adhesive activated by heat, applied in a heat-vacuum applicator as specified by the sheeting manufacturer.

The adhesive should form a durable bond to smooth, corrosion and weather resistant surface of the base plate.

Fabrication: The surface to be reflectorized shall be effectively prepared to receive the retro-reflective sheeting. The alluminium sheet shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plan surface. If surface is not smooth, approved surface primer may be used.

Complete sheets of the material shall be used on the sign except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesive shall be overlapped not less than 5mm and sheeting with heat-activated adhesive may be



spliced with an overlap not less than 5mm or butted with a gap not exceeding 0.75mm. Where screen printing with transparent colour is proposed, only butt joining shall be used. The material should cover the sign surface evenly and shall be free from twists, cracks and folds.

All cabling/wiring/conduiting works etc. shall be in conformity to CPWD specifications & as per IE Rules with up to date amendments.



PACKAGE – H

WATER SUPPLY SYSTEM



A: HYDRO PNEUMATIC SYSTEMS

1.0 HYDRO PNEUMATIC SYSTEMS (Domestic, Flushing and Soft Water Transfer Pumps)

1.1 Hydro pneumatic systems (With Variable Frequency Drive for Domestic water supply, Flushing water supply and Soft water supply)

1.1.1 Scope & Components

1. The scope of this section covers compact packaged type skid mounted, self-contained variable frequency drive hydropneumatic systems, one hydropneumatic system working (2 nos minimum 50LPM each)+ one hydropneumatic system(1 nos minimum 50lpm) as standby.
2. The skid mounted, factory assembled hydro-pneumatic system shall be provided with pressure transmitters, frequency convertor for noiseless operation of the pump at varying duty point.
3. The convertor shall be provided with short circuit safety, earthing, over current, under voltage protection.
4. The pump shall be complete with suction and delivery pipe.
5. The system shall comprise of multiple pumps working and one stand-by to meet the system discharge requirements.

1.1.2 Specifications

It shall conform to the following specifications:

- (a) Pumps shall be vertical, multistage centrifugal and fulfills all specifications as specified in the Clear water pump section.
- (b) Pressure vessel shall be of non-corrosive FRP composite construction lined with NSF and/or FDA listed material, like high density polyethylene with fully replaceable polyurethane with air cell burst pressure of minimum of five times the vessel operating pressure with charging connections to discharge pipe line with necessary flanges, gaskets, isolating valve, nuts/ bolts etc. with suitable foundation bolts & other accessories, complete. Capacity provided shall be as per manufacture specifications.
- (c) Panel mounted microprocessor multi pump controller with large graphical display and variable frequency drive (VFD with each pump) with pressure sensor transmitter. The graphical display is capable to show number of pumps running & also communicate with other controllers following with open protocol through RS485 port. System should be capable to compensate for frictional losses at lower flows. All alarms should be displayed in the controller. The panel should also have provision for manual / automatic alternate (cyclic) operation of pumps, ON/OFF switch, dry run protection, inter connecting power and control cabling etc. complete.



1.1.3 Control Panel (For Hydro Pneumatic Systems)

The control panel shall be compatible with BMS system and terminals for:

Remote monitoring.

Pump fault.

Analog output signal for frequency convertor.

Pressure sensor / Pressure switches as per system requirement.

1.1.4 General Functions

The hydro pneumatic system shall be capable of maintaining a constant pressure at varied consumption.

The hydro pneumatic system shall be complete with pressure sensor and microprocessor based controller for flow control by means of frequency variation (in case of VFD operated system).

The controller should have time control switch to adapt pump operation to actual requirement in peak load situation.

The control panel should also have manual operation.

The pumping system shall perform the following functions:

Shut off the pump at zero demand.

Shut off the pump at zero suction (Dry Run protection).

Protect the pump from overvoltage, under voltage, overload & earth fault.

Vary the time of pump speed acceleration and deceleration.

Compensate for higher friction losses at high flow rates.

Send out a signal for remote monitoring of flow as well as pressure.

Conduct automatic test run of pumps at set time.

Keep track of run time for pumps.

Perform run time equalization of all pumps in system.

1.1.5 Installation

Hydro pneumatic systems shall be mounted on a common base frame & installed as per manufacturer's recommendations.

Pump sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting.

The vibration isolation pads, foundation bolts etc. shall be supplied by the Contractor.

Contractor shall ensure that the foundation bolts are correctly embedded.

Pump-sets shall be factory aligned, wherever necessary, site alignment shall be done by competent persons.

The entire system along with pumps & control panel must be sourced from single manufacturer only for unit responsibility.

1.1.6 Testing of Pumps

1. The pumps shall be tested according to the standard recommendations of the manufacturer.

2. The following parameters are to be recorded and plotted and submitted to AAI:



- a. Discharge Q
 - b. Pressure P or Head H
 - c. Motor voltage and current.
 - d. Efficiency
3. The power consumption is to be computed and cross checked with manufacturer's data.
 4. Any abnormalities, if noted, shall be brought to the notice of the manufacturer and necessary corrective action be taken before commissioning and handing over, without any extra cost.
 5. Manufacturers test certificates shall also be submitted to AAI for verification.

2 Level Switch In Water Tanks

The Contractor shall supply and install controller in the water tanks as indicated below and shown on the drawings.

Raw Water Tanks in Utility Block with some necessary requirement given below:

1. High level alarm (over-flow)
2. Low level alarm;
3. Low level cut-out for raw water pumps.
4. Earthing probe.

Treated Water Tanks in Utility Block with some necessary requirement given below:

1. High level alarm (over-flow).
2. Low level alarm.
3. Low water level cut-out domestic water pumps.
4. Earthing probe.

General Probe Requirements:

1. Each probe shall be of the correct length for the particular application and tank location.
2. Electrodes shall be of polished stainless steel 20 mm OD.
3. Electrode holders shall be weather proof in all respect.
4. The earthing probes shall be connected and wired to the building earth systems of the building.
5. The level switch set shall operate with a stepped down voltage at 24V maximum.



6. Stepped down transformers shall be provided for each set of control probes and shall be installed inside centralized control cubicles inside pump room.

B. SPECIFICATIONS FOR RO WITH DRINKING WATER FOUNTAINS

Manual double bubbler SS finish type recessed bi level drinking water fountain and one sensor based bottle filling system with 60 LPH Cooling capacity, chilling unit with tank with insulation, RO and UV along with sediment filtration 50 LPH RO system with 60 ltr, with Necessary housing of SS-316 steel body, as specified. Shall comply with ANSI 117.1 and ADA. GRIHA certified, TUV-SUD certified. Minimum Qty. 04 nos or more as per site requirements.

Drinking water fountains shall be wall hanging Double level drinking water fountain and shall have the following specifications & features.

Technical specifications:

1. Recessed bi level drinking water fountain, with double SS finish bubbler and one bottle filling station Drinking water fountain with 60 LPH cooling capacity, stainless steel body, approx.. size 1003mm X Depth 400 mm X height 1162mm SS bubbler guard operated between 50 to 120 PSI, chilling unit suitable for R134a refrigerant, adjustable thermo state, With MDCU29, supply complete with all accessories.
2. R-134a refrigerant.
3. Shall comply with ANSI 117.1 and ADA.
4. Shall be listed by Underwriters Laboratories to US and Canadian standards, GRIHA Certified (Green Rating for Integrated Habitat Assessment), TUV-SUD Certified ..
5. Shall comply with ANSI/NSF 61 and NSF/ANSI 372, with UV and sediment filtration along with 50 LPH RO system with 60 Ltr HTP Tank.

Features:

1. Drinking Water Fountain shall deliver required flow of 50 °F Degree water at 90 °F ambient and 80 °F inlet water temperature.
2. 2 nos Vandal Resistance antimicrobial copper MDCU29 push buttons to activate the water flow and low flow TUV certified SS bubbler.
3. Designed to eliminate the splashing water and standing water saver bubbler to reduce the water waste by 50% and shall have ss bubbler guard and operate between 20 to 100 PSI.
4. Key Aqua Pointe bottle filler component contain FRESHSHIELD which utilizes a silver-based antimicrobial compound that reduces the growth of micro-organisms and mildew to protect the surfaces from discoloration, odors and degradation.
5. Refrigerant R-134a



6 Touchless, sensor-activation, designed for easy use. MDCU29 Antimicrobial surface to prevent the growth of bacteria and microbes. Plastic water bottles saved from waste. Mechanical and sensor both activation for bottle filling station and Drinking water fountain. Meet the need of ADA Compliance- Physically challenged and the able-bodied.



PACKAGE – I

PA & Voice Alarm System(PAVA)

Technical Specification for Public Address and Voice Alarm System **(PAVA)**

1.0 GENERAL

1.1 The offered equipment shall be compact, fully solid state, highly reliable and shall use latest state of the art technology.

1.2 The design and selection of the equipment shall be consistent with the requirements of long term trouble free operation with highest degree of reliability and maintainability.

1.3. All equipment shall be manufactured to continuously operate safely without undue heating, vibration, corrosion, electromagnetic interference or any similar problems.

1.4. The equipment shall be designed for continuous operation (24 hours a day and 365-days a year). The design life of the equipment shall be a minimum of Five years.

1.5. This life shall be achievable through normal and regular maintenance.

1.6. All types of spares and spare modules of the offered equipment shall be readily available with the bidder during life-time of the equipment, for maintenance, repairs and up keep of the equipment during warranty & CAMC period, as per tender scope of work.

1.7. Equipment shall undertake and ensure implementation of its offered solution and shall keep its in view the safety and protection of personnel, during normal operation and maintenance or during malfunctioning of any equipment or its sub-component. This shall be ensured as an integrated feature of design, manufacture and installation of offered equipment by bidder.

1.8. Equipment shall ensure adequate protection to be included for ensuring safety of personnel from any possible hazards, including EMI radiation, high voltages, etc.

1.9. Equipment shall furnish the details of EMI and Safety Standards met by his equipment and built-in safety features.

1.10. The Equipment shall be constructed on a modular basis, using plug-in type units and components to the extent possible. Parts subject to failure, wear, corrosion or other deteriorations or requiring occasional inspection, adjustment or replacement shall be made accessible and capable of convenient inspection and removal.

1.11. Input and output termination of cables in offered equipment shall be properly labelled to permit ready identification of the incoming/outgoing wiring.

1.12. All interconnecting cables shall also be appropriately labelled to facilitate convenient interconnection and minimize chances of incorrect connection.

- 1.13. All connecting cables required to inter-connect the equipment shall be supplied as a part of the offered system. All cables shall be fully assembled, connector, reterminated and factory tested at the time of supply as part of overall system check.
- 1.14. Licenses: All Hardware system/component and Software supplied shall be licensed, as applicable, in favour of Airports Authority of India and valid for lifetime of the offered system.

1.15. Installation Standards

- a) Installation shall be carried out by technically well qualified and certified personnel as per the requirements.
- b) Contractors shall not outsource any part of the contract to any other vendor/third party contractor without prior permission of AAI.
- c) Liability, if anything, arising out of such third-party contracts to any other vendor by contractor shall be to the contractor's account.
- d) AAI shall not be liable on behalf of contractor to any other third-party contractor/Government of India/State/Regulatory Authorities.
- e) Any liabilities arising out of such third-party contracts by contractor or its men working at site shall be only to contractor's account and shall be deducted out of its running bills.
- f) Contractor shall submit Police Verification Certificates and obtain necessary Airport Entry Permits, for allowing its men to work at AAI restricted premises (If required).

1.16. RELIABILITY

To ensure high availability and high reliability, the offered equipment design by the bidder and its OEM partner shall employ the most suitable engineering techniques, materials and dependable components, field proven design and rigorous inspection during manufacturing to ensure a very high MTBO (Mean Time between Outage) and MTBF (Mean Time between Failure) of equipment.

2.0 ENVIRONMENTAL CONDITIONS

The Main Equipment's, Rack, Servers, UPS shall be installed in the control/Equipment room. Suitable size of control/equipment room with environment controlled, shall be made available in the Terminal building. 100% PA circuits shall be considered in UPS with minimum 30 min. back up capacity. The equipment shall maintain its guaranteed performance when operating continuously for 24 hours a day and 365 days a year without any deviation in quality or degradation of system performance and all the parameter detailed in these specifications shall be guaranteed over the following environmental conditions:

- 2.1 Equipment Operating Temperature: 0 degree to + 40 degree Centigrade. Relative Humidity: 90% up to 35 deg centigrade. Storage Temperature: 0 to + 45 degree Centigrade.

3.0 SITE ACCEPTANCE TEST (SAT) & COMMISSIONING

- 3.1. It shall be the responsibility of the bidder to submit the system test procedure for conducting the post-installation site acceptance testing. The procedure submitted by the bidder firm shall be drafted in line with the standard practices followed in the industry and shall be in accordance with the test procedures. The acceptance test procedure on approval by AAI shall become the document for acceptance of the equipment after installation at the site.
- 3.2. The draft copy of system test procedure shall be made available to AAI before THIRTY calendar days of the schedule site acceptance date.
- 3.3. The bidder shall supply, install, test and commission all hardware and software as per the requirement of the tender with the system. Bidder shall supply technical documents (hard and soft copy - one set each) at site. The system shall be commissioned after successful completion of – SAT approval, operational & maintenance training and all the works under the scope of the tender.

4.0 PATENTS, LIABILITY & COMPLIANCE OF REGULATIONS

- 4.1. Bidder shall protect and fully indemnify AAI from any claims for infringement of patents, copy right, trademark or the like.
- 4.2. Bidder shall also protect and fully indemnify AAI from any claims from bidder firm's workmen/ employees, their heirs, dependents, representatives, etc. or from any other person(s) or bodies/ companies, etc. for any act of commission or omission while executing the order.
- 4.3. Bidder shall be responsible for compliance with all requirements under the laws and shall protect and indemnify AAI completely from any claims/penalties arising out of any infringements by bidder firm or its workmen / employees.

5.0 PUBLIC ADDRESS & VOICE ALARM SYSTEM (PAVA)

A centralized Public Address & Voice Alarm System will be used to broadcast General Announcements - both manually and automatically to all areas of the facility and, Flight and Passenger Voice Announcements, and Background Music to Public Address Zones. The specified system shall be continuously supervised, monitored and automatically adjust the announcement signals sound level(s) relevant to the facility ambient noise. The specified system shall be integrated with the facility Telephone system enabling programmed facility DTMF (Dual tone multi frequency)/VOIP telephones to access and make emergency announcement through PAVA system. The system shall be network based and shall operate over standard Ethernet topology using common switch components for both audio and control signals. System field devices such as microphone stations, amplifier mainframes, Ambient noise collectors, logic I/O collectors and Monitor/Test collectors shall be Ethernet network based and shall connect to a dedicated VLAN of the house network through local Telecommunication (TC) rooms. Location of VLAN of the house network and type of communication establishment to be followed as per system design provided under IT and IP EPABX packages.

5.1 LIFE SAFETY CODES, STANDARDS & REGULATIONS

The proposed PAVA system equipment shall be certified by Recognized test laboratories & comply with any of one in the following life safety & voice alarm codes & standards.

- a) EN 54-16: Voice alarm control and indicating equipment.
- b) EN 54-4: Power supply equipment.
- c) EN 54-24: Components of voice alarm systems, Passive Loudspeakers.
- d) IEC 60849:1998 Sound systems for emergency purposes.
- e) BS 5839-8:2013, Code of Practice for the design, Installation, Commissioning and maintenance of voice Alarm Systems.
- f) BS 6259: 1997, Code of practice for the design, planning, installation, testing and maintenance of sound systems.
- g) DIN VDE 833 Part-4 requirements for voice alarm systems in case of fire, Evacuation.
- h) IEC 60268 -16: 2011, Objective rating of speech intelligibility by speech transmission index.
- i) ISO 7240-16:2007, Sound System Control & Indicating Equipment.
- j) ISO 7240-19, Design, Installation, Commissioning & service of Sound system for Emergency purposes.
- k) EN 54-17: 2005, Fire detection and fire alarm systems Short-circuit isolators.
- l) NFPA 72:2013 National Fire alarm and signaling code.
- m) NFPA 101:2012 Life Safety Code.
- n) PH120 as per clause 26.2 BS 5839-1 of Circuit Integrity PH120, LPCB, Fire survival armored cable.
- o) IEC 60065: Audio, Video and Similar electronic apparatus – safety requirements.
- p) Approval from the AHJ & associated Civil Defence/Fire Dept. as applicable in the geographical region of the project.

5.2 ABBREVIATIONS

- AAS - Automated Announcement System
- CAN - Airport Communication Network
- AHJ - Authorities Holding Jurisdiction
- AODB - Airport Operational Database
- AVC - Automatic Volume Control
- BMS-Building Management System
- BSI - British Standards Institute
- CPU - Central Processing Unit
- dB – Decibel
- DSP - Digital Signal Processor
- EN - European Norm
- FACP - Fire Alarm Control Panel
- IEC - International Electro technical Commission
- IP -Internet Protocol
- ICD -Interface Control Document
- ISO- International Standardization Organization
- LAN -Local Area Network
- MTBF -Mean time between Failure

- MTTR- Mean time to Repair
- NFPA -National Fire Protection Association
- NTP -Network Time protocol
- PAVA- Public Address & Voice Alarm System
- SPL -Sound Pressure Level
- STI- Speech Transmission Index
- SNMP -Simple Network Management Protocol
- TCP/IP- Transmission Control Protocol/Internet Protocol
- TER - Telecommunication Equipment rooms
- UPS -Uninterrupted Power Supply
- V-LAN -Virtual Local Area Network
- VE -Voice Evacuation
- WAN -Wide Area Network
- AA -Automatic Announcement
- CA - Central Announcement
- DGA - Digital Gate Announcement
- DGAC - Digital Gate Announcement Client
- QS - Queue Server
- QC - Queue Client
- ASS - Announcement Synthesis System
- AST - Audio Streaming Server
- URL- Uniform Resource Locator
- GUI - Graphical User Interface
- IATA - International Air Transport Association
- PAX- Passengers

5.3 PERFORMANCE REQUIREMENTS

- The system shall be based on distributed or centralized architecture with DSP control units processing digital audio with routing & switching features at the telecom equipment rooms. The DSP control units located in telecom equipment room shall have integrated synchronization for Audio & Control data via the LAN network.
- There shall be no single point of failure as the system should have backup unit for amp and controller.
- The DSP Control unit must have high MTBF parameters with a minimum of 250,000 hours of MTBF specified for continuous & uninterrupted operation.
- Loudspeaker type & position shown on the drawing are indicative. The contractor shall be required to provide a 3D acoustic modelling & simulation in all the typical areas of the terminal building to determine the STI & SPL results expected for approval of Engineer In charge (E.I.C) during the detailed design stages. Each Loudspeaker type, location & mounting height shall be coordinated with Architectural and Interior Design Consultants.
- The Contractor shall be responsible to ensure that the proposed Loudspeaker type & location shall deliver the specified speech intelligibility index.
- The PAVA sub contractor shall provide 3D Acoustic Modelling & Simulation for the typical areas of the AAI for the pre-emptive prediction of Speech Transmission Index.

The sub-contractor may utilize any one of the following software tools with latest available versions for the Acoustic Modelling & simulation works.

- Ease - AFMG, Germany
- Ulysses - IFB Soft, Germany
- Catt-Acoustic CATT, Sweden
- Odeon Bruel & Kjaer, Denmark

5.4 SCOPE OF WORK

The contractor must employ a specialist voice alarm sub-contractor with adequate number of manufacturer certified engineers & technicians for the supply, installation, configuration, testing, commissioning & maintenance of an integrated high performance public address & voice alarm (PAVA) system equipped with features for the broadcast of live announcements, prerecorded messages, emergency evacuation messages & automated flight announcements. The system shall be equipped to broadcast back ground music signals in certain areas of building as per operational requirement of AAI. The system shall be designed & configured to deliver high performance digital audio with high speech intelligibility in all the areas of the Terminal Building etc. The contractor has to hire a third party acoustic consultant for PAVA to vet the design of system as per tender requirement before start of execution/submission to AAI. The contractor scope of work is a turnkey solution with responsibility for fully provisioning for PA system including design, supply, installation, configuration, testing, commissioning, & maintain the following equipment (s):

- a) PA Speakers.
- b) Acoustics Analysis from OEM/SI must provide the required details of their system.
- c) TCP/IP PA Controller.
- d) TCP/IP Class D Multi-channel Amplifiers/Amplifiers with TCP/IP based controller, automatic single/multi-channel, channel backup switching complete.
- e) Digital Microphone Paging system based or Digital Microphone Paging system direct connectivity controller.
- f) Server /Workstation based Automatic Flight Announcement.
- g) Ambient Noise Analysis System with digital signal processing technique including Noise Sensing Microphone.
- h) Background Music sources.
- i) Circuit Integrity PH120, LPCB, Fire Survival Cable as per specification enclosed.
- j) Public Address software integrate with Digital Automatic Announcement system.
- k) 19" Rack height should be considered with 10% extra from the actual site requirement with Cable manager, required no. of Trays, Fan, Wheel, gland plate, cable glands, ferrule, thimble, lugs, cable tie, cable /equipment dressing material complete as required.
- l) Server/workstation as required.
- m) Public Address system should be so that it can integrate with Airport Common LAN network for distributed architecture.
- n) UPS power supply.

- o) Supply, Acoustic analysis, Installation, Integration, Testing, Commissioning& maintaining the system during DLP complete.

5.5 INTERFACE OF PUBLIC ADDRESS SYSTEMS WITH FOLLOWING SYSTEMS/EQUIPMENT'S

- VOIP/DTMF Telephone System.
- Automatic Announcement system.
- Flight Information Display System or Automatic Flight Announcement System.
- Fire Alarm System to ensure PA system sources (BGM and Flight Announcements) are muted in the event of an Emergency/Fire Alarm trigger and that emergency messages are played in affected/ all zones.

5.6 SYSTEM ARCHITECTURE

The basis of design of this system is a networked distributed/centralized scheme intended to provide maximum flexibility and high performance. Different system architectures may be proposed if it can be proven to provide same or better features, performance, operational effect of equipment failure, flexibility for future expansion. Contactor shall include all costs for differences in hardware, cabling, and conduits caused by different system architectures.

5.7 TERMINAL BUILDING PA SYSTEM

- 1) The Terminal Building PA System for the announcements should be divided to multiple Zones.
- 2) The Terminal Building however should be divided initially in to Zones as given below but the system shall be scalable enough to accommodate additional zones by addition of amplifier's in future. The terminal building drawing including indicating the areas for providing PA system indicating the area where 1017 has to be provided.

Z1	Public Concourse, Curb Area city side
Z2	Check In Area & Pre security Hold area
Z3	Security Hold area
Z4	Departure VIP Lounge
Z5	Arrival Baggage Claim & Break-up Area
Z6	Service Area & Baggage make-up Area

In the above zones announcement could be made either individually or to all zones or a group of zones. Suitable marking should be provided in the announcement consoles for identifying the Zones. By selection, the user should be able to transmit announcement to particular Zone or zone groups in the terminal building.

- 1) The Terminal Building PA system should have system priority as under:
 - a. Fire announcement / alarm:1 No. with 1st priority
 - b. Airport Manager's office: 1 No. with 2nd priority
 - c. PA System Control Room: 1 No. with 3rd priority
 - d. Check-in area: 4th priority only for local announcements

- e. Security Hold Area: 5th priority only for local announcements
 - f. Arrival Hall and Baggage Claim Area: 6th priority - only for local announcements
- 2) In addition to the above; the system shall be scalable for installation and upgradation of new zones and more announcing stations. The system should also have in-built provision of playing music & manual announcement and pre- recorded announcements.
 - 3) Priority should be user programmable.
 - 4) The system should also be able to play different BGM (background music) in different zones. Normally music should be played through speaker network in all the selected Zones/ areas. However, the system should automatically override music of the relevant zone for announcements to be heard. The announcements should not interrupt BGM (Back Ground Music) in other zones than the ones being paged.
 - 5) The distribution network in the control room should receive the input signals from paging consoles/Stations and music input, and processes, then distribute it through speakers. Digital Signal Processing techniques should be used for equalization (RTA based) in the halls. Microphones meant for Noise sensing should be installed in various locations of the terminal to get noise level to regulate the volume in that area automatically and maintain signal to noise ratio about 10dB to 15dB while maintaining a minimum of 65dB and a maximum of 85dB SPL with + or - 3dB variation over 90% of each zone. The PA system shall allow modification of these parameters to set to desired levels as per site requirements. The system, in evacuation mode, should be able to override all settings and work in a pre-configured setting, including announcement level.
 - 6) The PA system shall have the ability to accurately differentiate between ambient noise and actual program material to vary the attenuation only based on ambient noise. In event of failure of noise analysis system, shall reset the paging levels in affected zone to pre-set levels. OEM must confirm on their Letter head / Data Sheets that proposed NSM (Noise sensing Microphone) are meant for the required purpose and not for Public Addressing purpose. For announcement purpose, microphone should be provided to ensure maximum isolation from the ambient noise so that the system delivers highly intelligible announcements and paging. In addition, the system should be capable to connect two or more NSM (Noise sensing Microphone) in one zone and should be monitor-able with the system logs.
 - 7) AGC (Automatic gain Control) and AEC should be provided in all zones where NSM's (Noise sensing Microphone) to be installed to maintain the sound level automatically in all the public announcement areas of the terminal of the terminal building. This should be programmable for day and night and should work automatically with Schedule or calendar logic once it programmed.
 - 8) DSP/Controller shall have separate logic Processing and Logic objects, which should be freely programmable to make any kind of logic circuits using digital logic components (gate, truth tables, counters & comparator).
 - 9) DSP shall have Speech sense feature to enhance the quality of announcement.
 - 10) The network control unit shall have extensive audio processing possibilities for audio inputs and audio outputs. 24 band parametric equalization, limiter, and gain can be adjusted with the configuration software.
 - 11) System shall be capable to handle +5V unloaded logic output voltage up to 6 connections to give visual LED indication for master paging operator for successful announcement notification.

- 12) Loudspeakers should be provided to ensure essentially uniform distribution of sound meeting +/- 3dB uniformity in more than 90% all the Passenger/Visitor and staff areas as required. In offices, VIP room, CIP room, restaurant etc., cabinet speakers with volume control should be used.
- 13) In the equipment room, all speakers' cables should be terminated in the main junction box and should be clearly marked with cable ferrules.

5.8 DESIGN PARAMETERS AND FUNCTIONALITY REQUIREMENTS

The system should be capable of delivering distortion free audio output and Intelligibility meeting the target criterion of measured STI PA of minimum 0.5 or more in more than 90% of all the public area zones where the announcements are made.

- 1) The system should allow an undistorted speech reproduction of 75db (peak up to 85db) SPL at listening level. The system should also provide uniform coverage within +/-3dB across more than 90% the entire area of all public zones of the terminal for the octave band 125Hz to 8 KHz. However, the integrator shall tune the system and make use of equalizer, crossover and other available signal processing capabilities of system to optimize the system performance. The frequency response of the PA system DSP/Controller and amplifiers should be 20HZ to 20 KHz (+/- 3 dB).
- 2) All Data of the System Integration Criterion shall be verified by Engineer In-charge. The bidders should use calibrated Acoustical measuring equipment to satisfy the system integration criterion to the AAI Engineer In- charge as given in the tender document. Engineer In-charge would do the technical assessment of the system integration and all bidders should extend full cooperation to the AAI technical team. The system should be of programmable matrix type for sound system management and control having modular structure for future expansion and up gradation to increase the zones as may be required.
- 3) The offered system should support broadcasting and routing of the digital announcements by automatic announcement sub-system that is external to the PA system and should have necessary provision for input as well as processing the announcements. The system should have appropriate no's potential free Analogue and Digital signal inputs for external audio feed.
- 4) The system architecture should be such that it allows for future expansion. The system should be modular for ease of maintenance.
- 5) The system should be programmable to provide for selection to allow a certain type of announcement to be routed to a specific zone in the terminal (such as fire, emergency etc.). The system should support minimum two announcement consoles in the control room/studio and also multiple remote announcement stations as may be required.
- 6) The system should have a provision for playing continuous soft background music round the clock in all public areas of the airport terminal with music level of 55-60 dB SPL max value should be maintained. For inviting attention of announcement a pleasing chime should precede every announcement. The tone of the chime should be programmable to be different for emergency announcements. The music should cut off during the announcements.
- 7) The PA system should support the broadcasting and routing of the alarm / speech generated by fire detection and alarm system (an independent system) with provision for connecting audio line for processing.

- 8) Reverberation time of each zone in the terminal should be considered and the Electro acoustical adjustments should be carried out to achieve the target criterion of measured STI PA 0.5 or more in 90% of each zone in all the public area where the announcements are made.
- 9) The system integration should take in to consideration the height of the ceiling at various places critical distance and directivity factor of the loudspeaker system.
- 10) Utilization of the zones as per traffic and distribution of loudspeaker system respectively.
- 11) Capacity of amplifiers and the distribution network requirement with maintaining 6dB head room minimum.
- 12) Peak hour occupancy of the spaces in different areas.
- 13) Provision to avoid echo during announcement a suitable feedback suppressor/AEC and audio processor should be used in the system integration as may be required depending on the analogue or digital interface.
- 14) Amplifiers to give distortion-free announcements with minimum 6dB SPL headroom.
- 15) Provision of pink and white noise and test tone generator for testing the system should be provided to calibrate the system as may be required.
- 16) Monitoring facility through speaker for individual amplifier output should be provided in the PA Rack.
- 17) Facility for switching ON and OFF of the music from equipment rack to be given.
- 18) The control system should have total access matrix, completely programmable and expandable having several inputs and outputs, each input can be directed to one or more outputs according to the configuration and the priority levels defined.
- 19) The control system is to be of modular structure which can be assembled as per functions desired and subsequently expanded for future requirements.
- 20) The control system should be easily configurable and programmable through external PC.
- 21) The system should have facility for selective call for different zones with provision of avoiding priority conflicts.
- 22) Automatic pre-recorded announcement system shall be used for general announcement information in form of pre-recorded messages in Hindi, English and local language. However, there should be provision for manual announcement. For the manual announcement professional microphones mounted on the announcement consoles should feed the distribution system controller. Each announcement console should be provided with zone selection button(s) that should be programmed to route the microphone inputs to one or several power amplifiers. These amplifiers in turn should feed the loudspeakers located in the geographical and / or functional zones with background music or announcements. However, the local announcement consoles installed in the terminal building should be programmed to automatically route the announcements originating from these local announcement consoles to the corresponding local area only.
- 23) Controller and Audio Power amplifier shall be from same make/OEM.

5.9 TECHNICAL SPECIFICATIONS OF EQUIPMENT/ ITEMS

All materials and equipment shall conform to the relevant Standards and shall be of the Preferred make. Deviation, if any will be highlighted by the tendered at the time of submission of tenders.

5.9.1 TCP/IP DIGITAL SIGNAL PROCESSOR OR CONTROLLER (DSP)

- a) The control unit is the heart of the public-address system & shall be capable of routing audio channels, fault reporting and controlling of the system. Unit shall be configured in 1+1 standby configuration with automatic changeover from Main controller or processor to Standby controller or processor in case of failure of Main controller. This unit can work either in stand-alone mode or with a PC connected to it. The PC connected to the network controller unit shows all status changes in the system with the configuration and diagnostic & logging software.
- b) The unit can be installed freestanding on a table top or mounted in a 19" rack.
- c) There shall be control inputs, which should be freely programmable. These can be programmed for actions to be done in the system and assigned priorities.
- d) The network controller shall have analog audio line Inputs for fire alarm signals, music sources etc.
- e) The network controllers/system shall have the capability to handle at least 20 levels of priorities and 50 zones or more, 20 call stations or more.
- f) The network controller shall monitor the status of all Zones in the system and report status changes.
- g) Attention and alarm tone definitions shall be stored in the network controller or recalled from an external storage device through control ports. These tones can be accessed by any call stations or control inputs for announcement broadcast or alarm broadcast.
- h) The network control unit shall have extensive audio processing possibilities for audio inputs and audio outputs. Parametric equalization, limiter, and gain can be adjusted.
- i) Technical Specifications:
 - i. Frequency Response: 20 Hz to 20 KHz (+/- 3 dB).
 - ii. Distortion: <.05% @ Full Bandwidth (20Hz -20kHz).
 - iii. Display: Front LCD /Display/LED indicator for Input/ Output/ Fault Monitoring/Programming.
 - iv. Interface: Ethernet for PC connectivity, Systems connection for call station/Amplifier on Fiber/ CAT-6A/CAT 5.
 - v. The network controller/DSP shall have standby working controller for digital audio network unit also like Cobra Net, Dante etc.
 - vi. DSP should have RS 232 port for integration with other System.

5.9.2. Digital CLASS D MULTICHANNEL POWER AMPLIFIERS

- a) The main function of the power amplifier is the amplification of audio signals for the loudspeakers. It shall be possible to select the output voltages of 70 or 100V. The power amplifiers are provided with a LCD/Display/LED indicator for fault monitoring and status display. The amplifier should be either single or multiple channel amplifier as per requirement of zone.
- b) The Power amplifier should be capable for being monitored from the Central location in the Control room through Computer software.
- c) The equipment shall be 19" rack mounting.
- d) The amplifier monitoring and changeover facility shall be realized through the means of a dedicated switching unit or shall be incorporated within the power amplifier. In case of failure of any working amplifier, the standby amplifier shall automatically come in the circuit. Each amplifier cluster shall comprises of multichannel amplifiers +1

backup amplifier channel /amplifier. The changeover from primary to backup and backup to primary amplifier shall be automatic without any human intervention.

- e) Technical Specifications
 - i. Frequency Response: 20 Hz to 20 kHz (+/- 3 dB)
 - ii. Amplifier Type: Class D
 - iii. Total Harmonic Distortion: <0.5%@ 20Hz to 20kHz
 - iv. Display: Front LCD LCD/Display/LED indicator or indicator for status and Fault Display.
 - v. Power Wattage (rms): >200W for each channel.

5.9.3. AMPLIFIER RACK

- a) All the control equipment and the power amplifiers shall be mounted in these standard 19" racks. The racks shall be located not less than 750 mm clear from the wall of the equipment room and shall have Cooling Fan, Mains panel On/OFF with required MCB and interconnectivity. If two or more racks are required, the racks shall be mounted side by side and bolted together.
- b) All audio inputs and inter-connections shall be made with approved shielded cable and plug connections. Output connections may be screw terminal type. All power supply connections shall be provided with ISI approved plugs.
- c) All inputs, outputs, inter-connections, test points shall be accessible at the rear of the equipment rack(s) for testing and maintenance. Each item of equipment shall be readily removable from the rack without disturbing other items and/or connections.

5.9.4. CONTROL WORKSTATION

- a. The control workstation shall be used to control, program and monitor the complete Digital Public address. Using the control software, it should be possible to program audio routing, amplifier level, music level, AVC, equalization, Call station microphone level, Chime tones, pre-recorded message, alarm inputs, define zone, priority level etc. It shall also be possible to view all systems operational and alarm/fault events log. The software should show log all announcement details with time, zone etc., amplifier failure, automatic amplifier standby status, amplifier overload/short circuit/ground short, main failure, system restart, call station error/disconnection etc.
- b. Control Software along with workstation of minimum configuration for complete administration:
 - i. Intel Core i7 or better processor,
 - ii. 8GB RAM or higher,
 - iii. 500 GB HDD or higher, DVD RW,
 - iv. 19" LCD Monitor,
 - v. Dual Network Interface Card-10/100/1000 MBPS
 - vi. Keyboard/Mouse,
 - vii. Sound card & Speakers.
 - viii. Including all licenses of Windows, antivirus etc. valid up to life time as required.

5.9.5. DESKTOP TYPE DIGITAL CALL STATION

- a) The call station is used for making a manual or pre-recorded call to location or executing a predefined action. The call station shall have a gooseneck or handheld microphone to transmit speech over the network and a press-to-talk.
- b) Desktop Type Digital Call Station (CAT6A/better or fiber connectivity) with keypad or with touch-screen, configured for zone selection facility for local or zonal announcements along with high quality gooseneck or handheld type microphone.
- c) The call station unit should be capable of extending the number of zones/facilities realized by addition of modules and/or through software programming.
- d) The call station shall have 10 or more freely programmable buttons or a touch- screen and a dedicated press-to-talk key to make a manual or pre-recorded announcement to any pre-assigned zones or executing a predefined action.
- e) The Paging station shall be powered locally or through Power-over Ethernet (PoE).
- f) The Paging station shall have CAT6A/better or Optical connectivity for audio transmission, control and monitoring.
- g) The call station shall be scalable and shall allow addition of keypad module/Buttons if required in future.
- h) It should be possible to program different priority level for different announcement calls.
- i) The call station keypad keys or the touchscreen user interface can be programmed for the following actions:
 - 1) Control system functions: live speech call, BGM off, BGM volume control.
 - 2) Select resources: BGM selection, pre- recorded message selection, attention and alarm tone selection.
 - 3) Zone selection, system control output selection.
- j) The call station must show BUSY- indication as per priority announcements.

5.9.6 NOISE SENSING MICROPHONES

Noise sensing microphones should be installed in all passenger movement zones. These noise sensing microphones should have hemispherical polar pattern with a support construction including mounting rod and/or junction box suitable for mounting on the ceiling/wall. The noise sensing microphones should sense the ambient noise level in the area in which they are installed. The average of this noise level, should be sampled continuously by the automatic gain control (AGC) circuit/algorithm for adjusting the output of its associated power amplifier in such a manner that the audio output from the corresponding power amplifier during the announcement is held at 10dB to 15dB above the ambient noise level in that area as may be required. These sensing microphones of each area should be connected through shielded microphones cables to the corresponding controller/DSP installed in control room equipment rack.

5.9.7 CEILING MOUNTED SPEAKERS (TYPE 3)

- a) The lower ceiling areas shall be supplied with Recessed Ceiling loudspeakers with a metal dome. The speaker is made up of metal housing, equipped with UL1480, UL2043 or (NFPA 90, /NFPA 70 /EN54) rating. The ceiling loudspeakers shall be rated for 6 watts output power, with an integrated 100V line matching Transformer with multiple taps.
- b) Power Handling: 9W peak

- c) Rated Power: 6Watts or better.
- d) Power Tapping: 70V 6/3/1.5W @ 100V/70B.
- e) Effective frequency range (-10 dB): 100 200 Hz to 18000 kHz
- f) Driver Sensitivity: 92 dB
- g) Opening Angle 2KHZ: 110 degree or better.
- h) Should have bare wire connection for easy installation
- i) Speaker Driver: (5 in) or better.

5.9.8. 30 W HORN LOUDSPEAKER WITH IP 65 RATING (Type 4)

- a. Wall mount Horn loudspeaker with all mounting bracket supplied by same OEM of speakers. The loudspeakers shall be rated for 30W watts output power, with an integrated 100V line matching Transformer with multiple taps.
- b. Should have Full-Range Driver 3.5" diameter
- c. Rated Power: 30 Watts, Power Tapping: 30/15W @ 100V/70V
- d. Effective frequency range (-10 dB) 50Hz to 5kHz Voice Band
- e. SPL at rated power : 115 Peak @ 1M
- f. Cabinet Material Rated : ABS
- g. Outdoor Capability : IP65

5.9.9 20/40 W LINE ARRAY PASSIVE COLUMN LOUDSPEAKER -OUTDOOR RATED (Type 2)

Wall mount passive line array loudspeaker with all mounting bracket supplied by same OEM of speakers. The loudspeakers shall be rated for 60W watts output power, with an integrated 100V line matching Transformer with multiple taps, speaker shall be NFPA 90 & NFPA 70 / EN54:24 rated.

- Should have Eight or more 2" or better Drivers
- Rated Power: 60Watts or better tapping at 100V
- Effective frequency range (-10 dB 300 Hz to 15 kHz
- SPL at rated power: 115 dB Peak @ 1M
- Opening Angle: 250 H x 52 V degree @ 1 KHZ
- Cabinet Material Rated: Fiberglass reinforced ABS cabinet UL94-5VB
- Outdoor Capability: IP-65

5.9.10. UPS

The specifications of UPS for PAVA system shall be as per technical specifications of online UPS minimum 5 KVA (1+1) redundant system with SMF batteries 30 minutes of backup with each UPS.

5.9.11 FREQUENCY RESPONSE OF THE SYSTEM

The PA system should be integrated so that it is capable to deliver all frequencies in the range of 20HZ to 20 KHz +/-3 dB in more than 90% area of each passenger zone. However, the integrator shall tune the system and make use of equalizer, crossover and other available signal processing capabilities of system to optimize the system performance.

5.9.12 TESTS TO BE CARRIED OUT BY THE TENDERER

The successful bidder shall carryout several tests to determine the quality and the performance of the installed sound system. These tests should be carried out in all the indoor passenger circulation zones of the building using professional measuring test equipment. All the necessary test equipment required for measuring the various acoustic and electroacoustic parameters should be arranged by the tenderer and shall not be provided by Airport Authority. A computerized test report showing the measured values for the various acoustic parameters in all the zones should be submitted by the tenderer, failing which the work would not be treated as complete.

The Bidder shall submit the measurement tool calibration certificate before the testing to the AAI and measurement tool should comply the IEC/BS standards

The different tests should be performed by the tenderer to ascertain the audio quality, intelligibility, function and performance of the system should be as under.

Sound Pressure Level (SPL) of all zones in different areas.

- i. Intelligibility Tests of all zones in different areas.
- ii. Reverberation Time of all zones in different areas.
- iii. RTA of octave band 125Hz to 8 KHz at +/- 3 Db.
- iv. Any other relevant test as may be required by AAI for assessment of the PA system and its performance of all zones in different areas.

Note: All the tests should be measured in the presence of the AAI Engineer-In-charge and should be carried out to the satisfaction of AAI Engineer In- charge. If necessary AAI team may ask some additional STIPA through STI & RTI measuring instrument, to carried out to evaluate the performance of the audio system installation. All the above measurements shall be verified by the Airport Authority of India by their own equipment or third party measurements shall be performed for verification of acoustical consultant from bidder side.

5.9.13 GUIDELINE FOR REVERBERATION TIME MEASUREMENT: STI

The tenderers are required to measure the RT60 (reverberation time) of all the Zones and submit the following:

- a) Name, Model Number, calibration certificate & accuracy of the equipment's used to measure the RT60 should be submitted in tender.
- b) Measurement report of the RT-60 measurement to be submitted to the Engineer in charge.
- c) The Reverberation Time (RT-60) to be measured at the following frequencies:
 - i. 125Hz
 - ii. 250Hz
 - iii. 500Hz
 - iv. 1 KHz
 - v. 2 KHz
 - vi. 4 KHz
 - vii. 8 KHz

5.9.14 GUIDELINE FOR STI MEASUREMENT:

Measured data of the STIPA of all the Zones at 6 (Six) locations in each Zone to be submitted to AAI as and when the halls are ready.

- a) STIPA at Listener location 1 –
- b) STIPA at Listener location 2
- c) STIPA at Listener location 3
- d) STIPA at Listener location 4
- e) STIPA at Listener location 5
- f) STIPA at Listener location 6 –

5.9.15 GUIDELINE FOR RTA MEASUREMENT:

Frequency Response curve at Six-listener zone to be measured & submitted.

5.9.16. GUIDELINE FOR SPL MEASUREMENT:

Total SPL shall be measured for all the passenger zone and submitted to AAI (Six location per Zone), SPL result should meet the System Design requirement.

6.0 SUBMITTALS

6.1 3 D mapping of the Zones as specified below shall be approved before starting the work to AAI/PMC. The name of the software used for this simulation should be clearly mentioned in the documents submitted by the bidder.

- Check In Area Z3
- Security Hold Area-Z4
- Baggage Claim Area and Arrival –Z5

6.2 Bidder shall have to achieve following parameters in 3D simulations

- STI should be 0.5 or better in 90% of the area
- Total SPL @ 1KHZ and 2KHZ should be 85dB or better with +/- 3dB in 90% of the area
- Total SPL @ 4KHZ and 6200 HZ should be 85dB or better with +/- 3dB in 90% of the area.
- Total SPL@ 250 HZ to Broadband should be 85dB or better with +/- 3dB in 90% of the area
- 50dB Noise should be considered for the simulations.

6.3 After successful completion of the computer simulation as per the parameter given below in this document, the bidder shall pack the project and submit the packed project file (in a CD) created on the simulation software. The bidder shall use commercially available software to do his 3D computer simulation. The packed project file should be importable in to the other commercially available software to evaluate and scrutinize by AAI/PMC.

6.4 Schedule finishes of materials data Approved by AAI for the purposed terminal building and allied structure shall be for 3D Audio simulations.

6.5 Product data sheets.

6.6 Layout plans with loudspeakers placement, NSM (Noise sensing Microphone) and paging stations location.

6.7 Block Schematics with redundancy and zone details,

6.8 Rack equipment's layouts.

6.9 Electrical load details with heat dissipation.

6.10 Fire alarm interface document.

PACKAGE – J

Fire Survival Cables

Fire Survival Cables

1.0 Specifications & Scope of Work:

- 1.1 Fire survival cable covers supply, laying & making end terminations as required as per the site conditions including testing & energizing all circuit cables.

Fire survival armored cable shall copper conductor, mica tape wrapped cross linkable zero halogen insulation, cores laid up together zero halogen inner sheathed GI wire strip armored zero halogen outer sheathed fire survival cables confirming to IEC-60331/BS 6387.

Insulation of armored cables shall be with cross-linkable low smoke halogen free inner & outer sheath should be extruded with LSZH(low smoke zero Halogen) polymer.

1.2 Cables laying:

Cable & conduit shall be laid as per CPWD specifications. Armored cable shall be laid on surface/cable tray, if cable is selected as un-armored, the same has to lay with protection either with-conduit or covered raceway.

Conductor size – Shall be selected as per load requirement/manufacture recommendation. However, conductor size shall not be less than 1.5 mm².

1.3 Testing:

The cable should meet fire performance circuit integrity test as per BS6387.

Note: The above specifications of the cable shall also be applicable for the PAVA System, Fire Alarm System & any other services where fire survival circuit integrity cables are required.

SCHEDULE- K
MISCELLANEOUS ITEMS

AUTOMATIC BI- PARTING (2 LEAFS) SLIDING DOORS

This section covers the requirement of Automatic Bi- Parting (2Leafs) sliding doors in modular design including internal cover to be provided on all passenger exit & entry in Passenger Terminal building excluding staff gates of minimum Qty. 04 nos or more quantity as per site requirements and as per approved drawings & specifications mentioned below:

Specification:

- **Opening Size:** minimum 2800mm(W) x 2400mm(H)
- **Control:** Microprocessor control unit.
- **Drive:** EC drive
- **Electricity:** Suitable for $230 \pm 5\%$ volts, single- phase, 50 Hz.
- **Safety:** Glass shutter shall have electromagnetic locking arrangement.

Other features: adjustable parameters for opening and closing speed, hold- open time, opening and closing force, high performance DC motors, night lock, safety sensors, inbuilt battery backup in controller profile section for emergency opening/closing in case of power failure, automatic reversing function with adjustable reversing pressure. The doors open automatically, if it meets an obstacle during closer.

AIR CURTAIN

This section covers the requirement of Air- Curtain for Passenger exit & entry in Passenger Terminal building excluding staff gates of minimum Qty. 8 nos (4 feet each) or more quantity as per site requirements and as per approved drawings and specifications mentioned below:

Specifications:

Size & type: 4 feet (approx.) length of one air curtain, having stainless steel & horizontal suitable for door. The air curtains shall be sized according to the width of the complete door.

- i. **CFM:** 1100 (APPROX.)
- ii. **BODY:** 304 Stainless Steel
- iii. **Construction:** Modular construction, self-aligning ball bearing and acoustically treated with insulation from inside to ensure absorption of sound.
- iv. **Air velocity & nozzle:** 21 m/s (max.)
- v. **Motors & Blowers:** as per manufactures standards
- vi. **Drive:** single speed, continuous rating motor.
- vii. **Electricity:** suitable for 230 + 5% volts, single- phase, 50 Hz 15 amps Ac supply.
- viii. **Permissible noise level:** maximum 50-70 Db.
- ix. **Installation:** Air curtain to be installed on the header above the door opening by taking necessary mounting arrangement (mounting plate, iron pieces, hardware etc.) as per actual site requirement. No extra cost will be paid.
- x. **Synchronization:** Provision shall be made in the Air- curtain in such a way that its operation will be synchronized with the existing sliding door operation.

AUTOMATIC JET HAND DRIER

Supply, installation, testing and commissioning of high-speed automatic Jet Hand Dryer(Hot & Cold) suitable for heavy-duty operation in public washrooms including all accessories and electrical connections. The minimum Qty. 18 nos or more quantity as per site requirements and as per approved drawings and specifications mentioned below:

General Requirements

- Type: Wall mounted, automatic, sensor based jet hand dryer.
- Operation: Touch-free infrared sensor activation.
- Body: High-impact stainless steel (Grade 304), vandal- resistant, corrosion- proof.
- Design: Slim, compact, aesthetically suitable.
- Mounting: Wall-mounted with fixing arrangements.

Performance Parameters

- Drying time: 10 to 20 seconds.
- Speed: Minimum 24000 rpm (Jet type).
- Air speed: 95 to 110 m/s.
- Noise level: ≤ 75 dB(A)at 1 meter
- Auto cut off: 60 seconds.

Electrical

- Power Supply: 230V $\pm 10\%$, 50 Hz, 1 Phase.
- Rated Power Consumption: 500 W – 800 W (energy efficient, heating optional)
- Motor: High-speed brushless DC/induction motor, long life.

Sanitary Napkin Hygiene Panel (4 IN 1)

Scope

This specification covers the design, material, manufacture, supply, installation, testing and commissioning of sanitary napkin hygiene panel (4 IN 1) wall mount for use in public toilets. The machine shall be robust, Hygienic, easy to operate and tamper proof designed to dispense Sanitary Napkins. The minimum Qty. 04 nos or more quantity as per site requirements and as per approved drawings and specifications mentioned below:

Specifications:

1. Cabinet: Made of Stainless Steel (Grade-SS304).
2. Combination: Sanitary Napkin Dispenser /Toilet Paper Holder / Disposable Bag Dispenser / Waste Receptacle Sanitary.
3. The machine shall be wall mountable suitable for indoor installation.
4. Napkin Capacity: 20-25 Pcs (minimum),
5. Waste Receptacle Capacity: 4.6 Liters (minimum), Equipped with Full-length Stainless-Steel Piano Flap.
6. Disposable Bags Capacity: 50 Bags (minimum).

Baby Diaper Changing Station

This specification covers the SITC OF Baby Diaper Changing Stations. The minimum Qty. 03 nos or more quantity as per site requirements and as per approved drawings and specifications mentioned below:

Material: Made of Stainless Steel (Grade-SS304) equipped with Safety Belt to Secure Baby When changing Diapers.

Dimension:

- Width: 905mm
- Height: 520mm
- Depth (Closed): 104mm
- Extension (Open): 495mm
- Maximum Load: 25 Kg

Mount Type: Recessed/Wall Mounted

Baby Protection Safety Chair

This specification covers the SITC of Baby Protection Safety Chair. The minimum Qty. 03 nos or more quantity as per site requirements and as per approved drawings and specifications mentioned below:

Material: High quality HDPE(High-Density Polyethylene)

Dimension:

- Width: 340mm
- Height: 510mm
- Depth (Open): 328mm
- Maximum Load: 20 Kg equipped with safety belt.

Mount Type: Wall Mounted

PACKAGE – L

Baggage Handling System

TECHNICAL SPECIFICATION FOR BHS

Scope of Work:

- (A) **Departure Conveyor** consisting of 4 nos weighing conveyor, 4 nos hold and dispatch conveyor, 25 mtr approx Take away/delivery conveyor, one Motor control panel, One rolling shutter, one Draught Curtain alongwith all required accessories.
- (B) **Arrival Conveyor** consisting of 34 mtr approx. loop length, , one Motor control panel, two rolling shutter, two Draught Curtain alongwith all required accessories.

1 **DESIGN CRITERIA FOR ARRIVAL AND DEPARTURE BAGGAGE HANDLING SYSTEM (BHS)**

- A)
 - (a) Conveyor system shall be design for handling passenger baggage of maximum size 1200 mm X 900 mm X 450 mm.
 - (b) Following Baggage sizes are classified as odd-size and are not acceptable by system:
 - Bigger than 1200 mm x 900 mm x 450 mm.
 - Smaller than 250 mm x 75 mm x 75 mm.
 - (c) Normal live load shall be 60 kg / linear meter
 - (d) The system offered shall be designed for trouble free operation for a continuous duty cycle, round the year with nominal operating time 20 hrs per day. The life span of the system should be 15 years.
 - (e) The conveyor shall be so designed that it is capable to start and stop with full baggage rated load without tripping or cause any damage to associated components of the system.
 - (f) The system offered shall not transmit any vibration to the buildings and near by flooring or shall be minimal.
 - (g) The design of the system shall be user friendly and provide maximum accessibility and convenience for operation and maintenance. Prime consideration to be given the safety of the passenger baggages, safety to passengers and personnel.

B) **Norms and regulations**

The BHS should comply with IATA regulations.

C) **Noise Level**

Noise levels at 1 m from any part of the equipment should not exceed the following values or ambient noise level of airport whichever is higher:

Public areas	=	65 dB
Non-public areas	=	75 dB

1.2 **SPECIFICATION FOR ARRIVAL BAGGAGE CAROUSAL SYSTEM**

- 1.2.1 The manufacturers standard design features are acceptable subject to meeting functional and technical requirements of AAI. The following specifications are given for guidance

- a) **Type** : Heavy duty endless, flat carousal (flexible overlapping slat type) with all accessories, materials, protection devices, and soft starter mechanism ensuring smooth flow of baggages.

- b) **Length / Shape of conveyor** : The shape of the conveyor shall be as per the drawing enclosed / finalized as per approved drawings. Loop length shall be as per the requirement given under the Schedule of Quantities (SOQ)/ as per approved drawing. The loop length shall be measured along the center of the carousal.
- c) **Overall frame size** : As per OEM Standard.
- d) **Curve radius** : As per approved drawing (Preferably 1500 to 1700mm).
- e) **Size of slats & slat carrier** : The overlapping slats shall be made of synthetic / polymer / moulded rubber of 6 mm thick black in colour with antistatic and flame retardant smooth top. The slat carrier support shall be 3.0 mm thick fabricated from MS sheet duly painted with support wheels.
- f) **Emergency Stops** : Provision shall be made in Panel and at three other locations of conveyor in the passenger baggage claim area.
- g) **Drive section** : The drive mechanism shall be Low noise, energy efficient compact Friction Drive with smooth start / stop function. Motor shall be of suitable rating. The design shall be able to take higher load and with minimum slips between and blocks.
- h) **Framework** : The framework shall be of mild steel profiles cross plates and side frame plates. All parts shall be bolted or welded together to form a complete framework of straight, curved and drive unit sections. The frames shall be 3 mm thick.
- i) **Supports** : The supports joining the sections shall be equipped with adjustable bases in order to level the supports during erection. All sections shall be bolted together i.e. standard, adjustment and curve sections shall be all bolted together with the drive sections to form the finished structure. Structural supports for the tracks will be spaced on a maximum of 1.5 meter intervals. Adjustment support legs shall be used as per design of OEM. Anti vibration blocks shall be provided as required.
- j) **Chain** : The chain consist of cast Aluminium links. Fabrication of chain shall be such that no lubricant is required.
- k) **Inner side wall** : The conveyor shall be provided with side wall guard raised the inner side to prevent falling of baggage. On the loading side of conveyor the inner side guards shall be of 2.0 mm thick SS sheet of 150 mm height above belt top.

NOTE: At loading area the conveyor should be provided with additional supports and suitable bumpers to withstand the impact caused while loading the baggage on the conveyor.

- l) **Trim / Fascia finish** : The frame work shall be covered with 2 mm thick stainless steel covers both inner edge and outer edge in all area.
- m) **Toe Kick plate** : The toe kick plate shall be 2 mm thick stainless steel sheet.
- n) **Bearings** : All bearings shall be self-aligned sealed type antifriction pre-lubricated for life. The bearing selected shall be for continuous duty and for service and loading of conveyors.

1.3 **SPECIFICATIONS FOR DEPARTURE BAGGAGE CONVEYOR SYSTEM**

1.3.1 **INTEGRATED WEIGHING SCALE CONVEYOR**

(a)	General	An integral baggage weighing scale conveyor equipped with a foot switch for introduction of baggage into dispatch conveyor after baggage had been weighed and tagged and subsequently feed the baggage into take away conveyor system. The weighing conveyor including, frame, belts, side guard are mounted directly on top of weighing scale. The conveyor weight is permanently balanced within the weighing system to provide Zero indication when the conveyor is empty. Complete unit shall be easy to maintain
b)	Type of Conveyor	Heavy duty Slider bed type Conveyor
c)	Overall frame size	As per OEM.
d)	Bed	Bed shall be made of 3 mm thick galvanized or epoxy coated mild steel sheet
e)	Size / length	1.2 mtrs.
f)	Tension adjustment	The system shall be provided with suitable positive and device precise tension adjustment mechanism
g)	No of load cell and load cell capacity	4 Nos. of high resolution load cells, each of suitable capacity
h)	Belt type	2 ply 2.0mm thick polyester black color PVC rough top, flame retardant, antistatic belt. The belt shall be robust, flexible, capable of providing continuous service, and of very low friction, bottom side fabric.
i)	Drive Unit & pulley	As per OEM.
j)	Power supply	415V/ 230V +/- 10%, 3Phase/ single phase, 50Hz AC Supply System
k)	Control logic & Protection	Control logic and over load protection, earthing protection shall be provided.

l)	Frame and supports	The conveyor structure for supporting rollers, drums, slider bed etc. shall be fabricated from MS formed channels/angles/strips 3 mm thick or of angle frame as required. The conveyor frame and its supports shall be mounted on the framework of weighing scale.
m)	Trim / fascia covering / finishing	Side, fascia covered with finishing SS-304 grade stainless steel of 2 mm (minimum) thick.
n)	Pulley	The system shall comprise of Tail pulley fitted with precision bearing operating on steel shaft. Head pulley & tail pulley shall be sized as per site requirement/ OEM design.
o)	Return Rollers/ Snub rollers of Rollers	Manufacturer designed bottom return standard design feature are accepted. If provided it shall be fitted with internal grease sealed bearing operating on steel shaft to conveyor side plates.
p)	Side Wall / Guard	A raised sidewall made of up to 150 mm height from belt top or a better design as per OEM of 2 mm of SS-304 grade stainless steel sheet on both sides shall be provided to prevent falling of baggage & to guide the baggage. The guard section shall have a smooth inner finish free from projection, fastening; weld metal, which may cause interference to flow of baggage. The width between the sidewalls at both the ends shall match the adjacent section.
q)	Accessories and Controls	In built electronic weighing scale complete with dual 7-segment display unit, interconnections etc. shall be provided on check in counters. The capacity of scale shall be up to 200 kg with scale graduation of 0.1 kg and accuracy of $\pm 0.05\%$. Each weighing conveyor system shall have individual foot operated device and shall also have ON/OFF switch of display unit and shall incorporate the following controls. i) Balance; to check and correct zero balance. ii) "Check" • "Zero" to restore the weight to Zero. iii) To check the 7 segment of digital display iv) LCD dual display unit to indicate weight to Ticketing staff as well as passenger.
r)	Calibration	Calibration of weighing conveyor by weight & measurement department of Govt to be provided by agency.

1.3.2. **HOLD & DISPATCH CONVEYOR**

a)	Type of Conveyor	Heavy Duty Slider Bed Belt Conveyor
b)	Useful belt width	The Belt width shall match with that of integrated weighing conveyor
c)	Overall frame size	Shall match with integrated weighing conveyor
d)	Height	Matching with weighing and collector conveyor
e)	Speed	25 to 30 meter per minute as per system design of OEM and functional requirement
f)	Normal live load	60 Kg per linear meter.

g)	Belt type	2 ply 2.0 mm thick polyester black color PVC rough top, flame retardant, antistatic belt. The belt shall be robust, flexible, capable of providing continuous service, and of very low friction, bottom side fabric.
h)	Bed	Bed shall be made of 3 mm thick galvanized or epoxy coated mild steel.
h)	Power Supply	415V/ 230V +/- 10%, 3Phase/ single phase, 50Hz AC Supply System
i)	Take Up	Screw take up.
j)	Pulleys	The system shall comprise of drive pulley (part of drive unit), Head and tail pulley, to meet the design parameters. The pulleys shall be complete with shaft, bearing, mounting brackets etc. as required. The requirement of take up pulley snub pulley shall be as per manufacturer design
k)	Return Roller	If required and provided, the bottom, return rollers shall be of nominal diameter 60 mm (O.D.) with internal bearing to meet the design parameters. Roller shall be spaced at not more than 1.5 meter center to center.
l)	Vertical baggage guide / tipping device	Suitable arrangement shall be provided at each diverter junction of the system & suitably located for easy guidance/ tipping/ diversion of baggage from dispatch conveyor to main conveyor and one section to another wherein the direction of baggage flow is different
m)	Frame and supports	The conveyor structure for supporting rollers, drums, slider bed etc. shall be fabricated from MS formed channels/angles/strips 3 mm as required
n)	Support	Support shall be adjustable and shall include provision for attaching directly to floor.
o)	Tension adjustment	System shall be provided with suitable positive and precise tension adjustment mechanism.
p)	Bearings	All bearings shall be self-aligned sealed type anti-friction pre-lubricated greased for life. The bearing selected shall be for continuous duty and for service and loading of conveyors
q)	Drive Unit	As per OEM
r)	Control Logic & Protection	Control logic and over load protection, earthing protection shall be provided..
s)	Trim /facia covering / finishing	Formed plate side facia covers with SS-304 grade stainless steel of 2.0 mm thick. This shall be suitably interfaced wherever side-raised wall is provided.
t)	Side wall / Guard	A suitable raised side wall made of up to 200 mm height above belt top or a better design as per OEM of 2.0 mm thick SS-304 grade stainless sheet on both side shall be provided to prevent falling of baggage and to guide the baggage. The guard section shall have a smooth inner finish free from projection, fastening weld metal, which may cause interference to flow of baggage. The width between the sidewalls at both the ends shall match the adjacent section.

12.3.3. **TAKE AWAY - DELIVERY CONVEYOR**

a)	Type of Conveyor	Heavy Duty Slider Bed Belt Conveyor
b)	Length of Conveyor	As per approved drawing / SOQ
c)	Overall frame size	As per OEM
d)	Height	As per approved drawings, to create easy flow of baggage from one section to adjoining section etc. as required.
e)	Normal live load	60 Kg per linear meter
f)	Belt type	2 ply 2. mm thick polyester black colour PVC smooth top, flame retardant, antistatic belt conveyor. The belt shall be of robust, flexible & capable of providing continuous service & of very low friction, bottom side fabric.
g)	Bed	Bed shall be made of 3 mm thick galvanized or epoxy coated mild steel sheet
h)	Power Supply	415V +/- 10%, 3Phase AC Supply System
i)		
j)	Pulleys	The system shall comprise of drive pulley, Head & tail pulley, take up pulley and snub pulley to meet the design parameters. The pulleys shall be complete with shaft, bearing, mounting brackets etc. as required.
k)	Return Roller	Bottom, return rollers of nominal dia. 60 mm (O.D) with internal bearing to meet the design parameters. Roller shall be spaced at 1.5 mtr centre to centre.
l)	Vertical baggage guide/ tipping device	Suitable guide / diversion roller shall be provided at each diverter junction of the system and suitably located for easy guidance / tipping / diversion of baggage one section to another wherein the direction of baggage flow is different. The material for guide roller shall be stainless steel & adequately sized.
m)	Frame and supports and cross members	The conveyor structure for supporting rollers, drums, slider bed etc. shall be fabricated from MS formed channels / angles / strips 3 mm thick or of angle frame as required.
n)	Support	Support shall be adjustable & shall include provision for attaching directly to floor.
o)	Support spacing	3 Mtrs except in loading area where spacing shall be 1.5 Mtrs.
p)	Tension adjustment	The system shall be provided with suitable positive and precise tension adjustment mechanism.
q)	Bearings	All bearings shall be self-aligned sealed type antifriction pre-lubricated greased for life. The bearing selected shall be for continuous duty and for service and loading of conveyors. Minimum life of bearings shall be 30,000 hours of operation
r)	Starting method	DOL starter
s)	Drive Unit	As per OEM
t)	Control Logic & Protection	Control logic and over load protection, earthing protection shall be provided.
u)	Trim / facia covering / finishing	Formed plate Side facia covers with SS-304 grade stainless steel 2.0mm thick in all area. This

		shall be suitably interfaced wherever side-raised wall is provided.
v)	Side wall / Guard	Both sides raised side walls of 200mm height above belt top made of 2mm thick stainless steel SS-304 grade sheet, in all area. The width between the sidewalls at both the ends shall match the adjacent section. For ease of maintenance, side guard panel shall be bolted or inserted with other mechanism on the conveyor frame.

1.3.4 GRAVITY ROLLER CONVEYOR

i)	Roller length	900-940 mm (nominal) or as per OEM
ii)	Over all width	To match with adjacent conveyor
iii)	Pitch & dia of roller	90/50 mm pitch / dia or as per OEM
iv)	Length of the section	As per drawing/ as per SOQ
v)	Quantity	As per drawing/ as per SOQ
vi)	Diameter	3mm thick stainless steel tubes or as per OEM
vii)	Roller capacity	60 kg per meter
viii)	Height	Suitably matched and sloped
ix)	Support / frame work	As per OEM

1.4 MISCELLANEOUS ITEMS

A. ROLLING SHUTTERS

i)	Material	Fabricated cast MS of deep convex corrugations with side channel guides plate brackets. Rolling Shutters are required to be provided wherever the conveyors are entering the space within the terminal building.
ii)	Size	To suit the opening in wall (refer drawing).
iii)	Auto Operation	The rolling shutters shall be provided with suitable rated geared motor directly coupled to the shaft of the shutter. Up & down movement of the rolling shutter shall be controlled by either limit switch or sensors. Interlock with conveyor motor starter so that the conveyor would start only when the shutter is in full open conditions. Down movement of the shutter could be done only with OFF switch of Conveyor System
iv)	Manual Operation	Provision for manual operation of shutter shall also be made with separate push buttons for up and down movements.
v)	Manual locking	Provision to lock the shutter from inside as well as outside shall be made.

NOTE: Necessary control provision shall be added in MCC for the complete function of rolling shutter as described above.

B. DRAUGHT CURTAIN:

Draught curtain shall be provided across the openings, through which conveyor is taken outside. It shall be fabricated with 3 mm thick nylon rubber flaps of adequate size each strip overlapping the adjacent strip by 50% giving an overall overlap 100%) will be hanged from top of the opening with the suitable SS sheet covers.

C. WIRING/ CABLE WORK:

Cable work and Wiring from nearest power terminated point to main electrical conveyor control panel, from control panel to various conveyor motors, remote control point and limit switches shall be provided. The power cable for motor shall be armoured and of adequate size to carry the full load current continuously and shall be of copper. Control wiring inside the control panel shall be copper and the size shall be as per standard practice followed by manufacturer. However, the size of the control wiring carried out at site i.e., from control panel to limit switches, remote emergency off switches, Buzzers, sensors etc. shall be of minimum 2.5 sq mm copper. The power and control wiring shall be fire retardant type and shall be laid on MS box type cable trays duly painted wherever possible or suitably fixed on the conveyor frame/floor as required.

D. EARTHING:

All the motors shall be provided with two separate earth connections by drawing suitable size conductor wires from the control panel earth connections. All switches, motors, structures etc. shall also be connected to the earth points as per the IS specifications which apply to the types of work.

E. END COVERS:

End covers shall be provided at all the dead ends of conveyor sections made of 2 mm thick SS cover in all area with ventilation arrangement for safety protection.

G. PAINTING

All metal parts shall be completely cleaned of rust, carbon deposits and if applicable, welding residue, de-greasing and priming. Thereafter, it should be painted with synthetic enamel paint / powder coated to get even and desired finish.

1.5 CONTROL LOGIC & CONTROL PANELS

1.5.1 CONTROL LOGIC FOR DEPARTURE CONVEYOR SYSTEM

The control logic shall be designed and provided by the Contractor to meet the system requirement as specified in technical / particular specifications. However, the following are provided as minimum criteria for guidance to the tenderers.

1.	ALARM AND DELAY START TIMERS	Whenever the system switched on to initiate the start function on each occasion a buzzer will be connected to the circuit (selectable timer 0-30 Sec) & which produce an audible alarm. The buzzer sound shall be different from the fire alarm buzzer installed in the building. After 30 seconds the alarm will be turned off. Then the conveyor system would start functioning as per sequence indicated below: (i) Rolling shutter start opening (Upper & Lower limit switch shall be provided to ensure full opening/ extreme closing of Shutter). (ii) Take away conveyor (section close to gravity roller). (iii) Second, third take away section if planned & provided. (iv) Dispatch conveyor
2.	DELAY OFF TIMER	One timer has to be incorporated into the circuit to Stop take away conveyors etc. after normal stop button is operated. The time selector is

		sufficient for the last luggage loaded at the check-in-counter to reach end & then the system will be either switched OFF. The OFF timer shall have a selectable/rating of 0-30 minutes minimum.
3.	EMERGENCY REMOTE OFF	The system shall have sufficient number of remote emergency OFF push button. When this switch is operated all timer circuit has to be bypassed & system should come to a grinding stop. Only after releasing the emergency Stop, the conveyor could re-start. The departure conveyor should have sensors installed one in front of each feeder conveyor such that the sensor continuously monitors the flow of baggage's & at any point of time if baggage gets stuck or jammed in front of the transfer points, the sensor should trip the entire conveyor system with a fault indication signal & audio alarm. Similarly when there is baggage on the conveyor in front of the sensor installed opposite to the feeder conveyor, the feeder conveyor should not function till the baggage in front of the sensor has been cleared.
4.	DISPLAY BOARD	An integrated Mimic Display Board with the MCC shall be provided to indicate the status of each conveyor section. The mimic board display shall be fabricated with fibre glass board with proper shape of conveyor and LED indications. Two different coloured LED indication shall be kept for each section for Conveyor to show ON and OFF. Proper ventilation shall be incorporated in the system.
5.	BUZZER	The buzzer shall be electronic type and rated for 230 Volts 50Hz AC supply. Buzzer with 24V DC supply is also acceptable. One buzzer at baggage make-up area & one in passenger area shall be provided.
6.	ROLLING SHUTTER	The rolling shutter shall be operated by motorized gear assembly connecting directly to the shaft of the shutter. Up and down movements of the shutter shall be controlled by either limit switch or sensor.
7.	SENSORS	The programmable logic control shall be achieved through sensors placed at the required location. The control logic shall be such that If a particular section wherein baggages to be delivered is not in working status then the baggage shall not be transferred to the adjoining section, by activation of necessary stop sensors of the feeding section which are placed at appropriate location of the section wherein the baggage move.
8.	REMOTE START / STOP	The system should be provided with remote start/stop station as per site requirement and to ensure safety of passengers & workmen.

1.5.2 **CONTROL PANEL FOR DEPARTURE CONVEYOR SYSTEM**

a)	Type of Construction	Cubicle type, indoor floor mounting compartmentalized, fabricated out of MS sheet steel of thickness 2 mm, duly powder coated. The panel shall be double door front, both side openable, operatable & accessible. All doors shall be provided with high quality neoprene rubber gasket. Door interlock feature with incoming power supply shall be provided as per manufacturer standard. The type of protection for enclosure of the panel shall be IP 54.
b)	Panel layout	Layout drawing shall be got Prepared by the contractor and approval obtained from the Engineer-in-charge before taking up the fabrication work.
c)	Incoming control unit	415 Volts TPN MCCB of breaking capacity not less than 35KA (Ics = 100% Icu) with Thermal overload & magnetic short-circuit protections.
d)	Incoming Protection	i) Single Phase Protection ii) Phase reversal protection
e)	Status Indication / display	Indication lamps (LED Type) in different colour for Three phases, power ON with MCB protections.
f)	Meters (Incoming)	Digital Multifunction meter with protection and CTs.
g)	Bus Bars	The Al. bus bars of 3-phase 4 wire system Bus bar support insulator shall be SMC/DMC type. Bus bars shall be sleeved with Heat shrinkable insulation.
h)	Outgoing for each section	As per BOQ
i)	Outgoing for rolling shutter	As per OEM.
j)	Outgoing for each weighing scale & dispatch conveyor	As per OEM
k)	Alarm / Time delay	Provision for time delay start, duly interconnected with buzzer and start the sequence of conveyor
l)	Interlock & logic	Relay logic to meet the operational requirement shall be worked out and got approved from Engineer-in-charge. Required number of sensors and other control devices shall be provided to meet the functional logical operation of conveyor.
m)	Air Louvers	The central panel constructional feature shall have air louvers for proper ventilation

Note. 1: Above given technical particular indicates minimum requirements and contractor shall examine accurate requirements of system and should design Control Panel accordingly. Standard product of manufacturer meeting standard may be accepted.

1.5.3 CONTROL LOGIC FOR ARRIVAL CONVEYOR

A.	ALARM AND DELAY START TIMERS	<p>Whenever the system switched on to initiate the start function on each occasion a buzzer will be connected to the circuit (selectable timer 0-30 Sec) and which produce an audible alarm. The buzzer sound shall be different from the fire alarm buzzer installed in the building. After 30 seconds the alarm will turned off. Then the conveyor system would start functioning as per sequence indicated below:</p> <ul style="list-style-type: none">i) Rolling shutter start opening (upper & lower limit switch shall be provided to ensured full opening / extreme closing of shutter.ii) Arrival carousal
B.	DELAY OFF TIMER	<p>One more timer has to be incorporated into the circuit to carousel conveyor after manual stop button is operated. The time selector shall be sufficient for the last luggage loaded to make three round of the carousel loop and then the system will be switched OFF. The OFF timer shall be of selectable i.e 0-30 minutes.</p>
C.	EMERGENGY REMOTE OFF	<p>The system shall have three remote / emergency OFF push button (push to Lock) suitably located in the area of carousel conveyor for emergency stopping of the system. When this switch is operated all timer circuit has to be bypassed and system should come to a grinding stop. Only after releasing the emergency Stop, the conveyor could re-start.</p>
D.	BUZZER	<p>The buzzer shall be heavy duty electronic type and rated for 230 volts 50 Hz AC supply. One buzzer at baggage make-up area and one In passenger area shall be provided.</p>
E.	REMOTE STAR/STOP	<p>The system should be provided with remote start/stop station as per site requirement.</p>
F.	ROLLING SHUTTER	<p>The rolling shutter shall be operated by motorized gear assembly connecting directly to the shaft of the shutter. Up and down movements of the shutter shall be controlled by either limit switch or sensor.</p>

1.5.4. **CONTROL PANEL FOR ARRIVAL CONVEYORS**

a)	Type of Construction	Cubical type, indoor floor mounting compartmentalized, fabricated out of MS sheet steel duly powder coated. The panel shall be double door front openable, front operatable All doors shall be provided with high quality gasket. Door interlock feature with incoming power supply shall be provided as per manufacturer standard. The type of protection for enclosure of the panel shall be IP-54.
b)	Panel layout	Layout drawing shall be got Prepared by the contractor and approved by the Engineer-in- charge before fabrication of panel.
c)	Incoming control unit	415 Volts TPN MCCB of breaking capacity not less than 25KA (Ics = 100 Icu) with Thermal overload protection & magnetic short-circuit protections.
d)	Incoming Protection	i) Single Phase Protection ii) Phase reversal protection
e)	Status Indication / display	Indication lamps in different colour for Three phases, power ON with MCB protection (LED type).
f)	Meters (Incoming)	Digital multifunction meter with protection and CTs
g)	Bus Bars	The bus bars shall be 3-phase 4 wire system with 200 Amps rating Aluminium. Bus bar support insulator shall be SMC/DMC type. Bus bars shall be sleeved with Heat shrinkable insulation.
h)	Outgoing for each section	1 – As per SOQ 2- Soft Starter for conveyor motors.
i)	Outgoing for rolling shutter	As per OEM
j)	Emergency Stop	Provision shall be made in panel & at three other locations for each conveyor in the passenger baggage claim area.
k)	Alarm / Time delay	Provision for time delay start, duly interconnected with buzzer and start the sequence of conveyor.
l)	Interlock & logic	A programmable logic to meet the operational requirement shall be worked out and got approved from Engineer-in-charge. Required number of sensors and other control devices shall be provided to meet the functional logical operation of conveyor.
m)	Air Louvers	The central panel constructional feature shall have air louvers for proper ventilation

(M)

LIST OF PREFERRED MAKES

STANDARD FOR LED LIGHT FITTINGS FOR DIFFERENT APPLICATIONS

S. No	TECHNICAL PARAMETER	RECOMMENDATION FOR INDOOR LIGHT	RECOMMENDATION FOR OUTDOOR LIGHT	RECOMMENDATION FOR RESIDENTIAL LIGHT
1	Efficiency of LED light fitting (Efficacy)	Min 100 Lumens / Watt	Min 110 Lumens / Watt	Min 70 Lumens / Watt
2	Life of LED light fitting	Not less than 50000 burning Hours	Not less than 50000 burning Hours	Not less than 35000 burning Hours
3	Approved make for LED	Nichia/Cree/Osram/ Phillips (Lumiled)/ Sharp/ Seoul/ Everlite/Citizen (Japan)/ Bridgelux (USA)/ Samsung.	Nichia/Cree/Osram/ Phillips (Lumiled)/ Sharp/ Seoul/ Everlite/Citizen (Japan)/ Bridgelux (USA)/ Samsung.	Nichia/Cree/Osram/ Phillips (Lumiled)/ Sharp/ Seoul/ Everlite/Citizen (Japan)/ Bridgelux (USA)/ Samsung.
4	CRI (Colour Rendering Index)	Min 80 for indoor applications .	Min 70 for outdoor applications.	Min 70
5	THD (Total Harmonic Distortion)	Less than 10 %	Less than 10 %	Less than 20 %
6	Voltage Range	140 V to 270 V	140 V to 270 V	140 V to 270 V
7	Type of Housing	Extruded aluminum / CRCA/Standard alloy housing	High pressure die cast aluminium / Standard alloy for outdoor applications.	Extruded aluminum/ High pressure die cast aluminium / Standard alloy.
8	IP Category	IP 20 or higher for indoor applications .	≥ IP65	≥ IP 20
9	Surge Protection	Shall be provided conforming to relevant IS standard / IEC For LED Driver (In-built): EN61000-4-5 or as specified in BOQ. > 2KV	> 4KV	> 2KV
10	Labeling / identification Mark	Manufactures Name/ Logo shall be engraved / Embossed on housing / body or on aluminium plate Labels or screen printed on housing / body .	Manufactures Name/ Logo shall be engraved / Embossed on housing / body or on aluminium plate Labels or screen printed on housing / body .	Manufactures Name/ Logo shall be engraved / Embossed on housing / body or on aluminium plate Labels or screen printed on housing / body .
11	Warranty period	5 years warranty from actual date of completion of work on complete luminaire including driver / control gear, LED, all accessories etc.	5 years warranty from actual date of completion of work on complete luminaire including driver / control gear, LED, all accessories etc.	3 years warranty from actual date of completion of work on complete luminaire including driver / control gear, LED, all accessories etc.
12	Power Factor	Equal to 0.95 or More	Equal to 0.95 or More	Equal to 0.95 or More
13	Total Power consumption of fitting.	Not More than 110 % of rated capacity of LED Light fitting.	Not More than 110 % of rated capacity of LED Light fitting.	Not More than 110 % of rated capacity of LED Light fitting.

S. No	TECHNICAL PARAMETER	RECOMMENDATION FOR INDOOR LIGHT	RECOMMENDATION FOR OUTDOOR LIGHT	RECOMMENDATION FOR RESIDENTIAL LIGHT
14	Approved Make of Driver	Meanwell / Inventronics/ C&S/ Moso Power/ BAG/ Phillips/ Wipro/ Osram/ Bajaj/ Pharos/ Fulham/ Helter/ OEM of Light Fixture	Meanwell / Inventronics/ C&S/ Moso Power/ BAG/ Phillips/ Wipro/ Osram/ Bajaj/ Pharos/ Fulham/ Helter/ OEM of Light Fixture	Meanwell / Inventronics/ C&S/ Moso Power/ BAG/ Phillips/ Wipro/ Osram/ Bajaj/ Pharos/ Fulham/ Helter/ OEM of Light Fixture
15	Type of Driver	Enclosed/Encapsulated	Enclosed/Encapsulated	Enclosed/Encapsulated
16	Efficiency of Driver	≥ 85%	≥ 85%	≥ 85%
17	Testing Facility	LED Luminaire manufacturer shall have In- house NABL accredited Photometry lab.	LED Luminaire manufacturer shall have In- house NABL accredited Photometry lab.	LED Luminaire manufacturer shall have In- house NABL accredited Photometry lab.
18	BIS Registration	All luminaires & drivers shall be BIS registered.	All luminaires & drivers shall be BIS registered.	All luminaires & drivers shall be BIS registered.
19	Housing thickness	Housing of luminaires shall ≥ 0.5 mm for CRCA or 1 mm for Extruded Aluminium or 1.5 mm for PDC aluminium or heavier if so required to meet the application requirement.	Housing of luminaires shall ≥ 0.5 mm for CRCA or 1 mm for Extruded Aluminium or 1.5 mm for PDC aluminium or heavier if so required to meet the application requirement.	Housing of luminaires shall ≥ 0.5 mm for CRCA or 1 mm for Extruded Aluminium or 1.5 mm for PDC aluminium or heavier if so required to meet the application requirement.
20	IK Rating	IK 04 or above	IK 07 or above	NA
21	LED Binning (Standard Deviation Colour Matching)	< 5 (SDCM)	< 5 (SDCM)	< 7 (SDCM)
22	Unified Glare Rating (UGR)	≤ 19	NA	NA



LIST OF PREFERRED MAKES FOR ELECTRICAL ITEMS

Note: The following list of preferred makes is exhaustive. However, additional manufacturers of brands may be considered for any specified product or item, depending on market availability, delivery timelines and proven satisfactory performance in similar projects or works—preferably where such a make or product has been used in quantities constituting at least eighty percent (80%) of the estimated or proposed requirement for the relevant project or work. To establish performance, completion certificates, performance certificates and purchase orders accompanied by tax invoices will be considered, provided that the products comply with the technical specifications stipulated in the tender document.

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
A.	PANEL, SWITCHGEARS AND RELATED ITEMS		
1	LT PANELS (TTA)	MAK / SHIV SHAKTI ENGINEERS / TECHNOCRAFTS / TENCO / KONTACT / ABB / RISHA / MARINE ELECTRICALS / POWERTECH SWITCHGEARS / ULTIMA / RITTAL / URJAYANT / EXCEL CONTROL SYSTEMS / BALAJI ELECTRO CONTROLS PVT LTD / KRUTI / CMKL(CORE METAL) / KEPL(KHOKHAR) / LEGRAND (NOVATEUR) / CONQUERENT / MITSUBISHI / LS POWER / ZENIYA / NEPTUNE / LAURITZ KNUDSEN / C&S / BCH / ADVANCE / TRICOLITE / SCHNEIDER / SUCHIR / EAP / TRISQUARE / MILESTONE / ADLEC / UNILEC / CONSUL (RR ISPAT) / PEATON/ HAROLD/ SPC ELECTROTECH / SIEMENS	CATEGORY-1
2	LT PANELS / FEEDER PILLAR (PTTA) / BUS TRUNKING	EXPERT ENGINEERS / MAK / APPLICATION CONTROL PANEL / AMBIT / ADLEC / SHV SHAKTI ENGINEERS / TECHNOCRAFTS / EXCEL CONTROL SYSTEMS / GLOBAL / SUPERTech CONTROL SYSTEMS / SWITCHGEARS & FABRICATORS / KONTACT / MARINE ELECTRICALS / R.P. CONTROLS / GOURAV EnerGen / TENCO / POWERTECH SWITCHGEARS / HAROLD / BALAJI ELECTRO CONTROLS PVT LTD / URJAYANT / KRUTI / ASSES / ITE-GURGAON (INDIAN TRANSFORMERS) / LEGRAND (NOVATEUR) / CONQUERENT / CORONET / RST ELECTRICALS PVT LTD / HPL / C&S / LS POWER / ZENIYA / PRECISION / ABB / EAP / TRICOLITE / SUCHIR / SCHNEIDER / LAURITZ KNUDSEN / NEPTUNE / HENSEL / ADVANCE / KEPL(KHOKHAR) / PEATON / RISHA / TRISQUARE / CMKL (CORE METAL) / SPC ELECTROTECH / BCH / MILESTONE / YOGU DIQI(P) LTD / ELINS / EVA / UNILEC / HAROLD / ENGINEERS & ENGINEERS / SIEMENS / ULTIMA / NIYA	CATEGORY-1
3	AIR CIRCUIT BREAKERS	LS ELECTRIC / BCH / MITSUBISHI / HPL / LAURITZ KNUDSEN / LEGRAND (NOVATEUR) / ABB / C&S / HAVELLS / SCHNEIDER / SIEMENS	CATEGORY-2
4	MOULDED CASE CIRCUIT BREAKERS (MCCB)	LS ELECTRIC / BCH / MITSUBISHI / LAURITZ KNUDSEN / LEGRAND (NOVATEUR) / ABB / C&S / HAVELLS / INDO ASIAN (NOVATEUR) / HPL / SCHNEIDER / SIEMENS	CATEGORY-2
5	CHANGE OVER SWITCH / FUSE DISCONNECTOR / SWITCH / SWITCH FUSE UNITS	BENTEC / BCH / INDO ASIAN (NOVATEUR) / SOCOMEC / LAURITZ KNUDSEN / C&S / LEGRAND (NOVATEUR) / HPL / ABB / HAVELLS / SIEMENS / SCHNEIDER	CATEGORY-2
6	METERS / MULTIFUNCTION METERS -ANALOGUE/DIGITAL	ELMEASURE / KRYKARD / SELEC / C&S / ABB / BENTEC / SELEC / C&S / MITSUBISHI / ABB / NEPTUNE / SOCOMEC / HPL / LAURITZ KNUDSEN / FINDER / SIEMENS / SCHNEIDER / CONSERVE / SECURE	CATEGORY-3
7	SELECTOR SWITCH / PUSH BUTTON SWITCH / EMERGENCY SWITCH	ABB/ TRINITY TOUCH / LAURITZ KNUDSEN / C&S/ BCH/ EATON / TEKNIC / SIEMENS / SCHNEIDER	CATEGORY-3
8	CTs / PTs	GLOBAL / KRUTI / WAGO / CG POWER / SELEC / NEWTEX / ANANT POWER (ADVANCE) / KAPPA	CATEGORY-3
9	PROTECTIVE RELAYS (ALL TYPE)	PZ POWER / WAGO / SELEC / HAVELLS / MITSUBISHI / LAURITZ KNUDSEN / CG POWER / C&S / ABB / SIEMENS	CATEGORY-2
10	CONTACTORS	MITSUBISHI / HPL / LAURITZ KNUDSEN / C&S / BCH / HAVELLS / ABB / TOK / SIEMENS / LEGRAND (NOVATEUR) / SCHNEIDER	CATEGORY-3
11	TIMERS / TIME SWITCH- ANALOGUE/DIGITAL	HAVELLS / LAURITZ KNUDSEN / SELEC / BCH / ABB / LEGRAND (NOVATEUR) / EATON / FINDER / SIEMENS / SCHNEIDER / C&S	CATEGORY-3
12	LED INDICATION LAMPS	EATON / OLIVE / ABB / LAURITZ KNUDSEN / C&S / BCH / VINAY LED / VAISHNOV / SCHNEIDER	CATEGORY-3

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
B. SUBSTATION RELATED ITEMS			
13	TRANSFORMER UP TO 500 KVA (DRY/OIL)	POWERWARE / ITE, GURGAON / ESENNAR / PVJ POWER / TRANSCON / AMES IMPEX / POWER STAR / JAY BEE / RTS / CG POWER / SUDHIR / VOLTAMP / BHARAT BULEE / KOTSONS/ SCHNEIDER / KIRLOSKAR	CATEGORY-1
14	TRANSFORMER MORE THAN 500 KVA (DRY/OIL)	POWERWARE / ITE, GURGAON / ESENNAR / PVJ POWER / TRANSCON / AMES IMPEX / POWER STAR / JAY BEE / RTS / CG POWER / SUDHIR / VOLTAMP / KOTSONS/ SCHNEIDER / BHARAT BULEE / KIRLOSKAR / SIEMENS	CATEGORY-1
15	H T PANEL	APPLICATION CONTROL PANEL / SHIV SHAKTI ENGINEERS / ITE, GURGAON / TECHNOCRAFTS / TENCO / MARINE ELECTRICALS / PASCAL / KEPL(KHOKHAR) / CONQUERENT / RISHA / CORONET / L S POWER / ZENIYA / EAP / CG POWER (CFPISL) / TRICOLITE / SUDHIR / LAURITZ KNUDSEN / ABS / TRISQUARE / SCHNEIDER / MILESTONE / EATON / ANANT POWER (ADVANCE) / ADLEC / SIEMENS	CATEGORY-1
16	BUS DUCT-SANDWICH	RISHA / ADVANCE / RR KABEL / LAURITZ KNUDSEN / C&S / LEGRAND (NOVATEUR) / EAE / SCHNEIDER	CATEGORY-2
17	H T / L T TERMINATION & JOINTING KIT	DENSONS / CABSEAL® (HARI CONSOLIDATED) / COMPAQ / RAYCHEM	CATEGORY-3
18	POWER CABLES ABOVE 1.1 KV	V-MARC / SBEE / SUYOG ELECTRICALS LTD / DICABS / APAR / GEMSCAB / HPL / RR KABEL / SPECIAL CABLES / JMW KABEL / PARAMOUNT / TIRUPATI / KEC / POLYCAB / DYNAMIC / HAVELLS / KEI / UNISTAR / GLOSTER / RAVIN CABLES / NICCO	CATEGORY-1
19	POWER CABLES UP TO AND INCLUDING 1.1 KV	ALLCAB / AURAFLEX / V-MARC / VISHAL / SBEE / POLYCORE / VIN POWER / TORTEK / SUYOG ELECTRICALS LTD / GEMSCAB / RR KABEL / PLAZA / SPECIAL CABLES / KEI / JMW KABEL / POLYCAB / AVOCAB (CHANDRESH) / DYNAMIC / PARAMOUNT / SVARN / RALLISON (LKB) / BCH / TIRUPATI / KEC / GRANDLAY / HPL / GLOSTER / BONTON / HAVELLS / UNISTAR / APAR / RAVIN CABLES / NICCO	CATEGORY-1
20	CONTROL CABLES	GEMSCAB / ALLCAB / AURAFLEX / V-MARC / SBEE / POLYCORE / TORTEK / NICCO / SUYOG ELECTRICALS LTD / RR KABEL / PLAZA / SPECIAL CABLES / JMW KABEL / AVOCAB (CHANDRESH) / PARAMOUNT / SVARN / RALLISON (LKB) / BCH / BONTON / TIRUPATI / KEI / KEC / GRANDLAY / UNISTAR / NATCAB (KOWALITY) / HPL / POLYCAB / DYNAMIC / ALCKE (ANKUR) / HAVELLS / GLOSTER / FINECAB / APAR / BATRA HENLAY / RAVIN CABLES	CATEGORY-1
21	TELEPHONE CABLE	POLY INFOCOM CABLES PVT LTD / ORBIT / DUCAB / RR KABEL / PLAZA / JMW KABEL / PARAMOUNT / ALOKE (ANKUR) / RALLISON (LKB) / BONTON / TIRUPAT / HAVELLS / KEI / KEC / KVV'S (INDUSTIRAL) / HPL / POLYCAB / NICCO	CATEGORY-2
22	CO- AXIAL/ INSTRUMENTATION/ FIBRE OPTIC/ CAT-6 / CAT- 6A CABLES	AURAFLEX / SBEE / TORTEK / SUYOG ELECTRICALS LTD / ORBIT / POLYCORE / POLY INFOCOM CABLES PVT LTD / BATRA HENLAY / GEMSCAB / RR KABEL / PLAZA / SPECIAL CABLES / JMW KABEL / POLYCAB / PARAMOUNT / LEGRAND(NOVATEUR) / SVARN / RALLISON (LKB) / BONTON / HAVELLS / KEI / ROSENBERGER / KEC / GRANDLAY / GLOSTER / SCHNEIDER / APAR	CATEGORY-2
23	GI / SS CABLE MANAGEMENT SYSTEM (CABLE TRAY-PRE-FABRICATED/ PERFORATED/ LADDER TYPE / WIRE MESH TYPE, ETC.)	GLOBAL / OBO BETTERMANN / MM ENTERPRISES / GLOBE / BEC / RMCON (RMO) / EXCEL CONTROL SYSTEMS / ADVANCE- ANANT / RMSCO (RAJASTHAN METAL) / SUMP / CTM / L S POWER / LEGRAND (NOVATEUR) / INDIANA / MM ENGG / SLOTCO / MEM	CATEGORY-3
24	UNDER FLOOR RACEWAYS & ITS ACCESSORIES	OBO BETTERMANN / BEC / ADVANCE- ANANT / SPC ELECTROTECH / CTM / MM ENTERPRISES	CATEGORY-3
25	CAPACITORS	SELEC / NEPTUNE / LAURITZ KNUDSEN / P2 POWER / LEGRAND (NOVATEUR) / HAVELLS / TDK INDIA / SCHNEIDER	CATEGORY-2

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
26	APFC PANEL/ ACTIVE & PASSIVE (HYBRID) PANEL	MAK / APPLICATION CONTROL PANEL / SHIV SHAKTI ENGINEERS / TENCO / RISHA / INPHASE POWER TECHNOLOGIES PVT LTD / GLOBAL / R.P. CONTROLS / ULTIMA / SUPERTECH CONTROL SYSTEMS / SWITCHGEARS & FABRICATORS (SOF) / POWERTECH SWITCHGEARS / HAROLD / AB POWER / URJAYANT / SELEC / EAP / CG POWER / P2 POWER / KEPL (KHOKHAR) / ITE-GURGON (INDIAN TRANSFORMERS) / CONQUERENT / BCH / ANANT POWER (ADVANCE) / RISHA / HAVELLS / CORONET / SPC ELECTROTECH / PEATON / L.S POWER / MILESTONE / LAURITZ KNUDSEN / LEGRAND (NOVATEUR) / C&S / NEPTUNE / SCHNEIDER / NEPTUNE / P2 POWER / SELEC / ANANT POWER (ADVANCE) / SCHNEIDER / SPC ELECTROTECH / ADLEC / RST ELECTRICALS PVT LTD / TDK INDIA / TRICOLITE / AMBIT	CATEGORY-1
27	LIGHTENING PROTECTION SYSTEM (LPS) COMPLYING UPDATED IEC / NBC	JEF / OBO BETTERMANN / GROUND ECA3G / NEXPO POWER SOLUTIONS / CAPE / JMV / ABB / DEHN / PHOENIX / TERCEL	CATEGORY-3
28	EARTHING SYSTEM (CHEMICAL)	JEF / OBO BETTERMANN / GROUND ECA3G / TERCEL / BEC / DEHN / ABB / JMV / NEXPO POWER SOLUTIONS / RMSCO (RAJASTHAN METAL) / CAPE / JK CHEMRODE / PROTEC-DHRUVA (DHRUVA) / APS	CATEGORY-3
29	SURGE PROTECTION DEVICES	OBO BETTERMANN / DSS / GROUND ECA3G / TERCEL / WAGO / HAVELLS / ABB / CAPE / LAURITZ KNUDSEN / LEGRAND (NOVATEUR) / DEHN / MERSEN / JMV / PHOENIX CONTACT / PROTEC ALLIED / SECOM / CITEL	CATEGORY-3
30	SCADA (HARDWARE & SOFTWARE EXCEPT COMPUTER & ACCESSORIES)	LAURITZ KNUDSEN / WAGO / PHOENIX CONTACT / HONEYWELL / SCHNEIDER / SIEMENS	CATEGORY-2
31	SF6 CIRCUIT BREAKER/ VACUUM CIRCUIT BREAKER	EATON / VOLTAMP / LAURITZ KNUDSEN / PASCAL / EATON / CG POWER / ABB / SCHNEIDER / SIEMENS	CATEGORY-2
32	SERVO / AUTOMATIC VOLTAGE STABILIZER	POWERWARE / KRYKARD / FUJI ELECTRIC / PVJ POWER / SELEC / ITE-GURGON (INDIAN TRANSFORMERS) / P2 POWER	CATEGORY-2
33	AUTO TRANSFER SWITCH (ATS)	EATON / HPL / LAURITZ KNUDSEN / LEGRAND (NOVATEUR) / SOCOMEC / HAVELLS / ASCO (SCHNEIDER)	CATEGORY-2
34	COMPACT SUB STATION	PVJ POWER / CORONET / ITE-GURGON (INDIAN TRANSFORMERS) / CONQUERENT / SUDHIR POWER / PEATON / L.S POWER / VOLTAMP / LAURITZ KNUDSEN / ABB / SCHNEIDER	CATEGORY-1
35	EMERGENCY LIGHT - LED (PORTABLE)	LIFE-GUARD / PROLITE	CATEGORY-3
36	CABLES GLANDS	HENSEL / POLYCAB / TRINITY TOUCH / ROXTEC / BRACO / MCI / (METAL/ CRAFT)	CATEGORY-3
37	LUGS & THIMBLES	WAGO / POLYCAB / TRINITY TOUCH	CATEGORY-4
38	SYNTHETIC / PVC INSULATING MATS	CPRJ certified for required voltage level	CATEGORY-2
39	INSULATION TAPE (HT / LT)	MODifs / BENLO / ANCHOR	CATEGORY-4
C DG SETS & RELATED ITEMS			
40	DIESEL ENGINE ABOVE 250 KVA	GREAVES COTTON / BAUDOUIN (SHANDONG) / MAHINDRA POWEROL / CUMMINS / KOEL / CATERPILLAR	CATEGORY-1
41	DIESEL ENGINE UPTO AND INCLUDING 250 KVA	GREAVES COTTON / BAUDOUIN (SHANDONG) / TMTL (TAPE MOTORS) / CUMMINS / MAHINDRA POWEROL / ASHOK LEYLAND / KOEL / CATERPILLAR	CATEGORY-1

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2026)	CATEGORY FOR TEST CERTIFICATION INSPECTION
42	ALTERNATOR	TDPS (TO POWER SYSTEM) / KIRLOSKAR / CATERPILLAR / GREAVES COTTON	CATEGORY-1
43	BATTERIES-LED ACID/LI-ION	CLN / EXIDE / AMARON	CATEGORY-3
44	BATTERY CHARGER	SELEC / VERTIV / DELTA	CATEGORY-2
45	UPS - ABOVE 10 KVA	DELTA / ORION / FUJI ELECTRIC / KRYKARD / 3EM / PROSTARM / UNILINE/ TMEIC / POWER ONE / RIELLO / ABB / SOCOMEC / EATON / SCHNEIDER / NUMERIC-LEGRAND/ VERTIV (EMERSON)	CATEGORY-3
46	UPS - UPTO 10 KVA	DELTA / ORION / FUJI ELECTRIC / KRYKARD / PROSTARM / RIELLO / UNILINE / ABB / POWER-ONE / DELTA / SOCOMEC / EATON / SCHNEIDER / NUMERIC-LEGRAND / VERTIV (EMERSON)	CATEGORY-3
D INTERNAL WIRING RELATED TEAMS			
47	MCB / ISOLATOR / MCBOB / RCCB / RCBO / ELCB	ANCHOR (PANASONIC) / ORIENT ELECTRIC / LAURITZ KNUDSEN / MITSUBISHI / LEGRAND (NOVATEUR) / C&S / HPL / ABB / POLYCAB / HAVELLS / SCHNEIDER / INDO ASIAN (NOVATEUR) / GM / MK HONEYWELL / BCH / EATON	CATEGORY-2
48	MS CONDUIT (ISI MARKED)	VPL / BEC / AKG / STEEL KRAFTS / TRINITY TOUCH / RMCON (RMG STEELS) / SUPER / JPC PIPES	CATEGORY-3
49	PVC CONDUIT (ISI MARKED)	VPL / FUSION / ASTRAL / SKYDA / BEC / NORPACK / MODI's / ANCHOR (PANASONIC) / POLYCAB / TRINITY TOUCH / AKG / GM / JPC PIPES	CATEGORY-3
50	INDUSTRIAL SOCKET IN SHEET STEEL ENCLOSURE WITH MCB/SWITCH	AJMERA ELECTROTECH LLP / LAURITZ KNUDSEN / POLYCAB / NEPTUNE-BALS / LEGRAND (NOVATEUR) / C&S / BCH / HAVELLS / HPL / SCHNEIDER	CATEGORY-4
51	INSULATED COPPER WIRE	RAJNIGANDHA / GEMSCAB / ALLCAB / AURAFLEX / V-MARC / SBEE / UNISTAR / POLYCORE / TORTEK / BATRA HENLAY / RR KABEL / AKG / ANCHOR (PANASONIC) / BENTEC / JMW KABEL / POLYCAB / AVOCAB (CHANDRESH) / SVARN / PARAMOUNT / RALLISON (LKB) / HAVELLS / NATCAB (KVALITY) / BONTON / GRANDLAY / GLOSTER / BCH / PLAZA / APAR / GM / PARAGON (ELEKTRON) / FINECAB / ZENIUM	CATEGORY-2
52	SWITCHES/ SOCKETS/ TELEPHONE/ TV/ DATA SOCKET/ BOXES (MODULAR TYPE)	RR KABEL / ANCHOR (PANASONIC) / ORIENT ELECTRIC / INDO ASIAN (NOVATEUR) / C&S / POLYCAB / HPL / LAURITZ KNUDSEN / LEGRAND (NOVATEUR) / HAVELLS / GM / MK HONEYWELL / WESTERN VEGA / ABB	CATEGORY-3
53	SWITCHES/ SOCKETS/ TELEPHONE/ TV/ DATA SOCKET/ BOXES (PIANO TYPE)	ANCHOR (PANASONIC) / BENTEC / HAVELLS / HPL / POLYCAB / MK HONEYWELL / WESTERN VEGA	CATEGORY-3
E FIRE ALARM EQUIPMENTS			
54	FIRE / SMOKE DETECTOR/ MULTI CRITERIA DETECTOR/ FIRE ALARM PANEL / REPEATER PANEL/ HOOTER / MANUAL CALL POINT / RESPONSE INDICATOR/ FAULT ISOLATOR	MOTOFIRE / VELOX / SCHNEIDER / PANASONIC / EATON / HOCHIKI / RAVEL / SIEMENS / BOSCH / APOLLO / EDWARDS (UTC) / G + M / SCHRACK / HONEYWELL / KIDDE (UTC) / GST (UTC) / TYCO / ASES	CATEGORY-2

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
55	FIRE SURVIVAL CABLE	GEMSCAB / SBEE / FRTEK / BATRA HENLAY / RR KABEL / SEPCIAL CABLES / SVARN / JMW KABEL / POLYCAB / ALOKE (ANKUR) / RALLISON (LKB) / KEC / GRANDLAY / RAVEL / GLOSTER / KEI / BONTON / BOSCH / WREXHAM / FUSION POLYMER	CATEGORY-2
56	FIRE SIGNAGES	ASES / LIFEGUARD (UNITED FIRE) / EATON / FIRE SHIELD / BOSCH / RAVEL / DELITE / AUTOGLD (PROLITE)	CATEGORY-3
57	ASPIRATION SYSTEM	SHOOTFIRE (VIMAL FIRE) / HOCHIKI / BOSCH / RAVEL	CATEGORY-2
F	LED LIGHT FIXTURE AND FANS		
58	LIGHT FIXTURE WITH LED - INDOOR	PYROTECH / GOLDWYN LED / KI KALINGIA / GM / NESSA / PLUS LIGHT TECH / LEGERO / MAGIK / LIGHTBOOK / LEKSA LIGHTING / R R KABEL (RR/ AARAYSTORM) / PANASONIC / EVEREADY / INSTAPOWER / POLYCAB / SURYA / HALONIX / HAVELLS / SIGNIFY / JAQUAR (JAQUAR LIGHTING) / HPL / BAJAJ / WIPRO / ORIENT / CROMPTON / REGENT	CATEGORY-2
59	LIGHT FIXTURE WITH LED - OUTDOOR/FACADE	PYROTECH / GOLDWYN LED / KI KALINGIA / GM / NESSA / PLUS LIGHT TECH / MAGIK / LIGHTBOOK / LEKSA LIGHTING / R R KABEL (RR/ AARAYSTORM) / PANASONIC / HPL / BENTEC (BENLO) / EVEREADY/ POLYCAB / K-LITE / SURYA / TRANSRAIL / HALONIX / HAVELLS / JAQUAR (JAQUAR LIGHTING) / SIGNIFY / INSTAPOWER / BAJAJ / WIPRO / ORIENT / CROMPTON / REGENT	CATEGORY-2
60	LINEAR LED/ CUSTOMISED/ DECORATIVE LED LIGHT FIXTURE	PYROTECH / GOLDWYN LED / KI KALINGIA / GM / LIGHT FORMS / PLUS LIGHT TECH / LEGERO / MAGIK / WMEL / FORUS / HUBLIT / LIGHTBOOK / PANASONIC / POLYCAB / R R KABEL (RR/ AARAYSTORM) / EVEREADY / SURYA / HALONIX / HAVELLS / HPL / SIGNIFY / BAJAJ / WIPRO / ORIENT / CROMPTON / REGENT	CATEGORY-2
61	AVIATION WARNING /OBSTRUCTION LIGHT	PYROTECH / FORUS / KI KALINGIA / HARYANA GENERAL INDUSTRIES / V5TP / K-LITE / SURYA / TRANSRAIL / HPL / INSTAPOWER / BAJAJ / WIPRO / CROMPTON /	CATEGORY-3
62	CEILING/ WALL / EXHAUST / PEDESTAL FAN (CONVENTIONAL / BLDG)	ORIENT ELECTRIC / RR KABEL / ANCHOR (PANASONIC) / POLYCAB / HALONIX / HAVELLS / ALMONARD / USHA / KHAITAN	CATEGORY-3
63	HVLS FANS	MARUT AIR / RR KABEL / RITE HITE	CATEGORY-3
G	AIRCONDITIONING AND FIRE FIGHTING ACCESSORIES		
64	G I / M S PIPE (ISI MARKED)	VPL / ITL / BEC / APL APOLLO / PRAKASH SURYA / JINDAL STAR / TATA / SAIL / HIRA PIPES (RR ISPAT) /	CATEGORY-2
65	MANUAL VALVE - BUTTERFLY/ SLUICE / CHECK / NRV / FOOT/GATE / GLOBE	LEHRY / SANT / VENUS / NEWAGE FIRE / CASTLE / ZOLOTO / VTM (VA VALVES) / EMERALD / ADVANCE VALVES / DIVINE / C&R	CATEGORY-2
66	MOTORISED VALVE - BALANCING / MODULATING / PICB / DELTA T / CONTROL / MIXING	SANT / VTM (VA VALVES) / CASTLE / DANFOSS / ZOLOTO / ANERGY	CATEGORY-2
67	SUCTION / POT / Y- STRAINER	VENUS / CASTLE / ZOLOTO / ANERGY / SANT / VTM (VA VALVES) / EMERALD	CATEGORY-2
68	FLEXIBLE CONNECTION FOR SPRINKLER / SPRINKLER	LIFEGUARD (UNITED FIRE) / FIRE SHIELD / NEWAGE / EXFLAME / HD / SAFEFIRE	CATEGORY-2
69	FIRE HYDRANT LANDING VALVES/ INSTALLATION VALVE/ FIRE BRIGADE CONNECTION	SHOOTFIRE (VIMAL) / LIFEGUARD (UNITED FIRE) / ZOLOTO / KALPEX (KALPATARU) / NEWAGE / EXFLAME / SAFEFIRE / HD / FIRE SHIELD	CATEGORY-2

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
70	FIRE HOSE PIPES/ FIRST AID HOSE REEL/ BRANCH PIPE / NOZZLE / COUPLINGS	SHOOTFIRE (VIMAL) / LIFE GUARD (UNITED FIRE) / KALPEX (KALPATARU) / NEWAGE / FIRE SHIELD / EXFLAME / SAFEFIRE	CATEGORY-2
71	FIRE EXTINGUISHERS	DSS / KANEX / SHOOTFIRE (VIMAL) / LIFE GUARD (UNITED FIRE) / CEASEFIRE / SAFEFIRE / AFS (ADVANCED) / KALPEX (KALPATARU) / EXFLAME / SUPREMEX / FIRE SHIELD / MINIMAX / SAFEX	CATEGORY-2
72	GAS BASED FIRE SUPPRESSION SYSTEM	SYNERGY & SYNERGY PLUS / FIRECEASE / FIRE TREX / VIVINA / ASES / CEASEFIRE / SHOOTFIRE (VIMAL) / LIFE GUARD (UNITED FIRE) / KALPEX(KALPATARU) / FOAMTECH / SUPREMEX / SIEMENS / FIRE TREX (SVS)	CATEGORY-2
73	KITCHENHOOD GAS BASED SUPPRESSION SYSTEM	SYNERGY / FIRECEASE / FIRE TREX / VIVINA / SHOOTFIRE (VIMAL) / UNITED / FOAMTECH / CEASEFIRE / KALPATARU /	CATEGORY-2
74	HIGH/LOW PRESSURE WATER MIST BASED FIRE SUPPRESSION SYSTEM	SYNEAQUAMIST / FIRE TREX / SHOOTFIRE	CATEGORY-2
75	FLOW SWITCH-PRESSURE SWITCH	OMICRON / ANERGY / DANFOSS / EMERALD / SWIZER	CATEGORY-3
76	FIREMAN AXE	LIFE GUARD (UNITED FIRE) / NEWAGE / FIRE SHIELD / ADVANCE	CATEGORY-3
77	DIESEL ENGINE DRIVEN PUMP FOR FIRE FIGHTING	TMTL (TAFE MOTORS) / KSB / WILLO / GRUNDFOS / KIRLOSKAR / ASHOK LEYLAND / CATERPILLAR / MAHINDRA POWEROL	CATEGORY-2
78	PUMPS -VERTICAL/ HORIZONTAL / SUBMERSIBLE	HAVELLS / WILLO / GRUNDFOS / ANDRITZ / KSB / KIRLOSKAR / XYLEM / AQUA_ANS / MATHER & PLATT / CROMPTON	CATEGORY-2
79	MOTORS	LHP / ROTOMOTIVE / KSB / HAVELLS / TMEIC / GRUNDFOS / BCH / KIRLOSKAR / BHARAT BULEE / ALSTOM / SIEMENS / CROMPTON	CATEGORY-2
80	MOTOR STARTER	BENTEC / KSB / HAVELLS / L.S POWER / GRUNDFOS / PHOENIX / C&S / BCH / SCHNEIDER / EATON / MOTOVARIO / SIEMENS / SCHNEIDER	CATEGORY-2
81	SINGLE PHASE PREVENTER / OVER LOAD PROTECTION/HIGH VOLTAGE/LOW VOLTAGE/EARTH FAULT PROTECTION	C&S / LAURITZ KNUDSEN / SELEC / SIEMENS	CATEGORY-3
82	G I SHEETS	JSW STEEL / TATA / HSL / SAIL	CATEGORY-2
83	GRILLS /DIFFUSERS	PRECISE / ASAWA INSULATION / MAPRO (AIR FLOW) / CRYSTAL / TRISTAR	CATEGORY-3
84	INSULATION MATERIAL - ROCK WOOL/ GLASS WOOL	ENSAVE / ROCK INSUL / AEROLAM / SUNROCK (THERMOCARE ROCK WOOL) / INSUFLEX (THE SUPREME) / LIONROCK / POLYBOND / EPACK / TWIGA INSUL	CATEGORY-3
85	INSULATION MATERIAL - XLPE/EPDM/ NITRILE RUBBER	AEROFOAM / PARAMOUNT / SAFARI / AEROLAM / INSUFLEX (THE SUPREME) / EPACK / SUNROCK (THERMOCARE ROCK WOOL) / INSUFLEX (THE SUPREME) / LIONROCK / POLYBOND / TWIGA INSUL	CATEGORY-3

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
86	PRE-INSULATED DUCT	ASAWA INSULATION / MECHEASY	CATEGORY-3
87	PRE-FABRICATED GI DUCT	ASAWA INSULATION / WAD / DUCTOFAB / WAVES / ZECO / ADVANCE VENTILATION	CATEGORY-3
88	FIRE DAMPERS	MAPRO (AIR FLOW) / GREENHECK / TRISTAR / RUSKIN / CARRIER	CATEGORY-2
89	AIR CURTAINS	EURONICS / MITZVAH / TECHNOCRATS / DOLPHY	CATEGORY-2
90	MODULATING MOTOR/FIRE DAMPER MOTOR	LHP / ANERGY / HONEYWELL / GRUNDFOS / BALEMO / SIEMENS	CATEGORY-2
91	AIR FILTERS (MERV/ESP/HEPA) FOR HVAC SYSTEM	MECHMAARK / ADITYA / O2 CURE / WAVES / HUMIDIN / INTELLIGREEN	CATEGORY-3
92	THERMOSTATS / HUMIDISTATS	OMICRON / ANERGY / FINDER / DANFOSS / HONEYWELL	CATEGORY-3
93	THERMOMETERS/ PRESSURE GAUGE	OMICRON / ANERGY / EMERALD / FIEBIG	CATEGORY-3
94	INTEGRATED BUILDING MANAGEMENT SYSTEM (IBMS)/BMS/ SCADA SYSTEM (HARDWARE* & SOFTWARE, EXCEPT COMPUTER & ACCESSORIES)	SCHNEIDER / ENLITE / PANASONIC / WAGO / PHOENIX / SIEMENS / AZBIL / LAURITZ KNUDSEN / TRIDIYM (* includes all hardware of BMS)	CATEGORY-3
95	FIELD DEVICES (FOR IBMS/BMS/SCADA)	SELEC / OMICRON	CATEGORY-3
96	VFD DRIVE	YASKAWA / SELEC / FUJI / TMEIC / LAURITZ KNUDSEN / DANFOSS / SCHNEIDER / SIEMENS	CATEGORY-3
H	AC PLANTS, AC UNITS & EQUIPMENTS		
97	AIR-CONDITIONER UNITS - SPLIT / WINDOW / CASSETTE/ TOWER	HAVELLS / HITACHI (JOHNSON) / LG / BLUE STAR / DAIKIN/ VOLTAS / SAMSUNG / HAIER / O GENERAL / PANASONIC / CARRIER	CATEGORY-2
98	PRECISION AIR CONDITIONING (PAC)	CLIMAVENTA / SWEGON BLUE BOX / SIDWAL	CATEGORY-3
99	PACKAGED AIRCONDITIONER	DAIKIN / HITACHI (JOHNSON) / VOLTAS / LG / SIDWAL / CARRIER / DAIKIN / BLUE STAR	CATEGORY-2
100	CHILLERS	KIRLOSKAR / DAIKIN / CARRIER / VOLTAS / BLUE STAR / LG / CLIMAVENETA / TRANE / YORK / SWEGON BLUE BOX / DUNHAMBUSH	CATEGORY-1
101	AIR HANDLING UNITS (AHU)	CRYSTAL / CITIZEN / WAVES / EDGETECH / CARRIER / ZECO / HUMIDIN / TRISTAR	CATEGORY-1
102	FAN COIL UNIT (FCU)	WAVES / CRYSTAL / ZECO / CITIZEN / EDGETECH / CARRIER / DAIKIN / TRISTAR / YORK	CATEGORY-2
103	VRV/ VRF HVAC UNIT	LG / HITACHI (JOHNSON) / SAMSUNG / DAIKIN / VOLTAS / HAIER / CARRIER / BLUE STAR	CATEGORY-2

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
104	COOLING TOWER UP TO 200 TR.	DELTA / BELL COOLING TOWERS / MIHIR / PAHARPUR	CATEGORY-2
105	COOLING TOWER ABOVE 200 TR.	DELTA / BELL COOLING TOWERS / MIHIR / PAHARPUR	CATEGORY-2
106	EXPANSION TANK	ANERGY	CATEGORY-3
107	AIR & DIRT SEPARATOR	ANERGY	CATEGORY-3
108	FAN - AXIAL FLOW / INLINE / VENTILATION / PROPELLER / PLUG	DYNAIR-MAICO / DUSTECH / KRUGER / WAVES / HUMIDIN / WOLTER / AIR FLOW / RR KABEL / CRYSTAL / GREENHECK	CATEGORY-2
109	R O SYSTEM /WATER SOFTENING PLANT	SURYA RO / DELTA / WAE / VENZA (MGROW)	CATEGORY-3
110	WATER COOLER	CLIMATROL / VOLTAS / ORIENT ELECTRIC / SIDWAL	CATEGORY-3
111	WATER DISPENSER	WAE / VENZA (MGROW) / VOLTAS	CATEGORY-3
112	DRINKING WATER FOUNTAIN	WAE / VENZA (MGROW) / OASIS	CATEGORY-3
I	PA SYSTEM & RELATED ITEMS		
113	AMPLIFIERS	ATEIS / SCHRACK / HEINRICH / BOSCH / HONEYWELL / OPTIMUS / BOSE	CATEGORY-2
114	ANNOUNCEMENT MICROPHONES /CAR CALL CONSOLES	ATEIS / SCHRACK / HEINRICH / BOSCH / HONEYWELL / OPTIMUS / BOSE	CATEGORY-2
115	CONTROLLERS	ATEIS / SCHRACK / BOSCH / HEINRICH / HONEYWELL / OPTIMUS	CATEGORY-3
116	SPEAKER	ATEIS / SCHRACK / HEINRICH / BOSCH / NOTIFIRE / OPTIMUS / BOSE	CATEGORY-3
117	DIGITAL CALL STATION / WORK STATION	AVTRON / ATEIS / HEINRICH / BOSCH / OPTIMUS	CATEGORY-3
118	EQUIPMENT RACK	HEINRICH / BOSCH / PRESIDENT / ORDEIN	CATEGORY-3
119	DVD/DVR /MP3 PLAYER	TYCO / HEINRICH / BOSCH / HONEYWELL / SIEMENS / OPTIMUS	CATEGORY-2
120	CABLE FOR MICROPHONE / SPEAKER	RR KABEL / JMW KABEL / POLYCAB / BONTON / BOSCH / HPL / KVVS (INDUSTRIAL)	CATEGORY-2
121	DIGITAL LINE ARRAY SPEAKER	ATEIS / HEINRICH / BOSCH / BOSE / OPTIMUS	CATEGORY-2
122	CCTV CAMERA	AVTRON / TYCO / ILLUSTRATE / HEINRICH / SIEMENS / BOSCH / HONEYWELL / ULTRAK / PELCO	CATEGORY-2
123	MONITOR /DISPLAY-LCD / LED / PLASMA	LG / PANASONIC / SAMSUNG / SONY	CATEGORY-2
124	COMPUTER /LAPTOP (FOR IBMS/BMS/SCADA)	HP / DELL / LENOVO / IBM	CATEGORY-4
125	COMPUTER ACCESSORIES (KEY BOARD/MOUSE)	HP / DELL / LENOVO / IBM	CATEGORY-4

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
J	SOLAR PLANT & ACCESSORIES		
126	SOLAR INVERTER/ POWER CONDITIONING UNIT	SELEC / HAVELLS/ POWER ONE	CATEGORY-2
127	SOLAR MODULES	SWELECT / HAVELLS/ JAKSON	CATEGORY-2
128	DC CABLES	GEMSCAB / APAR / RR KABEL / SPECIAL CABLES / JMW KABEL / POLYCAB / HAVELLS / RALLISON (LKB) / KEC / HPL / GLOSTER / KEI / BONTON	CATEGORY-2
K	MISCELLANEOUS & OTHER MECHANICAL ITEMS		
129	HAND DRIER	TECHNOCRATS / EURONICS / DOLPHY / ANAND AUTOMATIC SYSTEM	CATEGORY-3
130	DOUBLE WALL CORRUGATED HDPE PIPE/PLAIN HDPE PIPE	VPL / GANGOTRI / ASTRAL / CPE / BEC PLAST / KESHAV KRIPA / VALENS / TIRUPATI PLASTOMATIC / GEMINI / HIMALYAN / MANGALAM	CATEGORY-3
131	AUTOMATIC SLIDING DOOR	HOUSYS / GEZE / NEPTUNE / S. ADITYA / DORMAKABA / TECHNOCRATS / AUTOINGRESS	CATEGORY-3
132	ELEVATOR	ORBIS / SCHINDLER / FUJITEC / INFRA / TRIO ELEVATOR / OMEGA ELEVATOR / ESCON / JOHNSON LIFTS / ECE / KONE / TKE / OTIS	CATEGORY-1
133	ESCALATOR /TRAVELATOR	ORBIS / SCHINDLER / TRIO ELEVATOR / OMEGA ELEVATOR / JOHNSON LIFTS / KONE / TKE / OTIS	CATEGORY-1
134	BOLLARD	HOUSYS / AVIANS / SWARAJ / S. ADITYA / TECHNOCRATS / EURONICS / NEPTUNE / BROSIS / FAAC	CATEGORY-3
135	BOOM BARRIER	HOUSYS / AVIANS / SWARAJ / S. ADITYA / DORMAKABA / TECHNOCRATS / BROSIS / NEPTUNE / AUTOINGRESS / FAAC / SPEEDGATZ	CATEGORY-3
136	TROLLEY GATE	AVIANS / SWARAJ / S. ADITYA / TECHNOCRATS / DELITE / AUTOINGRESS / LOTUS	CATEGORY-3
137	TYRE KILLER/SPIKE BARRIER	HOUSYS / SWARAJ / S. ADITYA / TECHNOCRATS / NEPTUNE / BROSIS / FAAC / SPEEDGATZ	CATEGORY-3
138	UNDER VEHICLE SCANNING SYSTEM	HOUSYS	CATEGORY-3
139	EXTERNAL LIGHTING POLES/ DECORATIVE LIGHT POLE	SUBHAM / AMBIKA POLES / LYSAGHTPOLE™ / VAKRANGEE / VSTP / UTKARSH / RMSCO (RAJASTHAN METAL) / SKIPPER / BP PROJECTS / K-LITE / TRANSRAIL / PRAKASH SURYA (SURYA ROSHNI) / SUMIP / SIGNIFY / BAJAJ / WIPRO / CROMPTON / ORIENT ELECTRIC	CATEGORY-3
140	HIGH MAST	SUBHAM / AMBIKA POLES / VAKRANGEE / VSTP / LYSAGHTPOLE™ / UTKARSH / SKIPPER/ BP PROJECTS / K-LITE / PRAKASH SURYA (SURYA ROSHNI) / TRANSRAIL / SIGNIFY / BAJAJ / WIPRO / ORIENT ELECTRIC / CROMPTON	CATEGORY-3
141	ALUMINIUM LADDERS / HYDRAULIC LADDERS	DELITE	CATEGORY-2
142	BOOM /SCISSOR/SPIDER/VERTICAL LIFT	MLIFT	CATEGORY-2
143	DASH FASTENERS	HILTI / FISCHER	CATEGORY-4
144	GEAR BOX	MGM VARVEL / IMAX	CATEGORY-3
145	GEARED MOTOR	LHP / LENZE / ROTOMOTIVE / MGM VARVEL / IMAX	CATEGORY-3
146	WEATHERPROOF JUNCTIONBOX	TRINITY TOUCH / SPELSBERG (CAPE) / RITTAL	CATEGORY-3

ITEM CODE	ITEMS	PREFERRED MAKES (W.E.F. 10.07.2025)	CATEGORY FOR TEST CERTIFICATION/ INSPECTION
147	EV CHARGERS	P2 POWER / E-FUEL / AXONIFY TECH SYSTEMS PRIVATE LIMITED	CATEGORY-1
L.	GROUND LIGHTING ITEMS		
148	PAPI (NON-LED)	AMA / VARDHMAN / NASU SYSTEM	CATEGORY-1
149	LAMP (HALOGEN)	YOUYANG	CATEGORY-3
150	AGL FITTING (LED)	VARDHMAN / AMA	CATEGORY-1
151	AGL FITTING (NON-LED)	VARDHMAN / AMA	CATEGORY-1
152	ALCMS / ILCMS	VARDHMAN	CATEGORY-1
153	ISOLATING TRANSFORMER	TRIO / CTC (CREATIVE TRADING) / VARDHMAN / AMA / BILDAL / ELECTROMACH / YOUYANG	CATEGORY-1
154	CONSTANT CURRENT REGULATOR (CCR)	VARDHMAN / AMA / HONEYWELL / YOUYANG / NASU SYSTEM	CATEGORY-1
155	5 KV GRADE AFL CABLE - UNSHIELDED / SHIELDED	GEMSCAB / APAR / RR KABEL / ALOKE (ANKUR) / RALLISON (LKB) / JRD / KEI / GLOSTER	CATEGORY-1
156	1.1 KV GRADE SECONDARY LEAD FOR AFL CABLE	GEMSCAB / APAR / RR KABEL / AMA / ELECTROMACH / ALOKE (ANKUR) / RALLISON (LKB) / JRD	CATEGORY-2
157	PLUGS / RECEPTACLE / CONNECTOR	CTC (CREATIVE TRADING) / ELECTROMACH / ALOKE (ANKUR) / VARDHMAN / NEPTUNE / AMA / BILDAL / YOUYANG	CATEGORY-2

Note: This is mere enlistment as preferred make and is subject to the compliance of Technical Specification mentioned in tender.

CATEGORY REQUIREMENT OF TEST CERTIFICATE/ INSPECTION

CATEGORY-1:

- Type test certificate for similar item done. If not one of the items offered is to be type tested.
- OEMs routine test certificate.
- Acceptance test to be conducted in the presence of AAI representative at OEMs factory.

CATEGORY-2:

- Type test for similar done. If not, one of the items offered is to be type tested.
- OEMs routine test certificate.
- Visual and functional check by PMC / Engineering Consultant representative (AAI official incase of non avialibility of PMC/ Engineering Consultant) at AAI airport site.

CATEGORY-3:

- OEM/ Dealer/ Contractor routine test certificate.
- Visual and functional check by PMC / Engineering Consultant representative (AAI official incase of non avialibility of PMC/ Engineering Consultant) at AAI airport site.

CATEGORY-4:

- Visual and functional check by PMC / Engineering Consultant representative (AAI official incase of non avialibility of PMC/ Engineering Consultant) at AAI airport site.

SCOPE AND FUNCTIONAL PARAMETERS OF SURVEILLANCE CCTV SYSTEM

SECTION- I

1. Guidelines:

- 1.1 IP SCCTV System shall be suitable for commercial supply of 230 V ($\pm 10\%$), 50 Hz.($\pm 5\%$) single phase AC and it shall be comprises of IP Digital Outdoor & Indoor Colour video Cameras, Network Switches, Network Video Recorder/ CAMERA SERVER. Storage system consisting of IP Network, Attached Storage for period of 30 days (NAS)/Storage Area Network (SAN) for recording, Application software with latest Surveillance Video Management System (SVMS), Colour LED/LCD monitor with LED back light, with workstation having Mouse-Keyboards for viewing of live and recorded images online UPS power backup for minimum 30 minutes on full load and including with cabling and conduit work as required at site. System shall have provision of WAN connectivity for remote monitoring.
- 1.2 System shall facilitate viewing of live and recorded images and controlling of all cameras by the authorized users present in the LAN and WAN connectivity for remote monitoring through firewall.
- 1.3 System shall provide inter-operability of hardware, operating system, software, networking, printing, database connectivity, reporting, and communication protocols. System expansion shall be possible through off-the-shelf available hardware.
- 1.4 IP based SCCTV System shall use video signals from various types of indoor/outdoor CMOS colour cameras installed at different locations, process them for viewing, recording and replay simultaneously on all workstations/Video wall at Central Control Room/Local Control Rooms of all the cameras after video compression using H.265 or better standard. Joystick controller/ Mouse-Keyboards shall be used for Pan, Tilt, Zoom, Camera Selection and other functions of desired cameras. When both the viewing stream and the recording stream are set at the same FPS and resolution, the camera shall send on the network a single multicast stream this shall help reduce network Bandwidth.
- 1.5 System must provide built-in facility of Water-marking & Digital Certificate AES 256 or better to ensure tamperproof recording so that these can be used as evidence at a later date. The recording shall support audit trail feature.
- 1.6 System to have facility of additional camera installation beyond the originally planned capacity for a minimum of 25% for hardware as well as VMS software expansion.

- 1.7 The offered system shall have facility to export the desired portion of clipping (from a desired date/time to another desired date/time) of multiple cameras on external storage Device. Viewing of this recording shall be possible on standard PC using standard software like Windows Media Player, though there should be an option available to export native recordings with OEM player. VMS Player should be able to play exported video in adaptive views and should be able to play up to 64 cameras.
- 1.8 VMS System should have built-in health diagnostic module to monitor details like Network link failure, device online/ offline details, Camera failure, Storage disconnection error, bandwidth loss errors etc. Further it shall be capable to monitor operation of all services and having facility to restart automatically when system malfunctions.
- 1.9 The system shall provide tamper-proof video recording.
- 1.10 **Retrieval:** The SCCTV software application should allow retrieval of data instantaneously or any date/time interval chosen through search functionality of the application software. In case data is older than 30 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any external storage device or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system, which can be audited at a later date.
- 1.11 Capturing of Driver's Photographs & Vehicle Registration Number:
 - (a) It shall have the capability of capturing photographs of drivers at Naka points.
 - (b) The system shall be equipped with Automatic Number Plate Recognition (ANPR) of vehicles.
- 1.12 **Artificial Intelligence:** It shall have image tracking facility. If any object is found to be stationary for a pre-defined period the system shall track the event and alert the operator. This facility may be provided on select cameras at Entry point, Boarding gates, and Arrival area and as defined by the Airport Operator/User. The system should have the features for identifying tail-gating, vehicle detection features, unattended baggage identification, queuing analysis, external text insertion feature and intruder detection. Various use scenarios of Artificial Intelligence based Video Analytics at Airports are mentioned in Appendix-1.
- 1.13 **Artificial Intelligence (AI) enabled Video Analytics and Face Recognition Software** shall be deployed on Servers at the CCTV Equipment Room within the Airport premises.
- 1.14 It shall provide video file export tool to export the native video format with all protections (e.g. digital certificate, encryption) for enabling to play this audio/video on a computer/Laptop.
- 1.15 The native file format audio/video player shall show the status of the

audio/video authentication as available with the original file format, to enable forensic officials to confirm whether audio/video file has been tampered with.

- 1.16** Video Management and Video Recording shall be deployed on Servers/Network Video Recorders. For Viewing and Monitoring of Cameras, requisite numbers of PC Workstations/Video Wall and Large format display monitors/LED walls shall be provided at CCTV Control Room. Required Storage shall be provided on Servers/Network Video Recorders or on Network Attached Storage (NAS)/ Storage Area Network (SAN).
- 1.17** In case of any failure or interruption of network, the Camera shall automatically start recording on Edge Storage Memory Card at resolution and frames per second as required and when the network recovers, the video data shall automatically be transferred to the Server/NVR without any impact on the system operations (Network Replenishment feature).
- 1.18** The system shall have diagnostics facility for Video & Network interfaces. System logging shall be possible either through system software or console port on the system.
- 1.19** The Recording shall be stored for at least 30 days for all Cameras with Full HD resolution and 25 FPS with H.265 or higher Video Compression.
- 1.20** Alarms shall be stored for at least 30 days.
- 1.21** The power supply available at the stations shall be 220 V / 50 Hz AC nominal and stabilized power from UPS to avoid fluctuation in the power supply. The UPS specification is out of the scope of this specification.
- 1.22** The CCTV Camera system and SVMS shall be time synchronized to IST using time server (that is NTP network time protocol), so that all devices of the system maintain same time.

SECTION- II

2 General Design/ functional parameters of SCCTV system

- 2.1 CAMERA SERVER software shall run on Commercial-off-the-shelf (COTS) Servers (Camera Servers & Database Server). Each Camera Server shall be able to handle 100 or more cameras. Camera, Database & Video Analytics Server will work as failsafe/redundant Server for each other.
- 2.2 VMS shall support failover for Recording, Management & Database Servers. Clustering shall be used for management and database server to provide high availability of application and recording servers should use native failover and users shall be able to play the video from failover servers without any manual interventions. Failover server video shall be synchronized with primary server once primary server is up.
- 2.3 Camera Server shall offer both video stream management and video stream storage management. Recording frame rate & resolution in respect of individual channel shall be programmable.

- 2.4 System shall ensure that once recorded, the video cannot be altered; ensuring the audit trail is intact for evidential purposes.
- 2.5 System shall provide sufficient usable storage of all the camera recordings in Full HD i.e. 1920x1080 or better for a period of continuous THIRTY (30) days on Serial Attached SCSI (SAS)/NL-SAS at minimum 25 FPS at 1920x1080 resolution or better quality using necessary compression techniques for all cameras (Extended capacities of Cameras i.e. present capacity +25%). In case thermal cameras are installed, recording of Thermal Cameras shall be as per their resolution @25FPS.
- 2.6 All the indoor cameras & control equipment shall be suitable for operation from 0° C to 40° C and relative humidity up to 80 % noncondensing. Cameras & other equipment, meant for outdoor installations, shall be suitable to work from (-) 10° C to (+) 55° C with RH up to 90% non-condensing. This temperature range may be achieved with or without heater.
- 2.7 Indoor cameras shall be either with vari-focal lens or Pan, Tilt & Zoom (PTZ) lens as per site requirement. All Cameras shall be Day/Night Wide Dynamic Range (WDR) and with Digital Noise Reduction (DNR) Colour Cameras. All Cameras should be with Infra-Red (IR) sensors.
- 2.8 All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.
- 2.9 Facility of camera recording in real-time mode (25 FPS) with option of lower FPS as well as in any desired combination must be available in the system.
- 2.10 Monitoring at Local control rooms may be restricted to operation of certain cameras only & System administrator should be able to configure the system, accordingly. More than one Local Control rooms may be required in the proposed system with individual configuration.
- 2.11 Database Server shall keep track of all configurations & events. This shall help in proper System administration & management of redundancies etc. suitable provision shall be made to keep database backup in same or another Server.
- 2.12 All the workstations in LAN should be provided with software to view and control the Cameras and retrieve the recorded video images from the CAMERA SERVER/NAS/SAN seamlessly.

2.13 Integration Interface with other system as per site requirement:

The system shall provide an integration interface to third party systems using well defined API SDK/ Open Database Connectivity. The API SDK for third party (Other system manufacturers involved in this project) shall be provided along the system without any additional cost,

which shall enable them to develop the software interface with CCTV system. The software shall have the inbuilt facility to seamlessly integrate to industry standards fire Alarm system & Building Management System (BMS) system and Baggage Handling System (BHS) with/without any SDK.

- 2.14 The Video Surveillance System shall be based on ONVIF, where the Video Management Software, Video Recording Software, Artificial Intelligence (AI) enabled Video Analytics Software and Face Recognition Software can work and integrate with any make of IT hardware like Server, Storage, Workstation, Network Video Recorder and Switches etc.
- 2.15 Required number of licenses shall be provided by OEM/Vendor for Video Management, Video Recording, Artificial Intelligence (AI) enabled Video Analytics and Face Recognition Software as per site requirement.
- 2.16 The Video Recording and Management System shall provide secured recording for evidence purposes and user authentication to protect data integrity.
- 2.17 Redundant Servers/NVRs shall be provided. The Redundancy System shall support defined number of Servers/NVRs in N+1 configuration (Value of N to be specified by the airport operator) so that the recording and playback availability is not affected in case of failure of any Server/NVR. The recording of last 30 days at any given point of time should be available through redundant Server/NVR in case of a Server/NVR failure. The recording should be available for users from redundant server without any manual intervention and disruption.
- 2.18 To ensure security of SVMS (Camera & Software) from vulnerabilities & breaches and discourage false undertaking from OEMs, security auditing and testing of equipment including source code of camera and software shall be carried out from STQC (Ministry of Electronics & Information Technology) and any other Government Agency from the list of CERT-In empanelled Information Security Auditing Organization. In order to ensure security of network and other IT equipment of the SVMS system, airport operator should ensure that cyber security auditing and testing at the time of POC (Proof of Concept) as well as at the time of completion of project are conducted or as specified.
- 2.19 OEMs must submit a declaration certificate regarding their genuineness, and shall not have 3rd party manufacturing from any company blacklisted in India or abroad (due to proven backdoor access and data vulnerability) or any country sharing land border

with India. The Intellectual Property Rights (IPR) of all manufactured final product and source code of all software including camera firmware, switch firmware, FRS algorithm, Command Control Centre Software etc. should not reside in countries sharing land borders with India, until unless specifically allowed by the Government of India and is registered with the Competent Authority of Government of India. Proof of IPR & source code residing in which country and requisite permission & registration with Competent Authority of Govt. of India, as applicable to comply with the above, shall be provided by the OEMs.

- 2.20 OEM need to confirm that the equipment, like Cameras etc., shall not be installed with standards like - GB28181, GB/T28181-2011, GB/T 28181-2011, GBT 28181- 2011, GBT28181-2011, GB/T28181-2016, GB/T28181-2022, GB/T25724 etc., protocols/standards and there shall be no option in the camera web page/settings to activate or deactivate such protocols/standards any of their version(s) or any such protocol which allow certain organizations to bypass all security parameters and look into the devices directly.
- 2.21 The MAC address of all cameras should not be registered in the name of any OEM/ company/ entity sharing land border with India until unless specifically allowed by the Government of India.
- 2.22 Mean Time Between Failure (MTBF) calculated at 40°C for each type of camera should not be less than 50,000 hours for which OEM shall submit complete and detailed test reports issued from Govt. / NABL Accredited Test Labs / 3rd party test house of international repute such as UL, TUV etc.

SECTION- III

3 Provision covered in video surveillance software system.

- 3.1 The software should provide for storage of configuration of cameras, IP Speakers, IoT Sensors, ANPR as applicable.
- 3.2 The software should come with a State of Art Graphical User Interface with interactive Geographic Information System (GIS) MAP for display of Camera location/ information.
- 3.3 The Graphical user interface (GUI) should be equipped with features such as map navigation features, measurement tools, Display and update of targets / intruders, display of text labels and annotations and top-level view of common operating picture.
- 3.4 The software shall support flexible 1/4/9/16/24/64 user defined Windows Split screen display mode or scroll mode on the PC/Workstation monitor/Video Wall or on preview monitor as per site requirement.

- 3.5 The software shall be able to control all cameras features such as PTZ control, Iris control, auto/manual focus, and colour balance of camera, Selection of pre-sets, Video tour selection, IoT Sensors etc.
- 3.6 The software is required to generate reports of stored device configuration. The control software is required to provide alarm and alarm log. The log shall be able to be archived, printed and displayed using a device filter, a device group filter and/or a time window.
- 3.7 The software shall have user access authority configurable on per device or per device group basis. The authorized user shall have the facility to request the access of any camera and can control the camera for a reservation period. Control of camera is released after the reservation period.
- 3.8 The system software shall provide User activity log (audit trail) with user id, time stamp, and action performed, etc.
- 3.9 The administrator shall be able to add, edit & delete users with rights. It shall be possible to view ability/ rights of each user or the cameras, which can be viewed & controlled as per the permission assigned by the administrator.
- 3.10 The users shall be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user. There shall be minimum 03 hierarchical levels of security for providing user level log in.
- 3.11 The system software shall have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes shall be disabled and enabled using scheduled configuration. It shall also be possible to search and replay the recorded images on date, time and camera wise. It shall provide onscreen controls for remote operation of PTZ cameras. It shall have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera shall be possible.
- 3.12 It shall provide programmable motion detection and recording, to be defined area-wise. Open interface to receive Motion trigger and open interface to define the areas (at least four different areas) should be available from the cameras. System must be able to support video motion detection algorithms to detect and track objects, learn the scene, adapt to a changing outdoor environment, ignore environmental changes including rain, hail, wind, swaying trees and gradual light changes. On Detection, software must be able to generate an alarm (visual/audio) to the operator.
- 3.13 The settings shall be individually configurable for each alarm and each camera, pre-record duration. This shall allow the Camera Server to capture video prior to the alarm/event, as well as after the alarm/ event. Shall be selectable from a list of values ranging between 0 seconds and 5 minutes.

- 3.14 Data storage should be at a central location in the airport. The Capacity of storage should be for the period of continuous 30 days or more. For every 30 disks, one spare disk needs to be configured over and above required capacity. The storage system should follow FIFO on recording.
- 3.15 The software shall support web based user connecting via the Internet/Intranet and mobile OS (Android, iOS).
- 3.16 The software shall support a built-in Hardware or Software Watchdog monitor module. Watchdog Software shall monitor operation of all services and automatically restart them if they are malfunctioning.
- 3.17 The software should be able to receive alarm signal of the camera and should be able to send relay out signal through the camera.
- 3.18 The software shall provide a facility for any alarm input initiating any action in the SVMS system from third party integrations like ACS, FAS, BMS, BHS etc. The software should provide a reporting utility for tracking but not limited to the following options. Video and images shall be stored with reports for documenting events.
- a) Alarms, Incidents, Operator logs, Service requests
 - b) The SMS/Email/WhatsApp Alert shall be generated in response to alarms triggered in SVMS software and sends out email alerts to a preconfigured list of recipients.
 - c) It shall be possible to export the settings of various entities within the SVMS i.e. Archive, Directory, cameras, warranty, etc. It shall be possible to print these reports
 - d) It shall be possible to get reports on past events by querying the audit databases. It shall allow the search by User Logon, Entity Configuration, Incident, Alarm, Application Failure, and Equipment Failure.
 - e) It shall allow passage of specific alarms to specified users rather than sending all alarms to every user.
- 3.19 The offered SVMS software should be ONVIF (Open Network Video Interface Forum) profile S, G, T & M compliant. The OEM of SVMS software should be full member of ONVIF.
- 3.20 The VMS must possess a security Vulnerability Assessment and Penetration Testing (VAPT) certification. This certification must be obtained through an agency empanelled by the CERT-In.
- 3.19. Artificial Intelligence (AI) enabled Video Analytics Software:
- A) Possible applications of Artificial Intelligence (AI) enabled analytics software

for specified number of Cameras (to be decided by AO, BCAS, ASG/APSU, IB) shall include the following minimum Artificial Intelligence (AI) enabled video analytics software.

- i) Intrusion Detection
- ii) Camera Tampering
- iii) Loitering Detection
- iv) Human & Vehicle Detection (also unauthorized/suspicious parking)
- v) Search of Humans based on Attribute
- vi) Colour Search
- vii) Fallen Person
- viii) Combination Search (Human/Vehicle & Colour)

Video Analytics system should have capability of integration with VMS. It should be possible to configure any of the camera from VMS application.

Note: The software shall have filters to distinguish between humans/ animals and vehicles/ objects.

Search of Humans based on Attribute:

1. The AI should be able to sort through hours of video with ease, to quickly locate a specific person of interest. Attribute Search should improve incident response time and enhance forensic investigations by helping operators compile robust video evidence, create a powerful narrative of events, and reveal an individual's route or last-known location.
2. AI software should allow operator to mark a person who has been identified as a suspect in any playback video or in live mode. It should then have the capability to track and search the objects movements across multiple cameras based on the Attribute of the person and show the results so that the user can track the movement of the person across cameras.
3. In the event when a suspect's face is not captured clearly or not recognizable due to any reason, the AI software should allow operators to search a Person based on a person's Attribute characteristics and retrieve intelligent information to locate a specific person or vehicle of interest across multiple recorded video streams from FHD Bullet/Box, Dome cameras.
4. It should sort through hours of video across all the station cameras with ease, to quickly locate the specified person across cameras based on his Attribute, reducing search time from day and hours down to minutes.

Colour Search:

5. In the event when suspect face is not clearly visible, in such case a colour base

detection and search should be available with Artificial Intelligence (AI) enabled video analytics.

Fallen Person

6. In case of any person falling due to any reason should be detected.

Combination Search (Human/Vehicle & Colour)

7. Artificial Intelligence (AI) enabled video analytics should be able to search for suspects with combination of search criteria like Colour and Object (Human / Car).

B) Artificial Intelligence (AI) enabled Video Analytics Software can be implemented at server (which should be able to work 24x7, 365 days) level in the control room.

C) The Artificial Intelligence (AI) enabled Video Analytic server shall support redundancy with N:1 redundancy configuration for Artificial Intelligence (AI) enabled Video Analytic Servers.

D) Security Verification Certification: The Artificial Intelligence (AI) enabled Video Analytics Software shall have security features which can be deployed meeting the security assurance requirements for security, vulnerabilities and verified from the STQC (Ministry of Electronics & Information Technology) or any other Government Agency from the list of CERT-In empanelled Information Security Auditing Organization for testing and issuing the certificate / clearance.

3.20. Face Recognition Software:

- i. Face Recognition System shall work on real time and offline mode.
- ii. The system shall capture face images from live CCTV video feed and generate alerts, if blacklist match is found. FRS alerts should be pushed to the Video Management System/ NVR. (Seamlessly integrated with Video Management System /NVR).
- iii. The system shall have the best suited technology employed for 1: N (one to many) matching application when they enter the field of view of CCTV Cameras. It should have a 1:1 (one to one) verification feature for Access control systems at some locations as required.
- iv. The system shall have the provision to take multiple samples of same face belonging to same person.

- v. The system shall be able **to** work on moderate face rotation either horizontal or vertical. It should support a yaw angle of -40 to +40 degrees, a pitch angle of -30 to +30 degrees and a roll angle of -20 to +20 degrees.
- vi. The system shall be able for matching suspect faces from pre-recorded video feeds obtained for CCTV deployed various identified locations.
- vii. The system shall be able to add photographs obtained from law enforcement agencies to the criminal's repositories along with option details for sex, age, etc. for future searches.
- viii. The system shall support diverse graphic & video formats as well as live Cameras.
- ix. The identification of faces should be contactless, at a distance and on the move and in the crowded area.
- x. The system shall have in-built tool with capability to build partial faces and enhancement of quality of image before enrolment.
- xi. The system shall be able to utilize any of the file formats like JPEG, PNG, BMP, TIFF etc. format for enrolment for matching.
- xii. The system shall be able to check if new enrolled face is already enrolled in the data base before registering the new enrolled face in the system.
- xiii. The system shall have option to enrol face images from CCTV Cameras.
- xiv. The system shall have capacity to create different categories of people with option to customize the matching threshold for different categories.
- xv. The system shall be able to work on full HD.
- xvi. The system shall be able to be implemented on IT hardware like Server (which should be able to work 24x7, 365 days).
- xvii. The system shall be able to use latest CPU and GPU based processing for multiple Camera streams in a single Server (which should be able to work 24x7, 365 days).
- xviii. The system shall be able to work on windows / Linux operating system.
- xix. The system shall employ database system like MS SQL or Oracle or PostgreSQL or

MongoDB or any other data base system.

- xx. The system shall have the capability to have face image data base up to 10,00,000 (or as specified by the purchaser) for 1 : N matching. The system should be scalable to upgrade for higher data size as and when required with additional license for data base.
- xxi. The system shall be able to work on cameras which are included in this specification.
- xxii. a) The Face Recognition Algorithm should have participated and have been established in the Face Recognition Algorithm Evaluation conducted by NIST (National Institute of Standards and Technology, U.S. Department of Commerce) The NIST benchmark/ latest performance FRVT test results of current calendar year with respect to the opening date of tender or last 1 preceding year, the performance efficiency of the algorithm shall be within the top 25 ranked algorithms of the FRVT (1:N) test results with FNIR (N=1.6M, T=0, Rank=1).

b) The FRS system shall be enterprise grade highly scalable providing most accurate results for the most demanding real time and post event off line mode.

c) The system shall work on partial occlusion of face, glasses scarf changes of facial expression etc. The FRS system should also overcome challenges such as crowded environment, poor lighting, moving subjects, angle and distance.
- xxiii. The image Database Server shall support redundancy with N:1 redundancy configuration.
- xxiv. Security Verification Certification: The Face Recognition Software shall have security features which can be deployed meeting the security assurance requirements as per Relevant clauses / paras to be applicable for security, vulnerabilities from STQC (Ministry of Electronics & Information Technology) or any other Government Agency from the list of CERT-In empanelled Information Security Auditing Organization for testing and issuing the certificate / clearance.

3.21. Software License:

- 3.21.1 OEM/Vendor shall offer required number of licenses for Video Management, Video Recording, Artificial Intelligence (AI) enabled Video Analytics and Face Recognition Software for all the Cameras, NVRs, Servers, PC workstations, Clients etc. as per requirement.

3.21.2 The Licenses shall be of life-time type. Licenses related compliance shall be ensured by purchaser depending upon the requirement.

3.21.3 All software license(s) should be provided as Paper License in favour of purchaser/ user.

3.22 Acceptance Test:

3.22.1 Face Recognition Software: The Face Recognition Software shall be tested for its performance as per clause above along with required no. of Cameras, Server/Workstation and other required devices & equipment's.

3.22.2 Any other tests shall be carried out as considered necessary by the inspecting authority.

SECTION- IV

4 User Facilities covered in application software

4.1 The user shall consist of Administrator Tool application, a Monitoring application, and an Archive Player application.

4.2 The client shall perform the following applications simultaneously without interfering with any of the Archive Server operations (Recording, Alarms, etc.):

- a. Live display of cameras
- b. Control of PTZ cameras
- c. Playback of archived video
- d. Retrieval of archived video
- e. Instant Replay of live video
- f. Configuration of system settings

4.3 The user applications shall provide an authentication mechanism, which verifies the validity of the user.

4.4 The user shall be able to define bookmarks, the amount of time he wishes to go back from a predefined list or through a custom setup period.

4.5 The user shall be allowed to add bookmarks to recorded clips of video.

4.6 The user shall be able to choose and trigger an action from a list of available actions included but are not limited to:

- a. View camera in a video tile
- b. View Map or procedure in video tile.
- c. Starting/ stopping PTZ pattern
- d. Go to PTZ preset

- e. Sending alert messages
- 4.7 The user shall be capable to display all camera sequences created in the system.
- 4.8 The user shall be allowed for unlimited cameras sequences, which can be run independently of each other on either of the monitor tiles.
- 4.9 The user shall be able to drag and drop a camera from a tree of available cameras into any video tile for live viewing.
- 4.10 The user shall support digital zoom on a fixed/ PTZ camera's live and recorded video streams.
- 4.11 The user shall be able to control pan-tilt-zoom, focus and dome relays.
- 4.12 The user shall be allowed to access the PTZ configuration menus with no need of additional hardware.

SECTION- V

5 DETAILED TECHNICAL SPECIFICATIONS

5.1 IP PTZ Day/Night Colour 4 Mega Pixel Camera:

Parameter	Proposed Specifications
Image Device:	1/2.8" or better progressive CMOS sensor
Optical zoom (For Indoor Camera):	20 x or better
Optical zoom (For Outdoor Camera):	30 x or better
Number of Pixels:	2560 x 1440 or better
Resolution:	4 MP or better
Minimum Illumination:	B/W: 0.1 Lux or better Colour: 0.6 Lux or better
Wide Dynamic Range (WDR):	120 dB or better

Pan Travel:	360° Continuous
Tilt Travel:	0 - 90°, Auto flip
Manual Tilt Speed:	0.5°/SEC to 90°/SEC
Manual Pan Speed:	0.5°/SEC to 90°/SEC
Preset Tilt Speed:	0.5°/SEC to 90°/SEC
Preset Pan Speed:	0.5°/SEC to 270°/SEC
Video Stream:	Dual H.265 or better video stream for independent viewing and recording
Auxiliary inputs & outputs:	1 alarm input, 1 relay output
Privacy masking zones:	8 or more
Preset positions Min:	128
Iris Control:	Auto
Focus:	Auto
White balance:	Auto
Electronic shutter:	Auto
Remote access:	Via browser for configuration, viewing and control
Ethernet:	10/100 Base-T Auto sensing, Half /Full Duplex (RJ45)
S/N Ratio:	>= 55 dB
SD Card Slot:	SD card slot with support for Micro SD, SDHC or SDXC cards up to 512 GB, and populated with 256 GB, AES encrypted.
Standard:	BIS standards as mentioned below: <ul style="list-style-type: none"> i. For safety – IS 13252-1 (2010): “Information Technology Equipment – Safety, Part 1”; and ii. For performance – IS 16910 (Part 5) 2020: “Video Surveillance Systems for Use in Security Applications”.
Compliance	ONVIF (Open Network Video Interface Forum) Profile S, G, T & M compliant

Power supply (Indoor type):	Shall have the ability to be powered by PoE+ 802.3 as well as DC/AC power adapter
Power supply (Outdoor type):	Power Supply should be of the same OEM of Camera
Cyber security:	User account and password protection, HTTPS, IP filter, Digest authentication, TLS 1.2 stream encryption, AES 256 / RSA encryption for video data.
Edge based / Server based analytics:	Auto Tracking
Health Monitoring:	Camera should have inbuilt browser-based dashboard to show details of Active connection, Camera Bandwidth, Network Port utilization, Camera Uptime, CPU Load and Camera Temperature.

5.2 IP Day/Night Fixed Colour 4 Mega Pixel Camera

Parameter	Proposed Specifications
Image Device:	1/2.8" or better progressive CMOS sensor
Lens :	OEM Varifocal lens, Auto/ programmable Iris, lens f ~ 3 mm to 9 mm ($\pm 25\%$ for Indoor Dome/Bullet Camera) & f ~ 10 to 40 mm ($\pm 10\%$ for Outdoor Box/Bullet Camera) or better
Number of Pixels :	2560 x 1440 or better
Resolution:	4 MP or better
Minimum Illumination :	B/W: 0.1 Lux or better; Colour: 0.6 Lux or better
Video Stream:	Dual H.265 or better video stream for independent viewing and recording
Electronic Shutter:	Auto
Auxiliary / Digital inputs & outputs:	1 alarm input, 1 relay output
Iris Control:	Auto
White balance:	Auto
Wide Dynamic Range (WDR):	120 dB or better

Remote access:	Via browser for configuration, viewing and control
Ethernet:	10/100 Base-T Auto sensing, Half/ Full Duplex (RJ45)
S/N Ratio:	>= 55 dB
IR Illuminator	Inbuilt IR (Range 30 Meters or Better)
SD Card Slot:	SD card slot with support for Micro SD, SDHC or SDXC cards up to 512 GB and populated with 256 GB, AES encrypted.
Standard:	BIS standards as mentioned below: <ul style="list-style-type: none"> i. For safety – IS 13252-1 (2010): “Information Technology Equipment – Safety, Part 1”; and ii. For performance – IS 16910 (Part 5) 2020: “Video Surveillance Systems for Use in Security Applications”.
Compliance	ONVIF (Open Network Video Interface Forum) Profile S, G, T & M compliant
Power supply (Indoor type):	Powered by PoE 802.3/ normal DC/AC power / PoE converter.
Power supply (Outdoor type):	Power Supply should be of the same OEM of Camera or OEM certified as per OEM’s design.
Cyber security:	User account and password protection, HTTPS, IP filter, Digest authentication, TLS 1.2 stream encryption, AES 256 encryption
Edge based analytics:	<ul style="list-style-type: none"> • Object in field, crossing line, Entering field, Leaving field, Loitering, • Wrong way detection • Idle object, Removed object, Occupancy, • Passenger counting, Crowd detection, Tampering, • Object classification (person)
Health Monitoring:	Camera should have inbuilt browser-based dashboard to show details of Active connection, Camera Bandwidth, Network Port utilization, Camera Uptime, CPU Load and Camera Temperature.

5.3 IP PAN/TILT THERMAL CAMERA

Parameter	Proposed Specifications
Image Device:	Long Wave Infra-red
Lens:	35/50/100 mm or more (As per site requirement)
Number of Pixels:	640 x 480
Pan Travel:	360° Continuous
Tilt Travel:	-70° - 0°
Video Stream:	2 simultaneous
Auxiliary inputs & outputs:	1 alarm input
Frame Rate:	1 to 25 FPS
Remote access:	Via browser for configuration, viewing and control
Ethernet:	10/100 Base-T Auto sensing, Half /Full Duplex (RJ45)
Housing (Outdoor):	IP 66, IK 10 rated.
Standard:	BIS standards as mentioned below: For safety – IS 13252-1 (2010): “Information Technology Equipment – Safety, Part 1”.
Compliance:	ONVIF (Open Network video Interface Forum) S, G, T & M compliant
Power supply (Outdoor):	As per OEM’s design, however generally AC 230 V @50Hz/12V or 24 V AC

Work Station (Type-A: For Video wall and Field Monitors; Type-B: For SCCTV Operator)

Parameter	Proposed Specifications
CPU:	Type A : Minimum 14th Generation Core i7 Intel/ AMD Ryzen 7 8700G Processor operating at 3 GHz Base clock or higher, 30 MB Cache or higher, 14 core processor . Type B : Minimum 14th Generation Core i7 Intel/ AMD Ryzen 7 8700G Processor operating at 2.6 GHz Base clock or higher, 30 MB Cache or higher , 8 core processor.
Memory:	Type A: 64 GB DDR 5 or Higher Type B: 32 GB DDR 5 or Higher
Hard Drives:	Type A & B: 256 GB NVMe SSD and 1TB HDD

RAID:	Type A & B: Supported
Mother Board :	Type A & B: Original
Keyboard:	Type A: Wireless Keyboard Type B: Wired Keyboard
Mouse:	Type A: Wireless Optical Mouse Type B: Wired Optical Mouse
Video Card:	Type A: Minimum NVidia RTX or AMD Radeon Pro Quad Ports Graphics Card with 16 GB Video Memory or Higher. (two no's graphic card for more than 50 camera viewing concurrently in video wall) and Field Monitors Type B: Minimum NVidia RTX or AMD Radeon Pro Quad Ports Graphics Card with 8 GB Video Memory or Higher (one number graphic card)
Network Adapter (NIC):	Type A: Minimum Two 10G Ethernet Ports with Bluetooth. Type B: Minimum Two 1G Ethernet Ports with Bluetooth.
Sound Card:	In- Built
DVD writer:	DVD RW/ Blu Ray combo internal/external
Monitor/Video Wall support:	Type B: 24" Full HD LED Display with HDMI/DP Connectivity
Ports:	One Display port, One HDMI port, Two USB at front panel, One USB at rear panel and at least one USB C Port (front/rear)
Operating system:	MS Windows OS or Linux (Latest versions)
Anti-Virus Software:	Anti-Virus Software compatible with Windows/ Linux (Latest version)

5.4 Network Video Management and Recording Server (For SCCTV System having 50 or less cameras)

Parameter	Proposed Specifications
Channels	64
Video Management and Recording	One 64 Channel appliance shall support Video Management and Recording of 64 nos. of Cameras with required Storage
Recording Bandwidth	400 Mbps or higher

Storage Capacity (Built-in)	72 TB or more
Video Playback	25 Channels simultaneously or higher
Power Supply	230 VAC
Performance	Should be able to run 24x7 at ambient room temperature of 27 °C.
Operating System	Embedded Windows server 2022 or higher / Linux
Video Compression	H.265 or higher
Drive	SATA for data recording SSD for operating system
Network Protocols	Suitable and required network protocol stack to work Camera in TCP/IP based Ethernet network environment. (as required for system working)
Discovery Interface	OEM interface to detect the camera automatically and configure network settings
Network Interface	2 RJ45 Gigabit Ethernet LAN ports (teamed)
Video Output	Two Digital 4K HDMI/DP Output
USB Interface	4 X USB 3.2 ports
Monitoring	SNMP, Remote Desktop and HTTP monitoring support.
Software Features	Video Management Software & Graphic User Interface Client Software and Video Recording Software shall be as per Software Requirement of the specification.
Security	On Board TPM crypto processor
Storage Drive Raid configuration	Raid 6 (recording server)
OS Drive	2 x 240 GB (RAID 1)
Audio out	1
Multi Screen	1,4,6,8,9,16,25,36,64

5.5 Camera/Database/Video Analytics/FRS Server (For SCCTV System having more than 50 cameras):

CPU:	Minimum Two Processor 12 Core each or higher Intel/AMD CPU operating at 3.0 GHz or more with a minimum of 24 MB cache or higher
Memory:	64 GB (DDR5) RAM Upgradable to 128 GB
OS Drive	2 x 240 GB (RAID 1)
Database transaction storage drive	SSD – 1 TB (minimum) and actual based on the alarm retention. (RAID 1 or higher)
Chassis type:	Rack mountable

Hard Drives:	SAS 10K rpm or higher hot swappable Hard Disk in RAID 6 configuration having usable space of 1TB or more.
Power supply:	Hot Swappable Redundant Power Supply
Network Adapter (NIC):	Quad 1Gbps ports
Keyboard:	USB Keyboard
Mouse:	Optical Mouse with scroll
Operating system:	MS Windows OS or Linux (Latest versions)
Anti-Virus Software:	Anti-Virus Software compatible with Windows/ Linux (Latest version)
Security	EAL2+ certified, Cryptographically verified trusted booting standard
GPU (for Video Analytics & FRS Servers)	2 x Nvidia L4 24 GB or better
Regulatory Approvals/ Certifications	BIS (IS-13252 : Part 1 : 2010 or latest) certification for Safety and BIS/CE/FCC Certifications for EMC & Immunity.
USB Port	Should be Available

5.6 NAS/SAN Storage:

- 5.6.1 NAS/SAN Storage System with RAID 6 configuration shall be used to record video streams based on the configuration assigned by administrator. Workstations & Servers within the LAN should be able to access the recorded video streams. The Storage device shall support simultaneous playback and recording at full duplex operation.
- 5.6.2 It shall provide a high-quality recording storage and play back of images. It shall support integration with LAN to provide Centralized Management and shall operate on Windows/ Linux/ UNIX OS. Support of user management for security level control and authentication required. These Storage devices shall have the following features and specifications:

Parameter	Proposed Specifications
Controller	Dual Active-Active Controllers in active failover mode with no single point of failure
Onboard Cache	128 GB Mirrored and scalable to 256 GB

Storage Disk	7.2K/10K rpm SAS/ NL-SAS disk for 30 days
Host Interface	At least Four 10G Ethernet and Four 32G FC Ports
HDD type support (Any one)	SAS, SSD, NL-SAS
Inbuilt RAID Support	RAID- Double Disk failure support/ RAID-6
Network Transport Protocols	TCP/IP
Server /Storage should support Protocol (As per solution) (Any one)	CIFS/ NFS/ iSCSI/ FCP/ HTTP/HTTPS/ FTP/ NTP/ SNMP/ SMTP/ DHCP and DNS
Operating System (OS)	Single unified built-in Storage OEM OS for all the protocols, Compatible with MS Windows/ Linux/ Unix
Power supply	Hot Pluggable Redundant Power Supply
Storage File Management Software	Inbuilt CLI & Web Based GUI administration management software
Mounting arrangement	Rack mountable
Scalability	The storage offered shall be scalable to add additional 50% usable capacity at site within the same storage.
Storage System should be provided with	No other upgrades should be required for desired scalability except for disk Arrays enclosures and Disk drives as required. Once data is stored in Storage, no client/operator should be able to delete or modify data.

5.7 Network Switches:

- a. All network equipment should be preferably from One OEM. MAC address of switches should be in name of OEM.
- b. Ethernet Network shall consist of Layer 3 Core Switches should in Active-Active HA Mode in Equipment/Server room.
- c. Ethernet Network shall consist of Layer 2 PoE+ Edge Switches in field interconnected via Single Mode OFC Cables only in such a manner that there is no single point of failure.
- d. Minimum PoE+ Power Budget should be 320 Watts per switch to provide adequate Power to PoE Devices.
- e. No Two Layer 2 switches to be interconnected via LAN or CAT-6 Cables in the field network.

- f. All Switches installed outside Building premises should be Industrial Grade.

5.8 LED Display Monitor (Specifications are indicative):

Screen Size:	55" (diagonal) or higher
Monitor Type:	Industrial/ Professional suitable for 24x7 operation
Back Light:	LED
Panel Technology	IPS (Inplane Switching)
Aspect Ratio:	16:9
Resolution:	Full HD, 1920 X 1080 pixels or better, should support UHD resolution
Brightness:	700 cd/m ² or better
Dynamic Contrast Ratio:	4,50,000:1 or better
Viewing angle:	178°
Operating Voltage :	Suitable for single phase AC supply 180-230 V, 50 Hz
Video Input Ports:	Ports: HDMI-2, DP, DVI-D-1; USB-1, RJ-45 (LAN-1)
Certification:	UL for safety, FCC for EMC and BIS

5.9 Video Wall (As per site requirement)

- 5.9.1 2x2 (4 Panels)/3x2 (6 Panels) or higher as per requirement. Thin bezel Industrial Video Wall Displays with Common Control Room Client Workstation complete with wall/ceiling/floor mounting arrangement as per specifications.
- 5.9.2 Video wall shall be Hardware/Software clustered displays with Client Workstation. 55" LED Thin Bezel Monitor with mounting accessories for display of video images of all cameras in Common Control Room as per following specifications:

Parameter	Proposed Specifications
Screen Size:	55" 3x2 (6 Panels)/ 2x2 (4 Panels) or higher as per requirement
Aspect Ratio:	16:9

Display Type:	Industrial/ Professional suitable for 24x7 operation
Panel Technology	IPS (Inplane Switching)
Brightness:	700 cd/m ²
Dynamic Contrast Ratio:	4,50,000:1 or better
Viewing angle:	178°
Resolution:	Full HD, 1920 X 1080 pixels or better, should support UHD resolution
Operating Voltage:	Suitable for single phase AC 180-230 V AC, 50 Hz
Video Input Ports:	Ports: HDMI-2, DP, DVI-D-1; USB-1, RJ-45 (LAN-1)
Output Ports:	Display port for daisy chain to run FHD content without controller, RJ-45 (LAN-1)
Bezel	Thin Bezel design: Bezel width 0.45 mm or better; Bezel to Bezel (Gap) : 1.0 mm or less
Certification:	UL for safety, FCC for EMC and BIS

5.10 Camera Housing & mount:

Housing (Indoor):	IP 54, Shall be of same make as of camera.
Housing (Outdoor):	IP 66 rated shall be of same make as of camera. Outdoor PTZ camera may be IK10 certified for vandal proof rating.
Mount:	Standard mounting of same make as of camera shall be supplied for Surface/Ceiling/pipe/corner/parapet/pendant with wall mount bracket/In Ceiling. Any extension to standard mounting according to site requirement may be supplied indigenous item.

5.11 Cables:

- 5.11.1 L3 Switch to L2 Switch: OFC
- 5.11.2 L2 Switch to Cameras: UTP Cat 6

Annexure-1

Area wise proposed/possible Use of Artificial Intelligence (AI) based Video Analytics, but not limited to.

i. Security and Surveillance Specific Use

Sl. No.	Purpose	Use of AI based VA	Area/Location/Security Check Points	Security and Surveillance requirement
1.	Identifying and detecting person	Facial recognition	<ul style="list-style-type: none"> ▪ Departure Entry ▪ Access Control points ▪ Check-in area ▪ Terminal building security check points ▪ Sterile Hold Area ▪ Boarding Area ▪ Arrival Area 	<ul style="list-style-type: none"> ▪ Identification and Detection of Person of Interest ▪ Tracking a Person of Interest ▪ Investigation
2.	Tracking Person	Person identification	<ul style="list-style-type: none"> ▪ Arrival Hall ▪ Arrival Exit Gate ▪ Arrival Forecourt ▪ BMA & BBA ▪ Apron and Ramp Area 	
3.	Identifying and detecting unattended object	Unattended object detection	<ul style="list-style-type: none"> ▪ Departure Forecourt ▪ Departure Entry ▪ Check-in area ▪ Sterile Hold Area ▪ Boarding Area 	<ul style="list-style-type: none"> ▪ Identification and Detection of Object of Interest ▪ Anti-sabotage measures ▪ Investigation
4.	Tracking Object	Object identification and tracking	<ul style="list-style-type: none"> ▪ Arrival Area ▪ Arrival Hall ▪ Arrival Exit Gate ▪ Arrival Forecourt ▪ BMA & BBA ▪ Apron and Ramp Area 	
5.	Intrusion Detection	Vertical movement detection	<ul style="list-style-type: none"> ▪ Perimeter Wall/Area ▪ Terminal Building ▪ Aircraft Parking/ Hangar Area 	<ul style="list-style-type: none"> ▪ Prevention of Intrusion/ Perimeter scale over

			<ul style="list-style-type: none"> ▪ ATC ▪ Apron and Ramp Area 	<ul style="list-style-type: none"> ▪ Prevention of scale over/unauthorized entry into Airport facilities
6.	Suspicious Movement detection	Detection of Loitering in sensitive/airside area, leaving baggage unattended	<ul style="list-style-type: none"> ▪ Terminal Building ▪ Departure/Arrival Forecourt ▪ Alighting point 	<ul style="list-style-type: none"> ▪ Anti-sabotage ▪ Prevention of criminal activities
7.	Prevention of Tailgating	Tailgating/Forcible Entry Detection	<ul style="list-style-type: none"> ▪ Access Control Points ▪ Card based access points ▪ Staff Gate 	<ul style="list-style-type: none"> ▪ Prevention of unauthorized entry into airside
8.	Vehicle Recognition and Tracking	Automated Number Plate Recognition	<ul style="list-style-type: none"> ▪ Entry/Exit Naka ▪ Alighting point ▪ Vehicle gates. 	<ul style="list-style-type: none"> ▪ Identification of false Reg. No. ▪ Detection of Vehicle of Interest
9.	Detection of Commotion/Altercations/Use of Force	Unusual Behavior/Pattern Detection	<ul style="list-style-type: none"> ▪ Access Control Gates ▪ Terminal Building 	<ul style="list-style-type: none"> ▪ Detection of Forced Entry

ii. Analysis and Planning

Sl. No.	Purpose	Use of AI based VA	Area/Location/Security Check Points	Analysis and Planning requirement
1.	Analysis of passengers' footfall, baggage, etc.	Passengers' and Baggage counting	<ul style="list-style-type: none"> ▪ Departure Entry ▪ Check-in area ▪ Sterile Hold Area ▪ Boarding Area ▪ Arrival Area 	<ul style="list-style-type: none"> ▪ Assessment on congestion ▪ Screening Channel requirement

2.	Queue management	Overcrowd detection at Access Points	<ul style="list-style-type: none"> ▪ Departure Access points ▪ Check-in area ▪ Sterile Hold Area 	<ul style="list-style-type: none"> ▪ Real Time Queue management ▪ Analysis & Planning on
3.	Peak hour s management	Rush/Crowd detection a t Access/PESC points	<ul style="list-style-type: none"> ▪ Boarding Area ▪ Arrival Immigration/ Customs area (Intl. Airport) 	optimum use of man & machinery ▪ Manpower Deployment
4.	Data on Male and female travelers	Counting of Male/female Passengers		▪ Resource allocation; especially for male/female screening channels
5.	Vehicle Counting	Counting of Vehicles	<ul style="list-style-type: none"> ▪ Entry/Exit Naka ▪ Departure/Arrival Road 	▪ Analysis & Planning on optimum use of man & machinery

iii. Passengers' Need/Facilitation (not mandatory)

Sl. No.	Purpose	Use of AI based VA	Area/Location/Security Check Points	Pax Need & Facilitation
1.	Medical/Trauma/ Shock case/ Accident detection	Fall detection/ Collapse of structure detection	<ul style="list-style-type: none"> ▪ Departure Forecourt ▪ Departure Entry ▪ Check-in area ▪ Sterile Hold Area ▪ Boarding Area ▪ Arrival Area ▪ Arrival Hall ▪ Escalators/ Travelator 	<ul style="list-style-type: none"> ▪ Assistance in medical issue of passengers ▪ Help in Accident/ collapse cases

2.	Tracking of lost Children	Reverse Tracking of person/ children	<ul style="list-style-type: none"> ▪ Terminal Building ▪ Sterile Hold Area ▪ Boarding Area ▪ Departure/Arrival Forecourt ▪ Adjacent area in City side 	<ul style="list-style-type: none"> ▪ Detection and uniting children separated at the airport
3.	Tracking of Lost/misplaced Baggage	Reverse Tracking of Baggage	<ul style="list-style-type: none"> ▪ Parking Area ▪ Alighting point ▪ Arrival city side 	<ul style="list-style-type: none"> ▪ Detection and restoration of lost/misplaced baggage of Pax

FIDS

Technical Specifications

1. FLIGHT INFORMATION DISPLAY SYSTEM (FIDS)

A. GENERAL

1. The offered equipment by the bidder shall be compact, fully solid state, highly reliable and shall use latest state of the art technology.
2. The design and selection of the offered equipment by the bidder shall be consistent with the requirements of long-term trouble-free operation with highest degree of reliability and maintainability.
3. All offered equipment by the bidder shall be manufactured to continuously operate safely without undue heating, vibration, wear, corrosion, electromagnetic interference or any similar problems.
4. The offered equipment by the bidder shall be designed for continuous operation (24-hours a day and 365-days a year). The design life of the equipment shall be a minimum of SIX YEARS.
5. This life shall be achievable through normal and regular maintenance.
6. All types of spares and spare modules of the offered equipment for the FIDS shall be readily available with the bidder during life-time of the equipment, for maintenance, repairs and up keep of the equipment during warranty & CAMC period.
7. The Bidder shall undertake and ensure implementation of its offered solution and shall keep its in view the safety and protection of personnel, during normal operation and maintenance or during malfunctioning of any equipment or its sub-component. This shall be ensured as an integrated feature of design, manufacture and installation of offered equipment by bidder.
8. The bidder shall ensure adequate protection to be included for ensuring safety of personnel from any possible hazards, including EMI radiation, high voltages, etc.
9. The bidder shall furnish the details of EMI and Safety Standards met by his equipment and built-in safety features.
10. The offered equipment shall be constructed on a modular basis, using plug-in type units and components to the extent possible. Parts subject to failure, wear, corrosion or other deteriorations or requiring occasional inspection, adjustment or replacement shall be made accessible and capable of convenient inspection and removal.
11. Input and output termination cables in offered equipment shall be properly labelled to permit ready identification of the incoming/outgoing wiring.

12. All interconnecting cables in offered equipment shall also be appropriately labelled to facilitate convenient interconnection and minimize chances of incorrect connection.
13. All connecting cables required to inter-connect the equipment shall be supplied by the bidder as a part of the offered system. All cables shall be fully assembled, connector pre-terminated and factory tested at the time of supply as part of overall system check.

14. LICENSES

All Hardware system/component and Software supplied by bidder shall be licensed, as applicable, in favour of Airports Authority of India and valid for lifetime of the offered system.

15. MAINS POWER SUPPLY

- 15.1 Complete offered equipment shall operate with an un-interrupted AC power 230 Volts ($\pm 10\%$) single phase 50 Hz $\pm 5\%$. Reliable over & under voltage and over current protection circuits shall be provided in the power supply units of offered solution. The power supply units in complete offered solution shall be self-protecting, and shall protect connected equipment against conducted interference, noise, voltage dips and surges & impulses.
- 15.2 Mains Power Supplies used in offered solution/equipment shall be rugged enough to withstand variation in mains voltage and frequency over a long period of time so that the failures in the equipment due to power supply are minimized.

16. INSTALLATION STANDARDS

- 16.1 Installation shall be carried out by technically well qualified and certified personnel as per the requirements.
- 16.2 Contractors shall not outsource any part of the contract to any other vendor/third party contractor without prior permission of AAI.
- 16.3 Liability, if anything, arising out of such third-party contracts to any other vendor by contractor shall be to the contractor's account.
- 16.4 AAI shall not be liable on behalf of contractor to any other third party contractor/ Government of India/State/Regulatory Authorities.

- 16.5** Any liabilities arising out of such third party contracts by contractor or its men working at site shall be only to contractor's account and shall be deducted out of its running bills.
- 16.6** Contractor shall submit Police Verification Certificates and obtain necessary Airport Entry Permits, for allowing its men to work at AAI restricted premises.

17. QUALITY ASSURANCE STANDARDS

The contractor shall use Quality Assurance procedure compliant with Quality Assurance in system design, development, manufacturing, and installation and servicing- ISO 9001 Quality Management and Assurance Standards Part 3 – ISO 9001 Application and Development, Supply and Maintenance of software.

18. RELIABILITY

To ensure high availability and high reliability, the offered equipment design by the bidder and its OEM partner shall employ the most suitable engineering techniques, materials and dependable components, field proven design and rigorous inspection during manufacturing to ensure a very high MTBO (Mean Time between Outage) and MTBF (Mean Time between Failure) of equipment.

19. ENVIRONMENTAL CONDITIONS

The offered equipment shall be capable of maintaining its guaranteed performance when operating continuously for 24 hours a day and 365 days a year without any deviation in quality or degradation of system performance and all the parameter detailed in these specifications shall be guaranteed over the following environmental conditions:

i) Indoor Equipment:

Operating Temperature: 0 degree to + 40 degree Centigrade.

Relative Humidity: 80% up to 35 degree centigrade.

ii) Outdoor Equipment:

Operating Temperature: -10 degree to + 50 degree Centigrade.

Relative Humidity: 90% up to 35 degree centigrade

iii) Storage Temperature: -10 to + 70 degree Centigrade

B. SCOPE OF WORK

- Scope of work is briefly but not exhaustively described in succeeding paragraphs. The bidder has to quote considering the following scope of work to meet general, qualitative and technical requirements of tender as per this Section and mentioned in design criteria.
- The bidder firm shall provide the following system at specified Airport.

S. No.	System	Requirement
1	Flight Information Display System (FIDS)	Design, Supply, Installation, Testing and commissioning of Flight Information Display System for complete terminal building.

- **The scope of Flight Information Display System comprises of:**
 1. Design and Supply of all required hardware such as Display Monitors, Video walls and LED Boards with controller, Servers, Data Entry Terminal, Network equipment, Equipment Rack, KVM Switch, UPS, Data & Power cabling etc. and all required software such as Application, Antivirus, AFAS etc. including their upgrades, their installation, testing & commissioning
 2. The upgrades for the supplied Application, Antivirus, Control and Management Software and firmware shall be supplied and installed by the Bidder and without any legal implication to AAI, during the complete period of contract i.e. guarantee/ warranty and defects liability period and comprehensive AMC period. Report of upgradation of software at site shall be submitted to Engineer in Charge periodically (every six months), failing which, necessary deduction, as finalised by Engineer in Charge, shall be done and it will be binding on firm.
 3. The required communication media (Fibre Optic and other cables) including their lengths and interface equipment shall be determined based on the locations of the different type of equipment (display, switches, client terminal etc.) and shall be supplied by the bidder firm. Requisite terminations and integration of FO cables with the main system shall be done by the bidder firm.

4. The supply and laying of various types of cables shall be made after the survey of the routes and ascertaining of the exact cable length (s) requirements at site.
5. The laying of the outdoor cables shall be in accordance with the standard industry practice.
6. The offered system shall be complete with all equipment and accessories including connectors, patch cords, other networking accessories, mounting, and fixing hardware, plugs, sockets, etc.
7. Supply and fixing of Adaptors, Connectors, Patch Cords, Mounting/ Fixing hardware, Electrical Switches/ Sockets inside the racks and other accessories required for completion of work is deemed to be included in the scope of Bidder firm. This also includes cable channel/ Tray to be installed by the bidder firm within Equipment Room/ Control room as per requirement.
8. Testing of system components shall be done as per original equipment manufacturers specifications and guidelines.
9. The entire work has to be executed with total responsibility by bidder firm. All necessary technical completeness shall be ensured by the bidder firm at the time of quoting/ completion of works.
10. Bidder shall be responsible to conduct Site Acceptance Test (SAT), and to supply detailed documentation including as-built drawing in hard, soft copy at the Airport.
11. The bidder firm may undertake survey at specified airport at its own cost to understand the scope and intricacies involved in carrying out the work as per scope of tender.

C. GENERAL & QUALITATIVE REQUIREMENTS

- i) The bidder has to fill **General & Qualitative** compliance statement in the table given below:
- ii) For stating **compliance**: Write “C” in the third column below.

S. No.	Description	Statement of compliance
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(1)	(2)	(3)
	FLIGHT INFORMATION DISPLAY SYSTEM	
1.	GENERAL REQUIREMENTS	
1.1	The offered equipment by the bidder shall be compact, fully solid state, highly reliable and shall use latest state of the art technology.	
1.2	The offered equipment by the bidder shall be designed for continuous operation (24-hours a day and 365-days a year). The design life of the equipment shall be a minimum of SIX YEARS. This life shall be achievable through normal and regular maintenance during the period of Warranty and Comprehensive AMC.	
1.3	All offered equipment by the bidder shall be manufactured to continuously operate safely without undue heating, vibration, wear, corrosion, electromagnetic interference or any similar problems	
1.4	<p>Equipment with better specifications shall be accepted.</p> <p>Note: - Original Equipment Manufacturer (OEM) of Servers-FIDS, Server-AFAS, Server-NTP, Switches, Workstations, LED Display Monitors, LED Display Boards, UPS, etc. shall be ISO firms & the offered products must be certified for Safety/Emission of standards such as BIS/CE/EN/UL etc.</p> <p>All types of spares and spare modules of the offered equipment for the FIDS shall be readily available with the bidder and its OEM partner during life time of the equipment for maintenance, repairs and up keep of the equipment during warranty and post-warranty Annual Maintenance Contract.</p>	
1.5	The bidder shall undertake and ensure successful implementation of the offered solution, keeping in view the safety and protection of personnel during normal operation and maintenance or during malfunctioning of any equipment or its sub component. This shall be ensured as an integrated feature of design,	

	manufacture and installation by the offered equipment bidder.	
1.6	The bidder shall ensure that offered equipment has adequate protection to be included for ensuring safety of personnel from any possible hazards, including EMI radiation, high voltages, etc.	
1.7	The offered equipment shall be constructed on a modular basis, using plug-in type units and components to the extent possible. Parts subject to failure, wear, corrosion or other deteriorations or requiring occasional inspection, adjustment or replacement shall be made accessible and capable of convenient inspection and removal.	
1.8	Input/output termination cables in offered equipment shall be properly labelled to permit ready identification of the incoming/outgoing wiring.	
1.9	All interconnecting cables in offered equipment shall also be appropriately labelled to facilitate convenient interconnection and minimize chances of incorrect connection.	
1.10	All cables required to interconnect the equipment shall be supplied by the bidder as a part of solution.	
1.11	All cables shall be fully assembled, connector pre-terminated and factory tested at the time of supply as part of overall system check.	
1.12	Licenses: All Hardware and Software component supplied by bidder shall be licensed in favour of Airports Authority of India and valid for the lifetime of FIDS.	
2.	QUALITATIVE REQUIREMENTS	
2.1	The Flight Information Display System (FIDS) shall be installed at Airports for display of Passenger Information, Flight Information, Baggage Belt Information, Check In-Counter/Boarding Gate Information, Multimedia Advertisement, Weather Information, etc.	
2.2	The Flight Information Display System (FIDS) shall primarily consist of following sub-systems:	

i.	Flight Information Display System – To provide visual display of Airport's Flight Schedule & Status, Gate, Baggage Belt information, etc. on LED Display Board, 43"/55"/65"/85" LED Display Monitor, etc. through FIDS Application Software and Database on Hot/Standby Servers and Data Entry Application on Client Workstation, Administrative Application for Control and Monitoring of various devices, Page Design Application on Server/Workstation, etc.	
ii.	Automatic Flight Announcement System (AFAS) – To provide & integration with Airport Public Address System for Zonal Announcements of information, through Automatic Flight Announcement Software module and necessary hardware interfaces.	
2.3	System architecture shall be open for future expansion. AAI should be able to integrate additional standard LED/TFT Displays and Client terminals with the FIDS Server to access, control and display the flight information without need of any extra licenses, OEM approvals, etc.	
2.4	The FIDS Software, drivers & modules shall support minimum up to 128 displays locations, 16 Data Entry Terminals, 12 zones announcement, 32 clustered displays, 08 Monitoring & Administrative terminals, third party OEM FIDS software, 03 make OEM displays i.e. FIDS shall be scalable and expandable pre-wired (hardware & software) to add standard client PC/Laptop and Standard Display Monitors to expand the system as and when desired by AAI.	
2.5	Weather Interface allows the airport to display weather information for the different destinations providing an additional service for the passengers.	
3.	SYSTEM HARDWARE CONFIGURATION	
3.1	Servers, Display Monitors, Switch/routers and other components shall be of high end Common Off-the-Shelf (COTS) hardware .	
3.2	Re-engineered COTS hardware shall not be permitted/accepted. If such goods are found to be supplied at any stage, then it shall be the supplier's	

	responsibility to provide appropriate replacement without any additional cost to AAI.	
3.3	FID System shall be provided with two servers configured to operate in Automatic Failover configuration without any need of any manual intervention. During change over there shall be no loss of database transaction.	
3.4	After change-over except for administrator user, other users need not to know which server is in use or connect to get requisite functions/ functionalities.	
3.5	System shall provide audio-visual alarm for Error, Failure and Changeover of FIDS main or standby server, to system administrator or a designated client terminal automatically.	
3.6	After restoration of faulty server, recovery assistant/agent shall recover the data back in to the faulty server, restart all application/ modules and keep itself ready for automatic and manual hot change over function.	
3.7	System shall allow manual & automatic change over from main server to the standby server and vice versa.	
3.8	System shall have facility to recover inconsistent system/FIDS database from the other healthy & active server.	
3.9	FIDS shall be provided with client-server architecture with latest version of UNIX or LINUX or Microsoft Window Server as operating system of Server/Cluster server, and Windows or Linux as operating system of client terminals.	
3.10	Hardware Keys, dongles, Terminators, converters, interface conversion, connector, power cables, etc. shall be provided with the system as per the system requirement. Details of all such devices used for the FID System shall be provided to AAI.	
4.0	a. Monitor Size – 43” to 55 “with minimum 1” High Character (font) at; <ol style="list-style-type: none"> 1. Each Check-in Counters 2. Each Boarding Gates 3. Each Baggage Belts 4. VIP / CIP Lounges 	

	<p>b. Monitor Size – 55” to 85 “with minimum 1” High Character (font) at;</p> <ul style="list-style-type: none"> 1. Departure Hall 2. Check-in Hall 3. Arrival Hall 4. Baggage Claim Area 5. After Security Check <p>c. Monitor Size – 32” to 43 “with minimum 1” High Character (font) at;</p> <ul style="list-style-type: none"> 1. Baggage Make-up /Break-up Area 2. Terminal Manager 3. APD 4. MI Room <p>d. Monitor Size – 100” or Active LED Board (6X3 Meter, 3x2 Meter, 1.5x1Meter) with minimum 1” High Character (font) at;</p> <ul style="list-style-type: none"> 1. City Side - Outdoor Arrival /Departure <p>e. All Monitors, LED Boards, Video Walls shall be installed on the walls or SS pole/Frame, as per site condition.</p>	
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2. SYSTEM DESIGN & TECHNICAL REQUIREMENTS

GENERAL GUIDELINES

- 1. “TECHNICAL SPECIFICATION” OF EACH ITEM SHALL BE THE PRIMARY CRITERIA FOR TECHNICAL EVALUATION HOWEVER, BIDDER HAS TO ENDORSE AGAINST ALL “TECHNICAL FEATURES” OF SYSTEM AND EQUIPMENT MARKING AS “COMPLIANCE” AS A TOKEN OF CONFIRMATION OF FEATURES OFFERED.**

2. THE SPECIFICATIONS DETAILED HEREUNDER ARE THE MINIMUM REQUIREMENTS. BIDDERS MAY OFFER SYSTEM/ EQUIPMENT/ ACCESSORIES/ SOFTWARE/ NETWORK EQUIPMENT/ CABLING OF BETTER SPECIFICATIONS.
3. THE BIDDER HAS TO FILL “TECHNICAL COMPLIANCE ALONG WITH FEATURES STATEMENT” AS PER DIRECTION GIVEN BELOW:
 - i) FOR STATING **COMPLIANCE**: WRITE “**C**” IN THE THIRD COLUMN OF STATEMENT.
 - ii) AGAINST EACH COMPLIANCE STATEMENT, WRITE SPECIFIC PARA AND PAGE OF SUPPORTING TECHNICAL DOCUMENTATION (FROM WHICH THE STATED COMPLIANCE COULD BE VERIFIED IN FOURTH COLUMN OF STATEMENT).
 - iii) **SPECIFICATIONS OF THE EQUIPMENT BETTER THAN THOSE MENTIONED IN “TECHNICAL REQUIREMENTS ALONG WITH FEATURES” SHALL BE ACCEPTED.**

1. TECHNICAL SPECIFICATIONS / PARAMETERS FOR FIDS EQUIPMENTS

Sl. NO.	Description	Statement of Compliance	Reference page & para no. of supporting document (Write N/A, if Not Applicable)
(1)	(2)	(3)	(4)
I.	FLIGHT INFORMATION DISPLAY SYSTEM		
1.	DISPLAY DEVICES		
1.1	GENERAL FEATURES:		
i.	System shall be capable of supporting various display devices including but not limited to TFT, LCD, LED Display Board, Intelligent Monitor, etc.		
ii.	Display clustering: System shall be capable of installing grid of multiple displays for		

	spreading one page of information on multiple displays. The grid composition shall be user configurable.		
iii.	Devices shall be capable of displaying the information in Portrait and Landscape mode. This shall be user configurable.		
iv.	The display client software shall be able to handle various graphic formats including MPEG 2/4, MP4, JPEG, video clips, etc.		
v.	The displays shall have LED's to indicate operational status and network connectivity for easy maintenance.		
vi.	All the displays shall have IR Remote, controlling basic display functions such as Brightness, Contrast, Colour Control, etc.		
vii.	The display shall not have any controls within the reach of the public/or such controls shall be suitably covered to avoid possible tampering.		
viii.	Display controller shall be capable of remote monitoring of the displayed content/ information from the central server & any work station in the network.		
ix.	It shall be possible to reset, restart and reboot the intelligent controller & display monitor remotely on the network.		
x.	It shall be possible to put the display in standby mode (soft power off) from the remote (network: server/workstation) or shall have a remote control to switch the display on or off in a go.		
xi.	Display monitor shall be provided with cabinet suitable for industrial/professional 24x7 use with arrangement for Wall and Ceiling Mount installation or on SS Poles from ground with provision for Swivel movement.		
xii.	Display Monitor cabinet shall be designed for uniform heat dissipation/removal and shall have mechanism to remove heat from the cabinet. Heat removal mechanism shall automatically start functioning when temperatures reach certain threshold levels.		

xiii.	Suitable wall/ceiling/pedestal mounting shall be provided for Display Monitors in single or clustered configuration.		
2.	FIDS APPLICATION SOFTWARE		
	TECHNICAL FEATURES:		
2.1	GENERAL FEATURES		
a)	Application software shall meet requirements specified in this tender document. Software shall be supplied with license for the complete site without having any consideration for the number of clients, display, etc.		
b)	FIDS application shall include appropriate tools and interfaces for control, configuration, administration and maintenance of FIDS server and FIDS Database.		
c)	FIDS software shall have Standard Graphic User Interface for all modules and shall be fully menu driven. All software tools, configuration windows shall be windows based and menu driven.		
d)	The FIDS software shall be an open application using industry standard interfaces/protocols.		
e)	The FIDS software shall be able to handle proprietary as well as standard interface protocols.		
f)	FIDS Application Software shall have HTML/. devices.		
g)	Necessary Software tools shall be provided by the bidder for System Administration, Maintenance, Monitoring and User/Client Operations, which shall monitor all connected devices and report status of the systems and all display devices.		
h)	Grouping of Display Devices in different areas of the terminal building shall be possible. The system administrator shall configure these groups. Assignment of relevant flight data to be displayed on different groups shall be possible.		

i)	The updated flight information shall be displayed on field display devices (Display Boards, Monitors, etc.) in real time.		
j)	The FIDS displays shall access the flight information database using standard web browsers (such as internet explorer, Firefox, safari, etc.).		
k)	In case of network outage, the client shall show the last updated information for a configurable period of time. Thereafter, display shall display a predefined page selected by user.		
2.2	RDBMS AND FIDS DATABASE		
a)	The FIDS Application Software shall be designed to work with industry standard RDBMS System like MS SQL, Oracle, MySQL, etc. The FIDS Application Software and the RDBMS shall be installed on the FIDS Servers.		
b)	The RDBMS shall be supplied with necessary number of client access license.		
c)	The Flight Information Database shall be maintained on the Main/Hot standby servers.		
d)	FIDS shall comply to push and pull data with AODB on XML/HTML; SITA/ARINC PREFANS/FANS ACARS based network, ICAO AFTN network, CUTE system, BHS and NTP Server for time synchronization		
e)	FIDS RDBMS shall maintain lookup tables for Airlines/Airports as per standard IATA Codes.		
f)	Transaction Log Tables and Archived Transaction Log shall be maintained on RDBMS Server for all transactions. The Transaction Log Tables records shall be moved to Achieved Log Tables based on administrator configurable time parameters.		
g)	RDBMS shall implement record level locking, to enable updating of a flight record from only one Server or a Workstation at a time. Suitable WAIT message shall be displayed to other users trying to access the same record.		

2.3	The database architecture shall be based on the following standards:		
a)	The flight schedule shall be stored in a seasonal flight table where every flight record contains the flight frequency, validity period, etc.		
b)	Each record shall be presented in ICAO and IATA standard Airport/Airline/Flight Number codes and formats.		
c)	Each record shall handle not less than eight exceptions on the schedule, e.g., for public holidays.		
d)	A flight record shall handle at least four VIAs.		
e)	A flight record shall handle at least six code share flight numbers.		
f)	The seasonal flight schedule shall be expanded into an actual flight table where every flight is one record. The time window for the expansion shall be configurable.		
g)	Actual flights which are operated shall be stored in an archive table for statistics and reports. The record shall be deleted from the actual flight table according to configurable time parameters.		
h)	The flight records in the actual and archive flight table shall have a departure and arrival log; a join to a rotation between the arrival and departure log shall be possible.		
i)	The flights origin, destination, VIAs, airline, codes shares, etc. shall be represented by the appropriate ICAO and IATA codes to be linked to lookup tables.		
j)	All flights shall be distinct by flight nature according to IATA flight nature. The flight nature shall be stored in a lookup table and linked by the nature code to the flight record.		
k)	The flight record shall be expandable to any field required by the airport. Information about the flight shall come from interfaces not limited to SITA, TEXT, AFTN, Flight Schedule, AODB and Docking System as made available at airport.		

I)	The design of FIDS Database and Application Software shall enable the user to retrieve reports and statistics for historical and actual flights.		
2.4	Administrative terminals, Client Terminals and Data entry terminals shall access the database using standard web browsers (such as internet explorer, Firefox, safari, etc.) for functions/processes:		
a)	Updating the flight information database; I. Accessing the flight information database; II. Configuration and administration of the FID System, Database;		
b)	Bidder shall supply all necessary protocols (ICDs - Interconnect Control Documents), details of database structures with detailed inter-dependencies, communication protocols of the system at site to enable integration of FIDS in future with various other third party automation technologies.		
c)	The FIDS RDBMS shall maintain a MASTER FLIGHT TABLE (MFT) based on defined periodicity.		
d)	ACTUAL FLIGHT TABLE (AFT): From the flight database, the system shall automatically generate Actual Flight Table containing flights in chronological order for a user defined time interval (time interval in multiple of Hours shall be configurable/predefined by user). The AFT shall be generated automatically by the system on continuous bases. Updating of the AFT shall also be on continuous basis. The left over flights of the previous intervals (configurable) and their status shall not be changed and shall be added on top of the new AFT automatically.		
e)	Each flight in the actual flight table shall have a traffic type flag not limited to the following		
	i. Operational		

	ii. Cancelled		
	iii. Diverted		
	iv. Re-routed		
	v. Non-operational.		
	vi. Suspended		
	vii. Planning		
f)	The current flights in the AFT shall be displayed on the display devices automatically as per the configuration of the display (by the operator through Software) without any manual intervention of the operator.		
g)	It shall be possible to manually update any data field of the Flight Information Data for all the flights in the AFT for the current day by the operator, and then transmit for displaying on the configured display devices.		
h)	System shall permit insertion and deletion of the flights from the AFT. System shall allow editing the database and updating the same from client terminal with appropriate access authorizations.		
i)	EDITING FLIGHT FOR A DAY: FIDS shall be provided with Software Tool to query the Database for a list of flights for any specific day of the week for editing. Operator shall have appropriate software interface for editing and modification of these flights.		
j)	Data entry on user forms/pages shall be validated for possible logical errors and accordingly pop-up shall be presented to user indicating warning along with the help options.		
2.5	DISPLAY CONFIGURATION TOOL		
a)	It shall be possible to schedule such designed templates to the display devices based on programmed template and timed sequence.		
b)	All the parameters in the display configuration tools shall be user		

	configurable.		
c)	Provision shall be available to configure number of displays into groups to display same set of information's.		
d)	The Display Configuration tool shall be primarily used to define the entire Video display network in terms of groups. The display shall be grouped on the bases of area (such as arrival, departure, etc.), flight types (domestic, international, etc.), flight operation (arriving, departing flight, etc.), language, gate type, baggage display, check in counter, etc. Once groups are made, each group will display the same set of messages in a synchronized manner.		
e)	For example, the Arrival Hall may be required to be split into two groups, namely those that display arrival messages in English and those that display arrival messages in Hindi. Once this is done using the Display Configuration Editor, these display monitors will automatically display arrival messages as per configured language option.		
2.6	INDIAN LANGUAGE DICTIONARY		
a)	The Indian Language Dictionary shall be created and maintained for all flight information fields.		
b)	The Dictionary shall be accessed during flight information display to provide automatic translation from English to Hindi and one local Indian language as per site requirement so that Flight Information entered in English by the operator is automatically translated into Hindi and any other Indian language script, by the use of this dictionary.		
c)	The dictionary shall be editable and it shall have feature for addition and/or deletion of more words of Hindi and Local Indian Language.		
2.7	BAGGAGE CLAIM SOFTWARE MODULE		

	FIDS software shall have Baggage Claim module, with the following features:		
a)	Assignment of Baggage Belt Number to a flight.		
b)	On changing of flight status to "ARRIVED", the assigned Baggage Claim information shall be displayed on the respective Baggage Claim Display Monitor and Directory Display Monitor.		
c)	The data entry from Client Workstation for First Bag and Last Bag shall be processed with timestamp, updated in database and displayed on Baggage Claim Display Monitor.		
d)	Directory listing of baggage claim facility information shall be available for Directory Display Monitor.		
e)	FIDS shall have provision for interfacing with other automatic baggage handling system for updating FID database of the system.		
f)	The Baggage Claim Software Module shall be operated from Client Workstation by authorized user.		
2.8	BOARDING GATE DISPLAY MODULE		
	FIDS software shall have Boarding Gate Display Module with following features:		
a)	Assignment of Gate Number to a Boarding Flight		
b)	Next Flight Number to be displayed for Boarding		
c)	Boarding information shall be possible through CUTE System		
d)	The Boarding Gate Display Module shall be operated from Client Workstation by authorized user.		
2.9	PAGE/TEMPLATE DESIGN TOOL		
a)	Page/Template Design Tool shall be provided for designing Screen Layout for display devices by choosing position of data (Header, Footer, Flight records, Airline Logo, Time of the Day, Free-form		

	messages, Ticker/Scroll messages with flight data, etc.), fonts, text attributes (Regular, Bold, Italics), colour (Foreground, Background), background image, scrolling (direction, speed), etc.		
b)	Page design tool shall be a standard OEM product using GUI (Graphical User Interface).		
c)	Page design tool shall work from the FIDS server and client terminal connected to the FIDS network.		
d)	The access to this module shall be protected by passwords, and controlled by access level assigned by system administrator.		
e)	The design tool shall have easy to use Tool bars, Menus, Buttons, etc. and shall include Search for help on various functions/ capability of the system.		
f)	The page design tool shall have ability to manage graphics, true type fonts, video clips, and multimedia advertising. It shall permit use of animation and graphics for displaying flight information and free-form information pages.		
g)	It shall have provision to use different images of common graphic formats as backgrounds for screen templates.		
h)	The page design tool shall support selection and display of multiple language fonts.		
i)	Page design tool shall be provided with predefined screen layouts (template) with the system, and shall also have capability for designing new page templates. Any number of such custom-made screens shall be stored and displayed on a specified date and time.		
j)	Page design tool shall allow user to define page format and design each page combining fixed and dynamic information.		
k)	The software shall also permit creation of free-form pages wherein any special message or information of the general type can be entered for selective display on the		

	intelligent display devices.		
l)	The Page Design Tool shall be user programmable. Display configuration shall be done to the extent of user to create and edit display script for one or many displays, display clocks, blank screens.		
m)	Only System administrator shall be allowed to publish newly designed pages.		
n)	It shall permit preview of any designed page.		
o)	The design tool shall allow the user to construct a display layout including graphics, true type fonts, video clips to a selection of flight data.		
p)	The tool shall have common features used in other design tools, like:		
	i. Horizontal, Vertical Grid alignment		
	ii. Snap to grid function		
	iii. Copy style function		
	iv. Different layers, bring to front, send to back, etc.		
	v. Tickers		
	vi. Page carousels.		
q)	Advanced table functions for summary displays		
	i. It shall be possible to place the Airline logo(s) (Image files in standard graphics format) on screen at User configurable/selectable specific positions using the page design tool.		
	ii. The system shall display free text information in a scrolling line at selectable position in the display devices (TFT- LCD/LED, etc.). This feature shall be user selectable and user configurable.		
	iii. The module shall allow creating pages for displaying on TV using full screen and also in scalable window. The page shall be selectable in the aspect ratio of 4:3, 16:9, 21:9 and free form.		

2.10	SECURITY		
a.	Security		
	i. Multi-level password security shall be incorporated for addition, deletion, modification and update of the database for individual users. This shall be configurable by the user.		
	ii. Access to Server Operating System, Database and FIDS Application Software shall be restricted as per user authorization matrix, with access passwords.		
	iii. All the Systems shall be protected by individual user Ids and passwords.		
b.	The following access level shall be provided:		
	i. System administrator or System Manager: System-wide access to flight records and main schedule for all airlines.		
	ii. Users: Assigned with necessary access rights to create, modify, delete and add flight data for a specific airline or multiple airlines (as assigned) from a client work station		
c.	The system shall maintain transaction log for every event occurring in the system. A transaction shall be time and user stamped. The log file shall be maintained & archived for auditing.		
d.	The access rights to view, add, delete and update flight data shall be controlled on data field level.		
e.	Dedicated processes monitor the smooth operation of the system. Errors of individual processes or any event in the system can be configured to generate a message to be stored in the system log files. The access to these log files is provided via the system console. Each system message to be stored in the log files can be individually copied.		

2.11	DEVICE MONITORING AND CONTROL		
a)	This module shall enable user to view status of displays/device connected to it and shall have access to the devices.		
b)	System shall monitor all the devices connected in the network and report status of system and display devices.		
c)	The modules shall be accessible from main system and also from remote PC connected to the FIDS network.		
d)	The access to this module shall be protected by passwords and controlled by access level assigned by system administrator.		
e)	Maintenance Utility shall be able to run from any PC/Client connected to the FIDS network.		
f)	The module shall remotely monitor health of each device connected in the system through SNMP and view online status of the display devices.		
g)	The module shall allow the user to remotely view the display content (i.e. currently displayed) of the LED/LCD display monitor.		
h)	Maintenance shall also enable to remotely view the content transmitted to the LED Line Display Board/LED Display Board.		
i)	Maintenance utility shall enable to remotely control display devices i.e. switch off, reboot, set device out of service, etc.		
j)	Licensed Remote Desktop Tool like Netviewer, Gotoassist, Logmein, Webex, Showmypc, shall be provided for remote access of Clients, Display Controllers, etc.		
2.12	REAL TIME CLOCK FOR DISPLAY DEVICES		
a)	The page design tool shall fix the clock to be shown in digital form at any selectable position on the screen. The clock shall have some of the attributes as for text items such as colour and size.		
b)	Clock's display shall be selectable for display and no display, as per user		

	requirement.		
c)	The clock shall automatically get synchronized with the database server clock/NTP server. Software provision shall be made in the display controller to force automatic periodic synchronization, as well as manual synchronization as and when required by the user.		
2.13	AUTOMATIC FLIGHT ANNOUNCEMENT SYSTEM (AFAS) MODULE		
a)	AFAS		
i.	This software module shall scan the flight information database for valid announcements, construct announcements, convert announcement text into voice format/audio signals and send to the appropriate zone of the PA system for announcing. It shall translate the flight information in to voice format for automatic announcement on the existing PA system of the Airport.		
ii.	The system shall construct announcements, convert in to voice and send to the appropriate zone for announcing on the PA System.		
iii.	The system shall select zone of the PA system and send zone selection signals to the PA system for effecting the announcement in the selected zone.		
iv.	To construct voice for announcement, the system shall have the following technology:		
	A. Text-to-speech engine to automatically synthesize flight information into a voice for announcement. The text to speech engine shall have:		
	a) The voice broadcast shall provision for male and female voice;		
	b) Different accents.		

	c) User shall have option to listen synthesized voice output		
	d) The above feature shall be user selectable.		
	OR B. Pre-recorded voice library for constructing announcements. Pre-recorded library shall include available list of 2048 airports, 2048 airlines, 4096 flight numbers and combination of existing flight route details up to 10240 in all three languages (Local, Hindi, and English) in male and female voices. The system shall allow updating of pre-recorded library and new voice file shall be added to the library.		
v.	This system shall translate flight information's into an audio file to be scheduled for announcement over Existing PA systems at the airport.		
vi.	The system shall be interfaced with the existing Public Address system. Audio output from this system shall be made available as input for the PA system.		
vii.	The System shall be built around proven technology such as IVR technology.		
viii.	The system shall build words and sentences from an in-built Voice Library as per match with the database.		
ix.	The system shall allow for creating new announcements and updating of Voice Library of pre-recorded announcements.		
x.	Multilingual announcement shall be possible i.e. Hindi, English and one of the Indian Language as per the requirement of the airport		
xi.	The system shall provide for the following predefined announcements but not limited to:		

	a) Arrival, Arrival Delay, Arrival Cancellation		
	b) Departure, Departure Delay, Departure Cancellation.		
	c) Check In Call		
	d) Boarding Call, Final Call		
	e) Baggage in hall		
	f) General announcements.		
xii.	Operator shall have control over the following parameters but not limited to:		
	a) Voice generation Technology i.e. Text to speech engine or pre-recorded voice library.		
	b) Accent, male/female voice in text to speech engine		
	c) Time of announcement,		
	d) Time between announcements,		
	e) Frequency,		
	f) Repetition rate of announcement		
	g) Male/female voice in case of synthesized		
	h) There shall be a provision of fixed announcements to be repeated at regular intervals.		
	i) The System shall be able to select zones for announcement		
	j) The system shall permit to perform flight announcement manually by the operator/user.		
	k) Complete announcement script in all three languages (Local, Hindi, and English) shall be provided well in advance to AAI for approval, before recording.		
2.14	INTEGRATION WITH OTHER SYSTEMS		
	The system shall be capable of integrating with the other systems such as:		
	a) Airport Operational Database (AODB)		

	b) Departure Control System (DCS)		
	c) Baggage Handling System (BHS)		
	d) CUTE System		
	Integration with other technology/system involved in Airport operation shall be brought out by the supplier as per tender conditions.		
2.15	PUBLIC SUMMARY DISPLAYS		
a)	CODE SHARE HANDLING		
	i) The carrier (master) shall be displayed in first line. The carrier is displayed in one row and all code shared are displayed in rotation (alternatively) in a second row in alphabetic order.		
b)	FREE TEXT, PAGING		
	i) All public displays shall have a free text line for important information.		
	ii) The free text line shall be displayed on demand (selectable by user) in the last row of the public display.		
c)	DISPLAY CLUSTERING		
	i) If a display in a cluster of displays fails, the system shall detect the failure and migrate the data to the next display device. i.e. if the 2nd display in a cluster of 3 fails the more relevant information of the second display shall move to the 3rd display until the 2nd display is back to operation.		
	ii) A carousel e.g. between different languages and flight information pages shall be synchronized		
	iii) The cluster shall always display the same type of information.		
	iv) The flight which was previously displayed in the last row shall be displayed		

	in the first row of the following display in a cluster of displays		
2.16			
A.	ARRIVAL SUMMARY		
	The display shall contain the following:		
	i) Airline logo		
	ii) Scheduled time of arrival		
	iii) Estimated time of arrival		
	iv) Flight number		
	v) Origin, via		
	vi) Remark *		
B.	DEPARTURE SUMMARY WITH GATE INFORMATION		
	The display shall display the following information:		
	i) Airline logo		
	ii) Scheduled time of departure		
	iii) Estimated time of departure		
	iv) Flight number		
	v) Destination, via		
	vi) Gate number		
C.	REMARKS FIELD SHALL DISPLAY FROM THE FOLLOWING		
i)	ARRIVAL FLIGHTS		
	a) On-time		
	b) Expected hh:mm		
	c) Delayed hh:mm		
	d) Landed hh:mm		
	e) Arrived hh:mm		
	e) Arrived hh:mm		

	g) Diverted		
ii)	DEPARTURE FLIGHTS		
	a) On-time;		
	b) Delayed hh:mm;		
	c) Departed hh:mm;		
	d) Cancelled;		
	e) Next Info hh:mm;		
	f) Gate Open;		
	g) Boarding;		
	h) Final Call;		
	i) Gate Closed;		
	D. LOCATION RELATED DISPLAYS (CHECK-IN COUNTER, BOARDING GATE, BELT)		
	a) The display shall show flight information only if the resource is active.		
	b) The operator shall be able to open the display on demand, if allocation time is exceeded due to delays. The operator shall be able to close the display at any time.		
	c) If a control device is used at location it shall be password protected. According to the allocation plan, only the current flight shall be displayed.		
	d) CHECK IN COUNTER DISPLAYS		
	i) The check-in counter display shall switch between common check-in, and dedicated check-in.		
	ii) In case the desk is allocated to more than one flight the display shall show information of all those flights allocated to the check in.		

	iii) The common check-in counter layout shall show airline or Ground Handler Logo, Class, and four free configurable Remarks.		
	iv) According to the allocation, the layout shall display the IATA Colour code.		
	v) The counter display shall show flight number and logo of the airline, as well as code share information, destination, Via, Passenger Class.		
	vi) Free text remark shall be made available as per the operator request.		
	e) BAGGAGE CLAIM AREA		
	i) The display will show up to 5 flights only if the flight is on blocks and allocated to the resource.		
	ii) Airline Logo, Airline, Code shares, Origin, Scheduled time of arrival, and First & Last Bag Time are to be displayed.		
	iii) The layout shall change automatically according to the number of flights to be displayed to achieve the maximum character size and legibility from distance.		
	iv) The flight shall disappear from the display after a configurable period of time or after the manual input "last bag" + 'x' minutes. The parameter 'x' shall be user configurable.		
	vi) BAGGAGE SUMMARY WITH BELT INFORMATION:		
	The display shall contain the following:		
	a) Belt number:		
	b) Airline logo		
	c) Origin, via		
	d) Flight Number		

2.14	CLIENT SYSTEM		
	FIDS Application Software and its component for access control and configuration of FIDS database as per the requirements specified in the tender.		
	The client application shall have standard web browser based/HTML interface to the FIDS server.		
	Touch Screen Client Application shall have design to utilize the touchscreen interface for easy data entry by on-screen keypads.		
	Any additional software plug in/ module, if required for access, control, configuration and administration of the FIDs, shall be supplied for use at an airport site irrespective of number of client/terminals at that site.		
3.	TRAINING & DOCUMENTATION		
	The bidder firm along with OEM partner firm shall provide following types of training as detailed below:		
3.1	MAINTENANCE AND SYSTEM ADMINISTRATIVE TRAINING		
	Maintenance and system administration training of minimum THREE trainees nominated by AAI, for FIVE working days at site. The training shall be designed and structured so that on successful completion of the training the participants shall be able to perform:		
	a. Basics of DBMS used.		
	b. System Administration of DBMS used.		
	c. Icon based and command line interface.		
	d. System setting up and Configuration of offered system from Scratch.		
	e. Adding, deleting, restricting of users to system		

	f. Adding of new displays, third party displays, user terminals & other components of the system		
	g. Interconnecting of system functional subcomponents		
	h. CCA/LRU replacement techniques		
	i. CCA/LRU level maintenance.		
	j. Preventive maintenance of the system		
	k. Basics of icon based or command line commands used		
	l. Configuration, optimization and alignment of the system with the help of the documents and software supplied along with the equipment/system.		
	m. Fault isolation up to Module/LRU level using diagnostic tools and general-purpose test equipment		
	n. Taking corrective action by replacing the faulty Module/LRU and restoring the equipment for normal operation,		
	o. Installation procedures for system hardware & software, configuration recovery, reloading of software drivers/modules of operating system and application software.		
	p. Performing full, differential, restricted backups and restoration to partitions as required.		
3.2	OPERATIONAL TRAINING		
	On the Job Operational Training shall be provided for THREE working days to one batch of SIX to EIGHT Trainees nominated by AAI from AAI, Airlines and other stake holders. The training shall be designed and structured so that on successful completion of the training the participants shall be able to perform:		
	a. Basics of icon-based commands used.		
	b. Understanding system is functional or not.		

	c. Basic fault/fault log monitoring.		
	d. Logging into the system.		
	e. Issue commands to display different shows.		
	f. Predicting restrictions of users to system.		
	g. Using of new displays, third party displays, user terminals & other components of the system		
	h. Using map depicting Interconnection of system fun		
	i. Call logging for Preventive maintenance.		
	j. Assisting System admin in Configuration, optimization and alignment of the system.		
	k. Assisting in Fault isolation up to Module/LRU level		
	l. Assisting in corrective action and restoring the equipment for normal operation,		
	m. Changing of different predetermined layouts, etc.		
	The bidder and OEM firm shall identify the prerequisite for the trainees for each of the training program. Complete training syllabus shall be submitted by the bidder in consultation with OEM to AAI before training.		
3.3	DOCUMENTATION		
	Two set each of soft copy and hard copy of Installation, Operations including theory of operation, Technical Manual, Maintenance manual; Troubleshooting of the system, procedure for loading of the system and application software, etc. shall be supplied at site . The Operation, Technical and Maintenance manual will cover:-		

	a. General technical description and theory of operation		
	b. Block diagram description up to LRU level		
	c. Component level lay out diagram with signal flows		
	d. Preventive maintenance		
	e. Fault analysis and repair		
	f. Detail circuit diagrams/schematic diagrams		
	g. Part list & component list with part number		
	h. Installation procedures for software, configuration recovery, reloading of software drivers/modules of operating system and application software.		
	i. Technical & operational manuals		
	j. Schematic/signal flow/block diagrams		
	k. Maintenance manuals		
	l. Maintenance and System Administrative procedures.		
	m. Operational Training.		
	n. Technical documents required for maintenance and fault finding for each module of the offered equipment shall be provided.		
	o. Integration with other systems: To enable integration of offered system, interface control document for the systems shall be provided.		

	MONITOR / LED LOCATIONS AND SIZE
3.4.1	Flight Information Display system (FIDS) Monitors locations at Airports.
	<p>f. Monitor Size – 43” to 55 “with minimum 1” High Character (font) at;</p> <ol style="list-style-type: none"> 1. Each Check-in Counters 2. Each Boarding Gates 3. Each Baggage Belts 4. VIP / CIP Lounges <p>g. Monitor Size – 55” to 85 “ with minimum 1” High Character (font) at;</p> <ol style="list-style-type: none"> 1. Departure Hall 2. Check-in Hall 3. Arrival Hall 4. Baggage Claim Area 5. After Security Check <p>h. Monitor Size – 32” to 43 “with minimum 1” High Character (font) at;</p> <ol style="list-style-type: none"> 1. Baggage Make-up /Break-up Area 2. Terminal Manager 3. APD 4. MI Room <p>i. Monitor Size – 100” or Active LED Board (6X3 Meter, 3x2 Meter, 1.5x1Meter) with minimum 1” High Character (font) at;</p> <ol style="list-style-type: none"> 1. City Side 2. Outdoor Arrival /Departure
	<u>Performance certificate for the past 2 Years from the end user is to be submitted with offered Monitors/LED Boards.</u>

	EQUIPMENT SPECIFICATIONS.		
4.	FIDS SERVER		
	To work as Main & Standby (Set of 2 Servers)		
4.1	TECHNICAL SPECIFICATIONS:		
i.	CPU: 64-bit high performance, 12 Core or higher Intel/AMD CPU operating at 3GHz or more with 24 MB Cache or more		
ii.	Memory: 32 GB of DDR5 RAM or more/better expandable up to 64 GB		
iii.	Chassis: Rack Mount type		
iv.	SAS /SATA 10K rpm hot-swappable Hard Disk in RAID 5 or better configuration having usable space of 1 TB or more.		
v.	Hot Swappable redundant power supply.		
4.2	TECHNICAL FEATURES:		
i.	NIC - Dual Integrated 10/100/1000 Mbps ports.		
ii.	DVD- RW Drive		
iii.	USB Optical Mouse with scroll, Keyboard shared through KVM switch, USB 3.0 or higher Ports and other Ports as required		
iv.	Other PCB/Modules/hardware as per system requirements.		
v.	OS: UNIX/LINUX/Microsoft Windows Server licensed (Latest version).		
vi.	Licensed Antivirus with update subscription valid till warranty and AMC period.		
5.	AFAS SERVER		
5.1	TECHNICAL SPECIFICATIONS:		
i.	CPU: Intel i7/AMD or better CPU operating at 3 GHz or more with 12MB Cache or more		
ii.	RAM: 16GB or more		

iii.	10000 rpm Hard Disk having usable space of 1 TB or more		
iv.	To be mounted in rack.		
5.2	TECHNICAL FEATURES:		
i.	NIC – 2 Nos. of 10/100/1000 Mbps ports		
ii.	At least 2 x PCI express I/O slots, suitable slot for 3rd party cards as required.		
iii.	USB 3.0 or higher port: At least 4 USB ports (2 in the front).		
iv.	DVD RW Drive		
v.	OS: UNIX/LINUX/Microsoft Windows Licensed Operating System		
vi.	Licensed Antivirus client version valid for Warranty & AMC Period.		
vii.	In addition to the above, the Server for AFAS shall be equipped with: PA Interface: Professional Two Channel On-board Sound Card with Digital I/O for AFAS Application with Zone Selection facility for at least 8 Zones.		
6.	CLIENT TERMINAL		
	Client Terminals shall be used to access FIDS Application Software User Interface for viewing and updating the Flight Information Database.		
6.1	TECHNICAL SPECIFICATIONS:		
i.	CPU: Intel i7/AMD or better CPU operating at 2.4 GHz or more with 8MB Cache or more		
ii.	RAM: 8GB or more		
iii.	Motherboard Chipset: OEM Motherboard		
iv.	SAS/SATA 7200 rpm Hard Disk having usable space of 1TB or more		

6.2	TECHNICAL FEATURES:		
i.	NIC – Gigabit Ethernet port		
ii.	At least 2 x PCI express I/O slots		
iii.	USB 2.0 or higher port: At least 4 USB ports (2 in the front).		
iv.	DVD RW Drive		
v.	USB optical Mouse with scroll and Keyboard		
vi.	23"/21" LCD/LED or better monitor.		
vii.	OS: UNIX/LINUX/Windows Licensed, latest version		
viii.	Licensed Antivirus valid for client version for Warranty & AMC Period.		
ix.	Standard Computer table made of combination of steel/MS material along with top shelf of standard material & size from reputed manufacturer such as Godrej/ Durion etc. as approved by Engineer in charge shall be supplied by the contractor with each Workstation/Client Terminal at equipment room		
7.	DISPLAY DEVICES		
7.1	GENERAL FEATURES:		
i.	Devices shall be capable of displaying the information in Portrait and Landscape mode. This shall be user configurable.		
ii.	All the displays shall have IR Remote, controlling basic display functions such as Brightness, Contrast, Colour Control, etc.		
iii.	It shall be possible to put the display in standby mode (soft power off) from the remote (network: server/workstation) or shall have a remote control to switch the display on or off in a go.		
iv.	Display monitor shall be provided with cabinet suitable for industrial/professional		

	24x7 use with arrangement for Wall and Ceiling Mount installation with provision for Swivel movement.		
v.	Suitable wall/ceiling/pedestal mounting of Stainless Steel (SS 304) shall be provided for Display Monitors in single or clustered configuration, the design of SS 304 mounting to be approved by Engineer in charge.		
7.2	FIDS LED DISPLAY BOARD		
	True Colour LED Display Board For Outdoor Installation		
7.2.1	TECHNICAL SPECIFICATIONS:		
i.	Display Area: For 3X2 m Board shall be 2.88mX1.92m Pixel Pitch: For 3x2 m2 Board: 6mm		
ii.	Pixel density: For 6mm pixel pitch it shall be 30000 dot/m2		
iii.	Pixel Configuration: For 3X2 m2 Board shall be 1R,1G,1B		
iv.	LED make: Avago, Cree, Nischia, Osram [RoHS compliant and Lead (Pb) Free]		
v.	Brightness: $\geq 4000 \text{ cd/ m}^2$		
vi.	Contrast Ratio: 3000:1		
7.2.2	TECHNICAL FEATURES:		
i.	Optimal viewing distance: 10 – 50 MTRS.		
ii.	Optimal Viewing Angle: 100° (H), 40° (V)		
iii.	Grey Scale/Colours: 256/16 Million Colours		

iv.	Processing: 16 bit/color		
v.	Interface: TCP/IP LAN RJ45		
vi.	Weather Protection: IP65 (Front) IP54 (Rear)		
vii.	Ambient Light Sensor		
viii.	Max. Power Consumption: $\leq 1000W/m^2$		
ix.	Construction material: Stainless Steel Cabinet SS grade 304		
7.3	FIDS LED DISPLAY MONITORS		
i.	Technical Features:		
ii.	Each Display monitor shall consist of:		
iii.	Professional Grade LED Monitor		
iv.	Suitable for 24x7 operation		
v.	Inbuilt Pluggable Intelligent Controller within OEM cabinet of Monitor. No external/ attached controller will be accepted.		
7.3.1	Flight Information Display System (FIDS) LED DISPLAY MONITORS: 42"/43"/55"/65" and 75" .		
i.	TECHNICAL SPECIFICATIONS:		
ii.	Back Light: LED		
iii.	Aspect Ratio: 16:9		
iv.	Resolution: Full HD or better.		
v.	Brightness: 700 cd/m2 or better		
vi.	Dynamic Contrast Ratio: 4,50,000:1 or better		
vii.	Viewing angle: (Horizontal/vertical): 176° or more		
7.3.2	TECHNICAL FEATURES:		
i.	Ambient Light Sensor		

ii.	Video Input Ports:		
iii.	Digital Ports: HDMI or DVI-D; USB		
iv.	Front Glass with Anti-Glare and Hard coating		
v.	Display Monitor for outdoor installation: No external cabinet to be installed over composite monitor. It shall be OEM Cabinet and inherent part of Monitor & protect from dust, sunlight, etc.		
vi.	Certification: UL for safety, FCC for EMC and BIS.		
7.4	INTELLIGENT CONTROLLER (for 42/43/55/65/75" Displays)		
7.4.1	TECHNICAL SPECIFICATIONS:		
i.	Processor: Intel/AMD 1.5 GHz or better, FSB 400 MHz		
ii.	RAM: 16 GB or more		
iii.	Flash Hard Disk: 64 GB or more		
iv.	Keyboard and mouse connectivity		
v.	LAN/Network: Integrated 10/100/1000 Base T NIC with RJ 45 connector		
vi.	Wi-Fi connectivity supporting 802.11 a/b g/n		
7.4.2	TECHNICAL FEATURES:		
i.	USB 3.0/2.0 Port: 2 Nos.		
ii.	Graphic Card shall be having specifications to meet the requirement of supporting Display/Monitor.		
iii.	Software: Windows or Linux base Embedded Operating system and associated software as required.		
iv.	Display controller shall be capable of remote monitoring of the displayed content/ information from the central server & any work station in the network.		

v.	It shall be possible to reset, restart and reboot the built-in intelligent controller & display monitor remotely on the network.		
8	NETWORK TIME PROTOCOL (NTP) SERVER		
8.1	TECHNICAL SPECIFICATIONS:		
i.	GPS/GLONASS satellite supported L1/L2/L5 Frequency band, Rack Mount Type, NTP SERVER to maintain and display IP based NTP time across the network containing L2/L3 switches shall be supplied by the bidder. NTP server shall act as a master clock with accuracy better than 50 ms in the network to which other clients shall interconnect over the network using NTP client software on Windows or Linux OS and synchronize periodically. It shall provide diagnostic and status ports/indications for automatic/ manual intervention.		
ii.	The GPS NTP Server shall be equipped with two independent network interfaces (10/100/1000 Mbps Ports).		
8.2	TECHNICAL FEATURES:		
i.	NTP Server shall support all the required networking protocols.		
ii.	SNMP v3 support for status and configuration and SNMP Trap messages.		
iii.	The GPS NTP Server shall be supplied and configured by bidder, with a GPS Antenna/Converter Unit and standard RG58 coaxial cable, as per site requirement.		
9.	FID Control Kiosk for Departure/ Arrival /Security Hall		
9.1	Manufacturer/OEM shall enclose copy of certification of ISO to ensure consistent product quality and meeting all regulatory norms.		

	The console shall be built to withstand life span of at-least 10 years on normal use, wear and tear.		
	<p>1. Kiosk shall have provision to accommodate upto one 21" to 23" touch screen, one metallic keyboard with track pad, Kiosk shall have sufficient space to accommodate the CPU, UPS & PDU (power distribution unit for powering all equipment with two spare 6A Power ports) and shall be accessible through rear door. The entire design shall be modular; consisting of interchangeable and replaceable parts. Touch/Non-Touch screen shall have separate door for the accessibility/maintenance and all locks shall feature 2-point locking arrangement. Design shall be extremely rugged to ensure a minimum life of 10 years for structural stability, moving and non-moving parts. The kiosk must be IP22 compliant to ensure rodent proof enclosure. Kiosk shall have PU wrist support for user comfort. Kiosk shall have feature of flush mounted metallic keyboard tray, in idle condition the tray shall remain flushed to the front fascia of the kiosk through "Child proof Clip Locking" and shall be accessed as and when required. Valid certificate to be submitted along with the bid.</p> <p>2. The structure shall be made up of minimum 2 mm thick heavy-duty vertical and horizontal profiles. These profiles shall be accurately inserted and welded over minimum 10 mm thick solid base. Outer shell, including all hinged and non-hinged parts shall be made up of minimum 1.5 mm thick sheet.</p>		

<p>3. All the sheet metal parts must be finished with a durable anti-bacterial powder coating (with added silver ions) to reduce formation of bacterial colonies on the front surface.</p> <p>4. The Base shall have concealed provision of grouting to the floor with anchor fasteners.</p> <p>5. Touch/Non-Touch Screen shall be accessible from Rear doors with hinges. All doors to have Foam Gasket to protect the equipment from dust particles. Doors shall have 2-Point Lockable system and shall have common keys for hassle-free maintenance.</p> <p>6. Modularity is to ensure replaceability in an unlikely case of damage. The rigidity and strength must not be compromised despite the modular feature of structure.</p> <p>7. Light Leaks, sharp edges and corners shall be deemed un-acceptable. Front Edge of the keyboard shall have moulded polyurethane edge for ergonomic wrist support.</p> <p>8. OEM shall enclose copy of certification of ISO.</p> <p>9. Bare Enclosure shall be RoHS certified to ensure restriction of hazardous material.</p> <p>10. Manufacture shall have CE Compliance certificate.</p> <p>11. A typical diagram for FID Control Kiosk is attached at Fig 3 for reference.</p>		
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	Final drawings and design will be approved by Engineer-In-charge/CHQ before the time of execution.		
	19" FLOOR STANDING EQUIPMENT RACK (42/40/36 U)		
	TECHNICAL FEATURES:		
	Equipment rack (standard 19") fully wired for housing Central Switches, FIDS Servers, AFAS Server, NTP Server, KVM Switch with integrated 17" Monitor etc.		
	All the Servers shall be installed in 19" 42/40/36U Rack with OEM Rack Mounting Kit(s).		
	Wiring shall be neatly done with suitable cable manager.		
	Power supply wiring with suitable capacity sockets and proper Earthing shall be neatly installed.		
	Rack shall include all required parts/accessories to install all devices/equipment. It shall have front and rear glass/perforated cover with locks. Rack's depth shall be sufficient to install all Servers and other network components and the doors remain closed.		
	Rack shall be provided with rack-mounted Fan unit (2 or more Fans) for Air Circulation.		
	17" LCD MONITOR WITH INTEGRATED 12-PORT KVM SWITCH		
	TECHNICAL FEATURES:		
	Rack mountable Integrated KVM Switch shall be provided for connecting Keyboard, Video and Mouse interfaces of the Servers. KVM Switch shall be OEM integrated unit having 17" LCD/LED foldable Monitor, Keyboard & Mouse and a selection		

	mechanism to allow connection to each Server/device connected to the KVM. The KVM switch shall be installed in the 19" Equipment Rack.		
	POWER REQUIREMENTS		
	10 KVA UPS IN REDUNDANT (1+1) CONFIGURATION (The capacity of 2 x 10 KVA is minimum. Bidder shall design the system and if required higher rating UPS shall be provided without any extra cost)		
	10 KVA Floor Mounted On-Line UPS 1+1 (Single/Three Phase AC Input & single Phase AC Output) with input/output Isolation Transformer (There shall be nothing common between input & output connections/leads) and Individual SMF Battery Bank to provide 30 minutes Battery back-up for each UPS, RS 232 Serial Port or RJ45 with Software for Computer Interface and Redundant Configuration.		
	UPS operation shall be configured in such a way that the failure of one UPS shall result in total load to be automatically transferred to other UPS of the cluster.		
	TECHNICAL SPECIFICATIONS:		
	General:		
	UPS shall be free from workmanship defects. The Equipment shall be complete with all parts and all parts shall be functional.		
	By-pass facility shall be provided for maintenance of UPS.		
	UPS shall supply output power and charging current at the same time.		

	Switching device shall be IGBT		
	Digital Signal Processors (DSP) shall be used for all monitoring and control electronics of UPS.		
	Switching frequency shall be above 10 KHz or better and shall be declared in the offer.		
	Input: 170V-280V Single phase /350V-450V, 50 Hz \pm 3% Three Phase AC		
	Output: 230V \pm 1% , 50 \pm 0.5Hz, Single phase. Voltage regulation from no load to full load shall be within \pm 1% in both the cases. UPS shall also have facility for operation in synchronous mode in which output frequency shall be same as that of mains frequency.		
	Total harmonics distortion at output: 3% maximum for UPS on resistive load, if total input harmonics are less than or equal to 10%.		
	Efficiency (at rated output voltage and frequency): Overall efficiency (minimum): 90%		
	UPS power factor at rated load: better than 0.8 lagging or better.		
	Over load: UPS shall withstand 20% overload for 1 minute and 50% over load for 30 seconds.		
	TECHNICAL FEATURES:		
	Protections: Following protection shall be provided in UPS:		
	Over voltage, short circuit, and overload at UPS output terminal.		
	Under voltage at battery terminal.		

	Overshoot and undershoot shall not be greater than 4% of rated voltage for duration of 40m sec. (maximum)		
	Indicators and meters:		
	Following indicators shall be provided:		
	Mains presence.		
	Battery charging and discharging		
	Output overload		
	Low battery voltage.		
	Digital Display shall be provided for indicating/monitoring the following parameters in UPS:		
	Input AC voltage.		
	Output AC Voltage, frequency		
	Battery voltage and current.		
	Battery bank:		
	UPS shall be supplied with SMF VRLA battery only.		
	Batteries for UPS shall be of the following makes: EXIDE, PANASONIC, AMAR RAJA, GLOBAL, ROCKET, BASE.		
	The UPS shall be complete with Trolley for battery bank and the firm shall also connect the batteries with UPS and commission the same.		
	Minimum AH rating of battery bank with suitable rack for the duration of back up time shall be as detailed below: UPS rating in KVA: 10KVA; Min. 30 minutes back up		
	Testing requirement for UPS:		

	Type Tests: Following shall constitute type test and at least one sample shall be type tested for each rating with maximum backup time. Type testing shall be conducted at the premises of the manufacturer in presence of an officer deputed by AAI:		
	Visual examination.		
	Verification of output power, capacity test and frequency.		
	Verification of voltage regulation.		
	Verification of efficiency.		
	Verification of total harmonics distortion.		
	Verification of overshoot, undershoot limits and over voltage protection.		
	Verification for insulation resistance, leakage current high voltage. Insulation resistance should not be less than 100 mega ohms.		
	POWER DISTRIBUTION PANEL (PDP)		
	TECHNICAL FEATURES:		
	The power distribution panels shall be provided to meet the system requirement along with UPS. The power distribution panel shall provide MCBs with proper ratings for all equipment including field equipment like Network Switches, Cameras, Workstations, Displays etc. Sufficient number of Loops are required to be made to avoid high current passing in single loop – one MCB for each loop and one Mains Control Switch.		
	EARTHING		
	TECHNICAL FEATURES:		
	The system shall be configured to be grounded electrically to a common ground point to prevent interference to the system		

	from external and internal sources and to protect equipment and personnel.		
	Earthing of the System: The contractor firm shall provide the Earthing to each system separately by making the earth-pit as follows:		
	Supply and installation of the copper plate - 600x600x3mm		
	GI (galvanized) pipe of 40 mm diameter is to be used		
	The earth-pit to be dug for a depth of 3.75 mts.		
	Copper plate is to be properly fastened with nuts and bolts to the copper wire of size 14SWG. This copper strip/copper wire is laid up to the main distribution board of the centre.		
	The copper strip without GI pipe or thick copper wire with GI pipe should be laid up to the Server Room.		
	19 mm GI pipe to be laid for watering purposes. This will have a funnel at the top of the earth pit chamber.		
	Minimum 70 Kg. of salt and approx. 100 Kg. of coal are to be filled in the pit, in layers, after the plate and the pipes are laid in the pit.		
	Measurement the earth resistance at the pit should be less than 2 Ohms.		
	Standard Chemical Earthing may be provided instead of above-mentioned Conventional Earthing in case of the rocky soil at site and/or 2 ohms resistance is not achieved.		

FLIGHT INFORMATION DISPLAY SYSTEM SCHEMATIC:

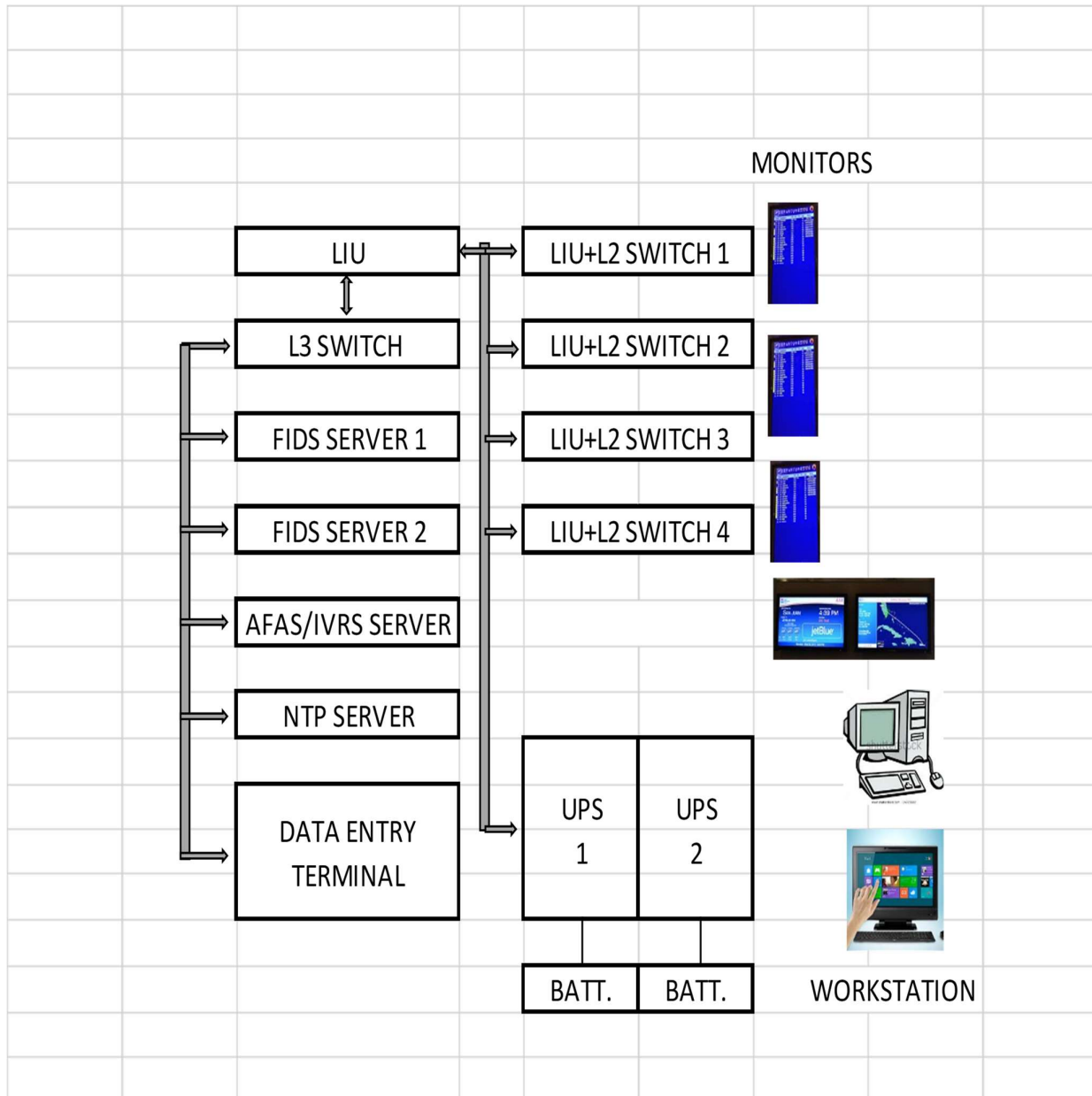
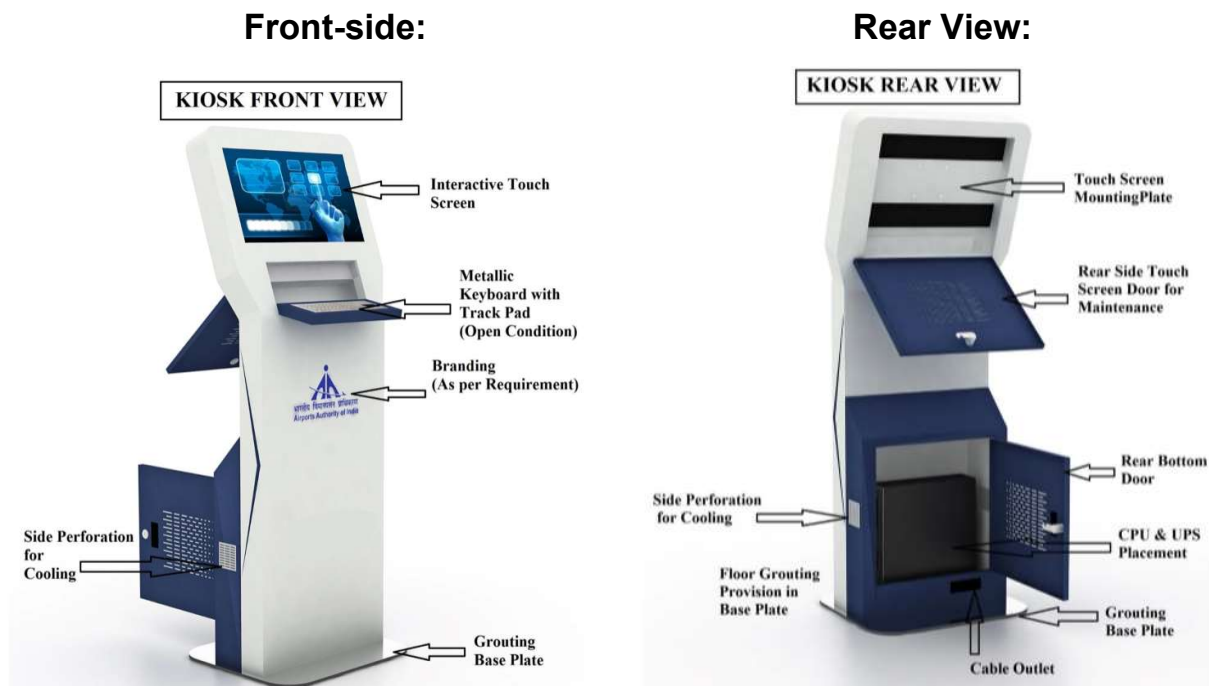


Fig 3: Typical diagram of FID Control Kiosk for Departure/Arrival/Security Hall



Technical Specifications for Active IT Components

Item no. 2 - Next generation Firewall (HA Mode)	
S. No	Generic Requirements
1	The appliance-based security platform should be capable of providing minimum Threat Prevention throughput of 1 Gbps or higher (2 Gbps in case higher traffic requirement) on real world / Ent <i>Mix</i> / App Mix traffic after enabling IPS, User ID, Anti-Virus, logging and Application Visibility security services in a single appliance from day one.
2	The Firewall should support Advanced Threat Protection like malware and zero-day threats with AI-based malware detection that do not yet have known signatures.
3	The appliance should have minimum 4x 1Gig TX, 8x10G SFP+ Ports, OOB, Console, 2x HA and USB from day-1. The trans receiver has to be proposed as per solution. The Appliance should have redundant internal power supply and fan.
4	The Firewall should have Application visibility and control/ AVC from Day 1.
6	The proposed firewall shall have built-in high availability (HA) features without extra cost/license or hardware component. High availability configurations should support Active/Active or Active/ Passive.
	Should support up to 1.5 Million or higher Concurrent sessions and at least 90000 or higher new sessions per second
8	Firewall should support at-least 1500 or higher users limit.
9	Firewall should provide State-full fail over. HA configuration that uses dedicated HA/ control interface apart from the mentioned traffic interfaces
10	System Throughput Should provide 4Gbps (8 Gbps in case higher traffic requirement) or higher Firewall Throughput Should provide 2 Gbps (4 Gbps in case higher traffic requirement) or higher IPSec VPN throughput on <i>rea</i> /world (Large Packet) Should provide 1.5 Gbps (3 Gbps in case higher traffic requirement) or higher IPS throughput. Should provide 1 Gbps (2 Gbps in case higher traffic requirement) or higher Threat Protection throughput (Firewall, Application Security/ AVC and IPS
11	Memory —at-least 8GB or higher and minimum 120 GB storage/ SSD
12	Support: - IKEv1 and v2, IPSec VPN standards, 56-bit DES, 168-bit 3DES, 256-bit AES encryption
13	Proposed solution must support Load Balancing/Load sharing of ISP Links.
14	Authentication, Authorization and Accounting (AAA) support: RADIUS or TACACS+
15	Support for: Network and application level attacks ranging from malformed packet attacks to DoS attacks, Support RSA and Diffie-Hellman, MD-5, SHA-1, SHA-128, SHA-256
16	Firewall should support static Routes, OSPFv2, OSPFv3 and BGP, PIM Multicast routing

17	The proposed NGFW should be native Layer 7 and the device should be able to handle Management functions like configuration, reporting and route update, Signature matching (like exploits, virus, spyware, CCP), Security processing (like apps, users, content/URL, policy match, SSL decryption, app decoding etc) & Network Processing (like flow control, route lookup, MAC lookup, QoS, NAT etc).
18	<p>Management</p> <p>Web based management to support for remote monitoring through firewall manager</p> <p>Accessible through variety of methods including: Telnet, Console Port, SSH Dedicated Out-of-Management interface Support SNMPv1, v2, v3 & Support for syslog</p>
19	The proposed firewall should have integrated Web Content Filtering solution without external solution, devices or hardware modules.
20	The proposed solution should support Data Loss Prevention (DLP) which allows administrators to prevent sensitive data from leaving the network. Administrators should be able to define sensitive data patterns and data matching these patterns that will be blocked and/or logged when passing through the device.
21	The Solution should be supplied with complete installation, configuration, and training by OEM /OEM certified technical staff.
22	The Firewall solution should support NAT46, NAT64,NAT66 DNS64 & DHCPv6
23	Implementation and integration of the proposed solution with the existing network infrastructure and configuring / setting up AAA / Directory Services and / or any other prerequisite application / package / service is also the responsibility of the Vendor (SI).
24	The proposed firewall should be certified by MCTE in reference to Gol. Any Original Equipment Manufacturer (OEM)/ importer/ dealer who wishes to sell, import, or use any telecom equipment in India, shall have to obtain Certificate from Telecommunication Engineering Centre TEC (Telecommunication Engineering Centre).
25	Firewall should be tested and certified for EAL 3/NDPP or above under Common Criteria Certification for security related functions or under Indian Common Criteria Certification Scheme (IC3S).
26	The proposed firewall should have 3 years warranty with NBD support (back-to-back from OEM)

Item No. 3 - Core cum Distribution Switch-(HA Mode)	
S. No	Generic Requirements
1	Switch should be with minimum 48/24 no. of 10 Gig SFP+ ports (as per requirement) and 4 nos. of 40/100 Gig QSFP ports from Day-one.
2	Switch should support for Active-Active High Availability or Virtual Chassis / Stacking.
3	Switch should have hot swap able 1:1 redundant internal power supply.

4	Switching system shall have minimum 32K MAC Addresses and 1K active VLANs.
5	Switch should support minimum 1500 ACLs, minimum 4K Multicast routes, minimum 20K Unicast Routes for IPv4 and 10K Unicast Routes for IPv6.
6	Should support IEEE Standards of Ethernet: IEEE 802.1D, 802.1s, 802.1w, 802.1x, 802.3ad, 802.3x, 802.1p, 802.1Q
7	Should have static routing, OSPF, OSPFv3, BGP, HSRP for IPv6/VRRPv3, VRF (Virtual routing and forwarding), IGMP v2/v3 and PIM multicast routing, VXLAN, Policy based routing.
8	Shall have 802.1p class of service, classification, policing/shaping. Should support strict priority queuing
9	Switch should support management features like SSHv2, SNMPv2, SNMPv3, NTP, RADIUS OR TACACS+,
10	Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard.
11	Switch should have IPv6 security features from Day-1.
12	Should support 802.1x authentication and accounting, IPv4 and IPv6 ACLs and Dynamic VLAN assignment. Switch should support MACSEC /GRE. Switch should support control plane policing to protect switch CPU from DoS attack.
13	Switch should support Weighted Round Robin (WRR) Deficit Weighted Round Robin (WDDR) scheduling or equivalent and Weighted Tail Drop (WTD)/Weighted Random Early Detection (WRED) or equivalent congestion avoidance.
14	Switch shall support application visibility/insight and traffic monitoring using-net Flow/ s flow/ j flow entries.
15	Switch shall conform to UL 60950 or IEC 60950/62368-1 or CSA 60950 or EN 60950/62368-1 Standards for Safety requirements of Information Technology Equipment.
16	Switch shall conform to EN 55032 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.
17	Switch/Switch Series should be tested and certified for EAL 2/NDPP/FIPS 140-2 or above under Common Criteria Certification or under Indian Common Criteria Certification Scheme (IC3S).
18	The proposed switch should be certified by MTCTE in reference to Gol. Any Original Equipment Manufacturer (OEM)/ importer/ dealer who wishes to sell, import, or use any telecom equipment in India, shall have to obtain Certificate from Telecommunication Engineering Centre TEC (Telecommunication Engineering Center).
19	Switch/ Switch Series should have Ipv6 Certified/IPv6 logo ready from Day-1.
20	Switch should support Operating Temperature Range of 0°C to +40°C. $\pm 5^{\circ}\text{C}$ Temp variation on lower and higher side is acceptable.
21	The proposed switch should have minimum 16 GB RAM, 16 GB Flash and 32 MB packet buffer.
22	Switch shall have event and system history logging functions. The switch shall generate system alarms on events. Facility to put selective logging of events onto a separate hardware where the analysis of log shall be available.
23	Switch should have Trusted Platform Module (TPM)/ Secure Boot Functionality.

24	Switch should have 3 years warranty with NBD support (back to back from OEM).
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Item No 4 - 48 Port Non PoE Access Switch	
S. No	Generic Requirements
1	Each proposed switch should be 1RU and must have 48 ports with 10/100/1000 Base-T and 4 SFP+ uplink ports available from Day1.
2	Switch should be populated with 2 Single Mode 10G SFP+ Modules from Day 1.
3	Each proposed switch must support stacking for up to 8 switches and should provide 80 Gbps or better stacking solution.
4	Switch should have minimum 1 GB DRAM, minimum 2GB Flash and minimum 6 MB packet buffer.
5	Shall have minimum 16K MAC Addresses and minimum 512 active VLANs.
6	Switch should have L3 functionalities like static routing and shall support RIP, PIM, OSPF, PBR & QoS features. Switch should have capability to support VXLAN for future requirements.
7	Switch should support Weighted Round Robin (WRR) / Deficit Weighted Round Robin (DWRR) scheduling or equivalent and Weighted Tail Drop (WTD)/ Weighted Random Early Detection (WRED) or equivalent congestion avoidance.
8	Switch should have 802.1p class of service and 802.1Q VLAN tagging.
9	Switch should have IPv6 security features to protect against IPv6 spoofing attack. Switch should support MACSEC/GRE.
10	Switch should have Trusted Platform Module (TPM)/Secure Boot functionality.
11	Switch should support control plane policing or equivalent to protect switch CPU from DOS attack
12	Should support 802.1x authentication and accounting, ACLs and VLAN assignment
13	Switch shall support application visibility/ insight and traffic monitoring using net Flow/ s flow/j flow entries.
14	Switch should be tested and certified for EAL 3/NDPP or above under Common Criteria Certification/Indian common criteria certification scheme (IC3S).
15	Switch should support DHCP, Auto Negotiation, LACP, UDLD, MDIX, GVRPVTP, TFTP, NTP, Per-port broadcast, multicast, Static routing, Layer 2 trace route or IPv4 and IPv6 trace route and unicast storm control.
16	Switch/Switch Series should be IPv6 Certified/IPv6 logo ready from Day-1.
17	Switch should have 3 years warranty with NBD support (back-to-back from OEM).
18	The proposed switch should be certified by MTCET in reference to Gol. Any Original Equipment Manufacturer (OEM)/ importer/ dealer who wishes to sell, import, or use any telecom equipment in India, shall have to obtain Certificate from Telecommunication Engineering Centre TEC (Telecommunication Engineering Center).

Item No. 5 - Access Switch: 24 Port PoE+	
S. No	Generic Requirements
1	Each proposed switch should be 1RU and must have 24 Nos. 10/100/1000 Base-T Ports and 4 Nos. SFP+ uplink ports available from Day1.
2	Switch should be with PoE+ capability and should have min 370W or above PoE Power.
3	Switch should be populated with 2 Single Mode 10G SFP+ Modules from Day 1.
4	Each proposed switch must support stacking for up to 8 switches and should provide 80 Gbps or better stacking solution.
5	Switch should have field replaceable Redundant Power Supply from Day 1.
6	Switch should have minimum 1 GB DRAM , minimum 2GB Flash and minimum 6 MB packet buffer.
7	Shall have minimum 16K MAC Addresses and minimum 512 active VLANs.
8	Switch should have L3 functionality like static routing and shall support RIP, PIM, OSPF, PBR & QoS features. Switch should have capability to support VxLAN for future requirements.
9	Switch should have 802.1p class of service and 802.1Q VLAN tagging.
10	Switch should have IPv6 security features to protect against IPV6 spoofing attack. Switch should support MACSEC/GRE.
11	Switch should support DHCP, Auto Negotiation, LACP, UDLD, MDIX, GVRP/VTP, TFTP, NTP, Per-port broadcast, multicast, Static routing, Layer 2 trace route or IPv4 and IPv6 traceroute and unicast storm control.
12	Switch should support Weighted Round Robin (WRR)/ Weighted Deficit Round Robin (WDRR) scheduling or equivalent and Weighted Tail Drop (WTD)/ Weighted Random Early Detection (WRED) or equivalent congestion avoidance.
13	Switch should have Trusted Platform Module (TPM)/Secure Boot functionality.
14	Switch should support control plane policing or equivalent to protect switch CPU from DoS attack
15	Should support 802.1x authentication and accounting, ACLs and VLAN assignment.
16	Switch shall support application visibility/ Insight and traffic monitoring using net Flow/ s flown flow entries,
17	Switch should be tested and certified for EAL 3/NDPP or above under Common Criteria Certification/Indian common criteria certification scheme (IC3S).
18	Switch/Switch Series should be IPv6 Certified/IPv6 logo ready from Day1.
19	Switch should have 3 years warranty with NBD support (back-to-back from OEM).

20	The proposed switch should be certified by MTCTE in reference to GoI. Any Original Equipment Manufacturer (OEM)/ importer/ dealer who wishes to sell, import, or use any telecom equipment in India, shall have to obtain Certificate from Telecommunication Engineering Centre TEC (Telecommunication Engineering Center).
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Item No. 6 - Access Switch: 24 Port non PoE	
S. No	Generic Requirements
1	Each proposed switch should be 1RU and must have 24 ports with 10/100/1000 Base-T and 2 SFP+ uplink ports available from Day 1
2	Switch should have slot/ports for stacking with stacking ports and cables and should provide 80 Gbps or better stacking solution.
3	Switch should have minimum 1 GB DRAM , minimum 2GB internal/external Flash and minimum 6 MB packet buffer.
4	Shall have minimum 16K MAC Addresses and 512 active VLANs.
5	Switch must have L3 functionality like static routing, RIP, PIM, OSPF, PBR & QoS features from Day 1. Shall have 802.1p class of service, classification, policing /shaping. Switch should have capability to support VXLAN for future requirements.
6	Switch should have IPv6 security features. Switch should support MACSEC/GRE. Switch should support control plane policing to protect switch CPU from DoS attack
7	Should support 802.1x authentication and accounting, ACLs and VLAN assignment.
8	Switch shall support application visibility/ insight and traffic monitoring using net Flow/ s flow/ j flow entries.
9	Switch should be tested and certified for EAL 3/NDPP or above under Common Criteria Certification/Indian common criteria certification scheme (1C3S).
10	Switch/ Switch Series should have IPv6 Certified/IPv6 logo ready from Day-1.
11	Switch should support Operating Temperature Range of 0°C to +40°C. $\pm 5^{\circ}\text{C}$ Temp variation on lower and higher side is acceptable.
12	Switch should support DHCP, Auto Negotiation, LACP, UDLD, MDIX, GVRP/VTP, TFTP, NTP, Per-port broadcast, multicast, Static routing, Layer 2_ trace route or IPv4 and IPv6 trace route and uni-cast storm control.
13	Switch should support Weighted Round Robin (WRR) / Deficit Weighted Round Robin (DWRR) scheduling and Weighted Tail Drop (WTD)/ Weighted Random Early Detection (WRED) or equivalent congestion avoidance.
14	Switch should have Trusted Platform Module (TPM)/Secure Boot functionality.

15	The proposed switch should be certified by MTCTE in reference to Gol. Any Original Equipment Manufacturer (OEM)/ importer/ dealer who wishes to sell, import, or use any telecom equipment in India, shall have to obtain Certificate from Telecommunication Engineering Centre TEC (Telecommunication Engineering Center).
16	Switch should have 3 years warranty with NBD support (back-to-back from OEM).

Item No. 7 - Access Switch: 48 Port PoE+	
S. No	Generic Requirements
1	Each proposed switch should be 1RU and must have 48 Nos. 10/100/1000 Base-T Ports and 4 Nos. SFP+ uplink ports available from Day 1 with PoE+ capability.
2	Switch should have slot/ports for stacking with stacking ports and cables and should provide 80 Gbps or better stacking solution.
3	Switch should be with PoE+ capability and should have min 760W or better PoE Power.
4	Switch should have internal redundant power supply .
5	Switch should have minimum 1 GB DRAM , minimum 2GB Internal/external Flash and minimum 6 MB packet buffer.
6	Shall have minimum 1 6K MAC Addresses and 512 active VLANs.
7	Switch must have L3 functionality like static routing, RIP, PIM, OSPF, PBR & QoS features from Day 1. Shall have 802.1p class of service, classification, policing /shaping. Switch should have capability to support VXLAN for future requirements
8	Switch should support Weighted Round Robin (WRR) / Deficit Weighted Round Robin (DWRR) scheduling and Weighted Tail Drop (WTD)/ Weighted Random Early Detection (WRED) or equivalent congestion avoidance.
9	Switch should have IPv6 security features. Switch should support MACSEC/GRE. Switch should support control plane policing to protect switch CPU from DoS attack
10	Should support 802.1x authentication and accounting., ACLs and VLAN assignment.
11	Switch shall support application visibility and traffic monitoring using net Flow/ s flow/ j flow entries.
12	Switch should be tested and certified for EAL 3/NDPP or above under Common Criteria Certification/Indian common criteria certification scheme (IC3S).
13	Switch/ Switch Series should have Ipv6 Certified/IPv6 logo ready from Day-1.
14	Switch should support Operating Temperature Range of 0°C to +40°C. ± 5°C Temp variation on lower and higher side is acceptable.
15	Switch should support DHCP, Auto Negotiation, LACP, UDLD, MDIX, GVRP/VTP, TFTP, NTP, Per-port broadcast, multicast, Static routing, Layer 2 trace route or IPv4 and IPv6 traceroute and unicast storm control.
16	Switch should have Trusted Platform Module (TPM)/Secure Boot functionality.

17	The proposed switch should be certified by MTCTE in reference to GoI. Any Original Equipment Manufacturer (OEM)/ importer/ dealer who wishes to sell, import, or use any telecom equipment in India, shall have to obtain Certificate from Telecommunication Engineering Centre TEC (Telecommunication Engineering Center).
18	Switch should have 3 years warranty with NBD support (back-to-back from OEM).

Item No. 8 - Access Switch: 8 Port Industrial Grade PoE+	
S. No	Generic Requirements
1	The proposed switch should be 1U 19" Rack Mountable and must have 8 Nos. 10/100/1000 Base-T Ports and 2 Nos. 100/1G/10G SFP+ uplink ports available from Day 1 with PoE+ capability.
2	It should have the capability to monitor Uni-directional Link Detection (UDLD) and prevent loops if unidirectional traffic is detected.
3	Switch should be with PoE+ capability and should have 4 ports of Class 6 PoE(60W) and 4 ports of Class 4 PoE(30W). It should have fixed power supply and fanless.
4	The Switch should support new UHD IP cameras, Wi-Fi access points, and future-ready Gigabit speed automation devices from Day-1.
5	Switch should have minimum 4 GB DRAM, minimum 1GB eMMC/Flash memory
6	Shall have minimum 16K MAC Addresses and 256 active VLANs.
7	Switch must have L3 functionality like static routing, RIP, PIM, OSPF, PBR & QoS features from Day1. Shall have 802.1p class of service, classification, policing /shaping
8	The switch should support IEEE 802.3az Energy Efficient Ethernet and PoE allocation by usage or class, with LLDP and LLCP-MED
9	Switch should have IPv6 security features. Switch should support MACSEC/GRE. Switch should support control plane policing to protect switch CPU from DoS attack, CPU protection. STP BDU port protection, STP root guard, traffic prioritization for real time classification.
10	Should support 802.1x authentication and accounting, ACLs and VLAN assignment
11	Switch shall support application visibility and traffic monitoring using net Flow/ s flow/ j flow entries.
12	Switch should be tested and certified for EAL 3/NDPP or above under Common Criteria Certification/Indian common criteria certification scheme (IC3S). Additionally, it should be complied for IEC 60068-2-27, IEC 60068-2-6.
13	Switch/ Switch Series should have Ipv6 Certified/IPv6 logo ready from Day-1.
14	Switch should support Operating Temperature Range of -40°C to +70°C. * 5°C Temp variation on lower and higher side is acceptable.

15	Switch should support DHCP, Auto Negotiation, LACP, UDLD, MDIX, GVRP/VTP, TFTP, NTP, Per-port broadcast, multicast, Static routing, Layer 2 trace route or IPv4 and IPv6 traceroute and unicast storm control.
16	It should extend geographical stability for longer distances coverage. It should support IP30 for protection from tools and wires greater than 2.5 mm. It should have protection against the corrosion (IEC60068-2-52)salt fog and (IEC 60068-2-60) mixed gas.
17	Switch should have Trusted Platform Module (TPM)/Secure Boot functionality.
18	The proposed switch should be certified by MTCTE in reference to Gol. Any Original Equipment Manufacturer (OEM)/ importer/ dealer who wishes to sell, import, or use any telecom equipment in India, shall have to obtain Certificate from Telecommunication Engineering Centre TEC (Telecommunication Engineering Center).
19	Switch should have 3 years warranty with NBD support (back-to-back from OEM).

Item No. 9 - WIRELESS LAN CONTROLLER/MANAGER (HA Mode)	
S. No	Generic Requirements
1	Solution must be compliant with IEEE CAPWAP/LWAPP/IITPS/VxLAN/IPSEC/EoGRE or equivalent standard.
2	All required licenses as per site requirement & mentioned specifications of complete solution to achieve the functionality should be provided from day 1. Device should be scalable to minimum 250 AP in same hardware and minimum 5000 clients.
3	Device must have at least 2x10G SFP+ and 2x 1/2.5G copper interfaces.
4	Controller should have console port, 1 x RJ45 OOB, USB port
5	Device Must support an ability to dynamically adjust channel and power settings based on the RF environment
6	The device should provide latest network authentication (WEP, WPA, WPA2) and encryption types like DES/3DES, TKIP and AES.
7	The device should provide air-time fairness between different speed clients — slower clients should not be starved by the faster clients and faster clients should not adversely affected by slower clients.
8	Device should support L2 and L3 roaming of IPv6 clients
9	The device should have ability to map SSID to VLAN and dynamic VLAN support for same SSID.
10	The device should support automatic channel selection for interference avoidance.
11	Must support coverage hole detection and correction that can be adjusted on a per WLAN basis.
12	Device must be MTCTE Certified as per Telecommunication Engineering Centre (TEC). Certificate to be enclosed.
13	Device should support IPv6 functionality from Day1.

14	Device should support client IPv6 from Day 1.
15	Device Should adhere to the strictest level of security standards, including 802.11i, WPA3, WPA2, WPA, 802.1X with multiple Extensible Authentication Protocol (EAP)
16	The device should detect and protect if a client/tool try to flood an AP with 802.11 management frames like authenticate/associate frames which are designed to fill up the association table of an AP.
17	Device should have rogue AP detection, classification, and automatic containment feature. It should automatically blacklist/protect clients when it attempts any attack.
18	Device should be able to detect attacks like Broadcast de-authentication / NULL probe from day one for all access points
19	Device Must support 802.11e and WMM
20	Device should have role based access for Data, Voice and Video Call Admission and Stream prioritization for preferential QoS. It should support session prioritization.
21	Device should have per client rate limit on same SSID.
22	Should have External Captive Portal Integration - Web-services based API for external web-portals to integrate with the controller. WLC should have library of well-documented REST-APIs and full set of MQTT/GPB to allow integration with 3rd party apps.
23	The device must support L7 DPI based Application based visibility, QoS and controlling capability.
24	WLC should be able to provide a web-based application that allows non- technical staff to create Guest accounts with validity for fixed duration like hours or days.
25	WLC should be have administration access through HTTPS GUI, SSH CLI. Administrative users should have account security features such as session idle timer, account Lockout, password expiration, password reuse, two factor authentication. Should have option to enable captcha to make sure a human is logging into the system
26	Device should be quoted with 3 years warranty with NBD support (back to back from OEM).

Item No. 10: Access Points (Indoor)	
S. No	Generic Requirements
1	Access Points proposed should have minimum 4x4:4 MIMO radios on both 2.4 GHz and 5 GHz antennas for transmission and receiving with minimum 3 Gbps or higher aggregate data rate. It should support MU-MIMO and OFDMA for increased and efficient connectivity from Day1.
2	Mounting kit should be standard from OEM directly.
3	Access Points should have dynamic bandwidth adjustments to accommodate fluctuating device density, enhanced roaming facilitated by an equitable distribution of Effective Isotropic Radiated Power (EIRP) to radios and real-time channel assignments to minimize co-channel interference.
4	Access points must support BPSK, QPSK, 16-QAM, 64-QAM, 256 QAM, 1024 QAM modulation types.
5	Must support 21 dBm or more of transmit power in both 2.4Ghz and 5Ghz radios.

6	Must have 1 nos. or more of multi gigabit Ethernet (RJ-45) 100M/1G/2.5G- IEEE 802.3bz supporting POE/POE+.
7	Must have minimum 16 SSIDs.
8	AP should be manageable from cloud/virtual WLC in future if required or without a controller wherever required.
10	The Access points should be Centrally Managed by a full-fledged controller.
11	In some small, isolated environments, the AP should be able to function as a full-fledged standalone access point without the requirement of a controller.
12	AP Should support detecting wireless interferences and should have advanced mechanism to minimize the impact of interference from cellular networks, Distributed antenna systems (DAS) etc.
13	AP should support AI powered analytics for client health, air time utilization, Access Point details and more.
14	AP Should support Radio resource management for optimum wireless
15	Must operate as a sensor for wireless IPS.
16	Must support WPA-PSK, WPA-TKIP, WPA2 AES, WPA3, WIDS/WIPS.
18	AP must have in-built IOT with ZigBee/ BLE(Bluetooth Low Energy).
19	Must be plenum-rated (UL2043) or equivalent.
20	AP must have Wi-Fi 6 Certified. Wi-Fi certificate to be enclosed.
21	AP should be quoted with 3 years warranty With NBD support (back-to-back from OEM).
22	AP should support IEEE 802.11 a/b/g/n/ac/ax. AP should support 802.1q VLAN tagging.
23	AP should support Authentication via 802.1X and Active Directory
24	Device must be MTCTE Certified as per Telecommunication Engineering Centre (TEC). A certificate should be submitted for compliance.

Technical Specification for Passive IT Components

S. No	Item	Generic Specification
1	Cat6A UTP Cable	<p>4-pair, Cat 6A UTP Cable, LSZH, Channel performance up to 500 MHz or more, ETL 4 connector performance channel test report as per ISO/IEC 11801 23 AWG bare solid copper, Meets EIA/TIA 568-C.2/ANSI/T1A 568.2D. RoHS Compliant/EN 50575. Cable Skew: ≤ 45 nsec/100 meters, Characteristic Impedence: $100 \pm 6 \Omega$ @ 1-500 MHz DC Resistance Max: 9.5 Ohms/100m, IEC 60332-3/60332-1, IEC 61034-2, IEC 60754-2, ISO/IEC 11801/EN 50173, Operational Temp: -20deg C to 60deg C</p>
2	Cat6A Patch Panel 24 Port(Loaded)	<p>Cat 6A U/UTP 24-port Jack Panel loaded with 24 nos. UTP ports for PCB based IO Jacks, 1U size, ISO/IEC 11801/EN50173 EIA/TIA 568-C.2/ TIA-568 2.D, UL Listed, RoHS Compliant, Current Rating: 1.5A @20°C or 68°F</p>
3	Cat6A Patch Cords for 3 feet and 7 feet both	<p>3 Feet (at Rack end) and 7 Feet (at User End) Cat 6A U/UTP Patch Cable, TIA- 568C/ TIA-568 2.D Category- 6A, UL-listed/ETL, RoHS, solid copper, Plug Insertion life Min. 750 times, LSZH, IEC 60332-3/ IEC 60332-3-22, IEC 60754-2/ IEC 60754, IEC 61034-2/ IEC 61034/ ISO/IEC 11801/EN 50173 Operational Temp: -20° to 60° Celsius</p>
4	Cat 6A UTP I/O	<p>Cat 6A UTP Jack PCB based Information Outlet (I/O) RJ45, TIA-568 C.2/T1A-568 2.0 Contact Resistance: maximum 100milli ohms; Insulating resistance minimum 500 milli ohms; Current Rating: 1.5 A (max), Meets and exceeds ISO/IEC 11801/EN 50173, EIA/TIA 568-C.2/ TIA-568 2.D ROHS compliant</p>
5	Cat6A Face Plate	<p>Single Port/Dual Port Face Plate of Size 3x3, Material should be ABS/UL 94 V-0 with spring shutter on plate or Jack, Face plate shall accept all modules for UTP, fibre optic and audio/video application,</p>
6	Cat6A Gang Box	<p>Gang Box to be supplied should be ISI approved.</p>

7	Fiber Optic Cable Single Mode	<p>Single Mode Optical Fiber 6/12 core, Uni-Tube/Multi-Tube, 9/125μm, OS2 Type, Corrugated Steel Tape Armoured (STA), Polyethylene (HDPE) outer, LSZH and RoHS Complaint, Telecordia GR-20, B1.3 and ITU T G652.D, ISO/IEC 11801, IEC-60793-1, 60793-2, EN50173, ANSI/TIA 568-C.3, Tensile Strength: 1500 N or better. Maximum Crush Resistance should be 2000N/10 cm or better. Max. Attenuation at 1310 nm: 0.34 dB/km and at 1550 nm: 0.22 dB/km. The product supplied should be OEM performance warranty of 20 years or more.</p>
8	12 Core Loaded LIU LC type SM	<p>12F for 12 core, 1U LC Style, Loaded with SM pigtails and Splice Tray & Couplers & Splice Protectors, Metal/Alloy housing, Telecordia GR-20 Pigtail should comply G.657.A1 (Bend Insensitive), LSZH and RoHS compliant, ANSI/TIA 568-C.3, Optical performance of pigtails: insertion loss max: 0.34 dB and return loss minimum: 50 dB. The product supplied should be OEM performance warranty of 20 years or more</p>

9	24 Core Loaded LIU LC type SM	<p>24F for 24 core, 1U LC Style, Loaded with SM pigtails and Splice Tray & Couplers & Splice Protectors, Metal/Alloy housing, Telecordia GR-20 Pigtail should comply G.657.A1 (Bend Insensitive), LSZH and RoHS compliant, ANSI/TIA 568-C.3, Optical performance of pigtails: insertion loss max: 0.34 dB and return loss minimum: 50 dB. The product supplied should be OEM performance warranty of 20 years or more.</p>
10	48 Core Loaded UU LC type SM	<p>48F for 48 core, 1U LC Style, Loaded with SM pigtails and Splice Tray & Couplers & Splice Protectors, Metal/Alloy housing, Telecordia GR-20 Pigtail should comply G.657.A1 (Bend Insensitive), LSZH and RoHS compliant ANSI/TIA 568-C3, Optical performance of pigtails: insertion loss max: 0.34 dB and return loss minimum: 50 dB. The product supplied should be OEM performance warranty of 20 years or more.</p>

11	LC-LC SM Patch Cords Duplex 3 Mtr.	<p>Bend Insensitive, LSZH and RoHS compliant, IEC 60332-3-22/60332-3-1, IEC 60754-2/IEC 60754-20, Duplex patch chord LC-LC connector on both ends, ANS/ICEA S-83-596/TIA/EIA-492 and Telecordia GR-409 and ANSI/TIA-568-C.3/568-D.3.</p> <p>The product supplied should be OEM performance warranty of 20 years or more.</p>
12	Cable Manager	The product supplied should be in compliance with the Rack.

Item Na 2- Integrated Modular Rack 42U	
S. No	Generic Requirements
A	Intelligent Integrated Smart Rack infrastructure with inbuilt hot and cold aisle containment of 1 rack should cater IT load up to 7 kW with redundant UPS and Cooling.
B	All the components used to design the system should be modular, redundant and in the events of failure the components can be changed easily. and immediately without any downtime. The scalable design should allow to extend the infrastructure easily without disturbing the existing setup.
	<p>All the components of the infrastructure should be such that it can be easily dismantled and relocated to different location.</p> <p>OEM shall be responsible for overall design and optimum functioning of integrated rack infrastructure. A certificate/ undertaking in this regard shall be submitted from OEM.</p>
C	The detail specifications of the intelligent integrated/inbuilt infrastructure, standalone system shall be in adherence to standard Data Centre guidelines and fulfil all the necessary norms of TIA 942 Data Centre standard and its components have to be complying with standards of IEEE, ISO & ASHRAE.
D	Racks should be equipped with Emergency Air Intake Fan at front Door and Exhaust fans at rear top and the same will provide for ventilation in case of Cooling unit failure.
2	Precision Cooling System: - (uniform distribution of cooling from 1U to 42U) Rack based closed loop Air-Conditioning (7 kW —02 nos. (1 Working+1 Standby))

A	Cooling System should be DX (Variable) type In-Row closed loop precision cooling system of min. 7 kW capacity with N+N redundancy. Shall have heater and humidifier to cater IT load up to 7 KW.
B	The redundant Cooling units ensure automatic changeover in the event of a failure of any one of the unit. It should be able to support indoor to outdoor piping up to 30 mtr.
C	Cooling system capacity must be rated at 45°C ambient temperature, 22° +/-1 °C in front of server racks and maximum 28°C return air temperature. Condenser Size should be selected as per 45°C ambient condition.
D	Each compressor variable capacity Scroll Compressor running on DC INVERTER brushless technology, R410 gas) should be equipped with preset high- and low-pressure switches for protection against high condensing and low evaporating temperatures.
E	32A Vertical Rack mount PDU of type IEC C13 & IEC C-19 combination, Each rack shall have two such PDU's. The 2 IPDUs in each rack should have different chassis colour for identification of UPS source.
3	Environmental Controls
A	<p>Intelligent Smart Rack should include basic environmental controls:</p> <ul style="list-style-type: none"> • Smoke Detector • Temperature & Humidity Sensor • Motion Sensor • Alarm beacon • Water Leak Detection system • Door Sensor • Rodent Repellent • Camera for local surveillance system
4	UPS
A	<p>Design, Installation, testing and commissioning of Rack /19" frame mountable 2 x 10 KVA/10 kW UPS (LCD Display), in N+N redundancy 1-Phase Input/ 1-Phase Output (The capacity of 2 X 10 KVA is minimum. Bidder shall design the system and if required higher rating UPS shall be provided without any extra cost)</p> <p>True Online, Double Conversion with PWM Technology with IGBT based Inverter with built in galvanic isolation, Rack /Tower Convertible, Form Factor 2U with <600 mm</p>
	<p>All PCB board to be conformal Coated. UPS to have Double layer FR4 material made power PCBA to guarantee high reliability in transportation and operation (Documentary proof needs to be provided)</p> <p>Single combo SNMP and Modbus card certified in accordance with UL and IEC standard for Cybersecurity.</p> <p>Technology and Capability:</p> <p>a) Nominal Output voltage for 1phase, 220, 230, 240 Vac (Single Phase)</p> <p>b) UPS should have IGBT topology for both PFC (power factor correction) and inverter. Efficiency of 95% or higher</p>
B	<p>Measurements (On LCD):</p> <p>Input: Voltage / Frequency, Output: Voltage / frequency, Load percentage, Battery Voltage</p>

C	Back-up time— 30 min with each UPS, Battery Type: VRLA, Batteries are to be kept in Closed Cabinet. Battery Backup Calculation: to be provided by vendor, BIS certified
5	Integrated Racks
A	<p>42U size, Min. 600mm width Server/Network Rack with front glass door with comfort handle, lock insert, Top cover with cut out with cover plate for cable entry (with Horizontal and Vertical cable manager).</p> <p>Depth of 42U rack used in system is min. 1000mm. Blanking panels for 100% rack U space required</p>
6	Power Distribution System
A	Intelligent rack PDU 32A, 200-240V with PDU level monitoring with minimum 24 nos. IEC C13 sockets and 4 nos. of IEC C19 with power cord for PDU input. Vertical installation saving valuable rack space, LCD/LED current display & overload warning indicator, Branch circuit breaker protection. The IPDU should have approvals form RoHS, CE/UL.
B	There shall be integrated electrical DB panel with energy meter with Branch Circuit Monitoring and should give the data of Voltage Current Power and THDi for the Each and every Circuit Breakers over the monitoring Window and same to be mounted on separate utility cabinet.
7	Monitoring
A	Intelligent Smart rack should have 1U rack mountable IP based monitoring unit capable of monitoring all the passive parameters inside racks, Email Alerts. The unit should support of dual power input for power redundancy.
B	Monitoring unit should integrate & monitor environmental parameters like temperature, humidity, door access, smoke etc. with UPS & cooling unit in a single dashboard along with other environmental parameters like temperature, humidity, smoke etc.
C	The monitoring unit should support basic protocols like Telnet, SSH, FTP, SFTP, HTTP, HTTPS, NTP, DHCP, DNS Server, smtp, TCP/IP4. It should support network interface of 10/100M self-adaptable Ethernet ports.
8	Biometric Access Control System
A	The system deployed will be rack based access control system based on electronic Technology. The front rack doors should be operated with Biometric door access system and will operate on fail-safe principle through Biometric access control system. Front/Rear doors should be operated with auto lock opening system. Should have provision for auto opening of front/Rear Door in case of Emergency situations.
9	Environmental Monitoring System

A	Integrated rack infrastructure shall have IP based monitoring system for all the rack parameters with sensors and notification system. It shall include sensors kit of Temperature/ Humidity, Water Leak Detection, Door, Smoke & Alarm Beacon and shall continuously collects critical information from environmental sensors & UPS system, Cooling Units be capable of sending Email notifications.
10	Installation
A	The entire system shall be installed and commissioned as per OEM recommendations & instructions including all interconnections for supply and control circuit.
11	OEM Past Experience
A	Smart Rack OEM or Manufacturer should be ISO 9001: 2000, ISO 14001, ISO/IEC 27001:2013 and ISO 45001 certified. OEM must have supplied min. 2 such systems using In-Row type Cooling of min. 7Kw Cooling in PIA
B	Smart rack OEM should have its own manufacturing & testing facility in India for offered capacity of Rack, UPS, Precision air conditioning units for high availability of the proposed solution. Supporting document/undertaking regarding the same to be submitted along with the bid.

TECHNICAL SPECIFICATION OF IPPBX SYSTEM

1. Introduction:

The following details specify the scope of work, design & technical specification for all the IPPBX Works in the new Terminal building. It comprises the systems listed out in this document and defines a turnkey solution.

2. Scope of Work:

The following details specify the scope of work, design & technical specification for all the IPPBX Works in the new Terminal building. It comprises the systems listed out in this document and defines a turnkey solution.

- **IP-PBX:** - UTP cable shall be laid for voice points by EPC Contractor. IPPBX exchange shall be established including direct PRI line also. Separate UPS connectivity shall be provided to exchange server.
- **AMC/ Warranty** – All product shall be offered with 2 years OEM Warranty from the date of completion of commissioning. After 2 Years, products shall be under 5 Years AMC with OEM Support/ Service for all items. All Inclusive Comprehensive Maintenance of IPPABX and its associated system for 5 years after DLP including trouble shooting, preventive maintenance and breakdown maintenance, supply of all spares and accessories and replacement of batteries of UPS as required etc. as required as per good engineering practice, recommendation of the manufacturer, instructions of Engineer-in-Charge/ as per terms and conditions specified.

3. General Guidelines:

i. Terms & conditions

- Payment against AMC shall be made quarterly after successful completion of services in the quarter.

ii. General Guidelines regarding Offered Products

- 1) The capacity given in the specification is minimum and Contractor has to provide as per requirement.
- 2) All Electrical/ Power Requirement shall be designed accordingly. UPS power supply for 24 x 7 to all Active Networking Equipments is mandatory.
- 3) UPS supply shall be provided to IPPBX Components installed at Field/ Remote Racks for uninterrupted service during power down.

- 4) OEM of all offered products shall have Technical Support Center presence in India.
- 5) There shall be compatibility of network with existing equipment at the airport (if applicable).
- 6) All Covered Cable Trays, concealed Conduit and other accessories like HDPE/GI Pipe Channel Conduit shall be provided for the passive cabling works by Engg-Electrical Contractor as per site requirement.
- 7) Cable Tray/ HDPE/ GI Pipe/ Conduit/ Channel conduit shall be confirming to the specifications similar to respective engineering items.
- 8) The offered equipment by the Contractor shall be fully complied with the specifications to full fill the requirements. Higher specifications suitable to requirement can be accepted. The offered products shall be complied by the standards given in the specifications or its equivalent standards in respective category.
- 9) The design and selection of the offered IPPBX networking components by the Contractor shall be consistent with the requirements of long-term trouble-free operation with highest degree of reliability and maintainability.
- 10) The offered equipment by the Contractor shall be designed for continuous operation (24-hours a day and 365-days a year).
- 11) All offered equipment shall be standard proven product already available in the market. Offered Item shall not be end of life or end of sale.
- 12) MAF & a letter from OEM shall be submitted in regards of warranty support & Non-Refurbished items, and no End of Life/ End of Sale against the offered product. OEM has to ensure that the support shall be provided for the offered products during the concurrency of the contract.
- 13) All types of spares and spare modules of the offered equipment shall be readily available with the Contractor during life-time of the equipment, for maintenance, repairs and up keep of the equipment during warranty & CAMC period, if applicable.
- 14) The offered equipment by the Contractor shall furnish the details of EMI and Safety Standards met by his equipment and built-in safety features.
- 15) The offered equipment shall be constructed on a modular basis, using plug-in type units and components to the extent possible. Parts subject to failure, wear, corrosion or other deteriorations or requiring occasional inspection, adjustment or replacement shall be made accessible and capable of convenient inspection and removal.
- 16) All offered/ supplied Hardware system/ component and Software by Contractor shall be licensed, as applicable, in favor of Airports Authority of India and valid for lifetime of the offered system.
- 17) Contractor has to offer/supply Passive Cabling Components as specified in the NIT or better and latest upgrade model/ version if available in the market at the time of execution.

- 18) Items mentioned in document is minimum. Contractor has to provide all requisite accessories/ items which are not included in the document to document to achieve the functionality of the NIT.

iii. General Guidelines Regarding Contractors

1. Installation/ Configuration shall be carried out by technically well qualified and certified personnel as per the requirements.
2. Contractors shall not outsource any part of the contract to any other vendor/ third party contractor without prior permission of AAI.
3. Liability, if anything arising out of such third party contracts to any other vendor by contractor shall be to the contractor's account.
4. AAI shall not be liable on behalf of contractor to any other third party contractor/ Government of India/ State/ Regulatory Authorities.
5. Any liabilities arising out of such third party contracts by contractor or its men working at site shall be only to contractor's account and shall be deducted out of its running bills.
6. Contractor shall submit Police Verification Certificates and obtain necessary Airport Entry Permits, for allowing its men to work at AAI restricted premises.
7. Vendor has to survey for final bill of quantity before implementation of work or procurement or approval from AAI Site In-charge.

4. Site Acceptance Test (SAT) & Commissioning:

- 1.1 It shall be the responsibility of the Contractor firm to submit the system test procedure for conducting the post-installation site acceptance testing. The procedure submitted by the Contractor firm shall be drafted in line with the standard practices followed in the industry and shall be in accordance with the test procedures & practices specified by the OEM. The acceptance test procedure on approval by AAI shall become the document for acceptance of the equipment after installation at the site.
- 1.2 The draft copy of system test procedure shall be made available to AAI before **THIRTY** calendar days of the schedule site acceptance date.
- 1.3 The Contractor firm shall supply, install, test and commission all hardware and software as per the requirement of the tender with the system. Contractor firm shall supply Technical documents (hard and soft copy – one set each) at site. The system shall be commissioned after successful completion of - SAT approval, operational & maintenance training and all the works under the scope of the tender.

5. Patent's, Liability & compliance of regulations

- 1.1 Contractor firm shall protect and fully indemnify AAI from any claims for infringement of patents, copy right, trademark or the like.

1.2 Contactor firm shall also protect and fully indemnify AAI from any claims from Contractor firm's workmen/ employees, their heirs, dependents, representatives, etc. or from any other person(s) or bodies/ companies, etc. for any act of commission or omission while executing the order.

1.3 Contractor firm shall be responsible for compliance with all requirements under the laws and shall protect and indemnify AAI completely from any claims/ penalties arising out of any infringements by Contractor firm or its workmen/ employees.

6. Documentation & Training

Two set each of soft copy and hard copy of Installation, Operations including theory of operation, Technical Manual, Maintenance manual; Troubleshooting of the system, procedure for loading of the system and application software, etc. shall be supplied at site. The Operation, Technical and Maintenance manual will cover: -

- a. Details of each active and passive component, serial no., IP address, Login Id and Password, version reports, configuration reports, Detail Bill of Material, spares, acceleration Matrix to log a complaint etc.
- b. General technical description, Block Diagram, Schematic/ flow diagrams (I/O level), Drawing of Passive Cabling laid in the building shall be required.
- c. Preventive maintenance procedures & Support Escalation Matrix
- d. Fault analysis – schematic diagrams
- e. Technical & operation manuals with user Operation

Hybrid IP PBX with Redundant Server & SIP User Licenses		
Make:		Model:
S.No	Technical Specification	Compliance (Yes/No)
1	IP PBX system shall have redundant servers (two Server for redundancy from day 1 and should be in active - active configuration to support up to 25 IP,10 analog users and extendable up to 500 users/ Extensions. Redundant Server shall always be in sync such that the system should be able to switchover to other server in case of failure of one server with full capacity i.e. with 500 extensions/ users in real time w/o dropping on going calls. (The user /extensions figures are given tentatively.)	
2	IP PBX software should be compatible with the Server provided.	
3	Both the servers should be commercial grade server with minimum specification should be Intel Xeon Quad Core with 16 GB RAM and minimum 1 TB SSD or better.	
4	The system should be based on pure server-gateway architecture running on Linux /Unix OS supporting Analog, IP Desk Phone (SIP) in any combination, IP Phone, Video IP Phone, wireless IP phone (802.a/b/g/n) and Soft Phone, multimedia PCs, 3rd party SIP phones etc.	
5	IP extension: Loaded with 25 IP Phone Licenses from day 1 and IP phone licenses (SIP) should be universal i.e. can be used with any other phone of same OEM or any third-party phone.	
6	Gateway should have universal architecture with dual power supply, minimum two redundant Gigabit Ethernet Ports. Gateway Should support at least 32 nos of analog extension & 100 SIP extensions from day one. Gateway further expandable up to 256 Analog user's w/o adding any extra hardware or software's or license.	
7	Gateway should support E1-PRI, SIP trunk, CO Trunk Interface Ports and FXS Ports.	
8	It Should have minimum 02 Analog Trunk Lines expandable to 08 trunk Lines.	
9	It Should have minimum 02 nos of SIP trunk port to support SIP trunk lines and support up to 256 SIP trunk channels per Primary /Secondary server at single site.	
10	It should have Digital Primary Rate Interface (PRI) Line: 01 Nos. Additional 1 spare gateway for PRI and TDM connectivity needs to be considered day 1	

11	Gateway should support self-survival mechanism in case of failure of WAN/LAN Link w/o dropping on going calls.	
12	No card-based systems, only server-gateway architecture-based systems will be acceptable.	
13	All the users to be managed in a single database, which is managed centrally, multiple databases & bundling of Telephony system will not consider to meet Specification & scalability.	
14	It should have 16 Party Audio Conference bridge with multiple conferences with variable number of users should be possible within each of the conferencing from day 1.	
15	Support Ad-Hoc & Meet-Me audio conferencing from day 1.	
16	Support sending emails to all the participants giving them the conferencing details including PIN based security and scheduling.	
17	It should have integrated Voice Mail features for all users, Voice mail system should be of same OEM which should support Mail Boxes for all users, should have at least two gigabit Ethernet interfaces for easy connectivity to the network, should support G.711 and G.729 Codecs, Multi-level IVR functionality should be available.	
18	The Voice Mail provided by the vendor should be based on industry standard server. Card based or 3rd party Voice Mail solution are not Acceptable/Disqualified	
19	System should support standards-based CTI integration with 3rd party applications. System should support built-in IPSEC based VPN connectivity	
20	System should support built-in Remote access server (RAS) functionality	
21	System should support Diffserv for QoS (Quality of service) for the voice packets traveling over data networks.	
22	The IP PBX server should offer BHCC (Busy Hour Call Completion) of at least 25000 per server to ensure superior traffic handling capacities.	
23	The system should manage CAC (Call Admission Control) mechanisms to optimize the usage of the bandwidth in the WAN for multi-site configurations.	
24	The System should support LDAP (Local Directory Access Protocol), and following protocols: ML-PPP (Multilink Point-to-point Protocol), PAP (Password Authentication Protocol), CHAP (encrypted password)	

25	The system should support standards-based multi-site networking, using QSIG, SIP trunks or advanced networking, to interoperate with other PABX's, allowing feature transparency.	
26	The system should support Voice CODEC support G.711, G.729, G.729a & G.722 or any less utilization bandwidth across WAN and LAN, Video CODEC: H.264 or Equal.	
27	System should support UC functionality with 10 users (desktop/Laptop & Smart Phone) from day-1 and can be added if required in future without any modification to hardware.	
28	Unified Communications (UC) client should provide users with real time, collaboration capabilities	
29	Support for Windows and Mac OS, Support for Android and iOS devices Smartphones and The Unified communication client on softphone should provide full call control from an iPhone or Android powered smartphone. Should have all call control features like Call Transfer, Call Pickup, call forward, call park, Multiparty conference, Video Conference, Chatting, File sharing, FAX, Voicemail, Presence, BLF, DSS, Call History, Favorite etc.	
30	UC user can use Audio conference at least 6 party.	
31	System should provide call control, mobility, IM and presence, and Messaging, centralized licensing in a single server.	
32	System should support recordable Hold on Music, it should support multiple files.	
33	Allows a user's calls to be presented to both their current extension and to another number (personal mobile number) from day-1.	
34	Support point to point video calls from day-1 from same OEM Hard Video phone and Softphone.	
35	Call administration features: Operator, Dial Emergency, DID/DOD (Direct Inward/ Outward Dialing), Call Forwarding, Call Hold, DND, Distinctive and Personalized Ringing, Alternate Routing, Fax on demand integration etc.	
36	Flexible numbering plan - Support up-to 2-10 Digit for an extension number and allow phone number assigned to a station to a station to be changed through software.	
37	Authorization Codes - 5-7-digit authorization code to make outgoing toll calls for ensuring no misuse of the system.	
38	CU (Caller Line Identification) facility (CLIP/CUR) - Calling Numbers (internal & external) should be displayed on all Analog extensions (FSK support phone).	

39	IP PBX shall have call recording with storage for 30 days.	
40	Support Mobility feature like Users can make and receive calls from any office as if using the phone on their own desk. Users have access to the centralized system and personal directory as well as their call logs (available on Analog and IP phones)	
41	The system should support complete encryption capabilities with the ability to encrypt all traffic (media and call control signaling) between IP phones, soft phones, call controllers, gateways and all other associated endpoints using a strong encryption algorithm like IPSec and SRTP.	
42	IP Phones should not support direct, external initiated, connections via HTTP, telnet, FTP, TFTP or any other protocol as means to prevent distributed Denial of Service attack exploitation, except those required for routine firmware upgrades.	
43	System should support SNMP based network management system to monitor all respected devices in communication network.	
44	The system to capable of supporting IPv4 and IPv6 IP addressing from days 1, System should have in built-in DHCP Server, which should be able to give IP Addresses to the endpoints.	
45	The equipment quoted by bidder must be SIP compliant.	
46	The offered system should have a valid TEC-GR approval certificate of server gateway system. TEC-GR approval certificate to interface with the public switch network should be enclosed along with the offer.	
47	The IP PBX should be capable of maintaining guaranteed performance when operating in continuously for 24 Hours a day for 365 Days.	
48	The IP PBX should have minimum warranty of 5 Years and should be the shelf-life of at least 6 years from the date of SAT.	
49	The IP PBX System shall be properly earthed.	
50	RoHS (Reduction of hazardous substance) compliance	
51	Declaration of Conformity (DoC) for EMC compliance	
52	Safety Declaration as per EN 62368-1, IEC 60950-1 & IEC 62368-1 compliance	

SITC of IP PHONES

S.No.	Generic Requirements
	Approved Make: Same as IPPBX
1.	Shall be on standard SIP protocol
2.	Shall have 10/100 connection, Echo canceling for local echo (AEC) half/ full duplex with auto negotiation and configuration along with Integrated Ethernet Switch for PC connection
3.	Shall support Voice compression standards G711, G722, G729a
4.	Shall support Power over Ethernet (PoE, IEEE 802.af)
5.	Shall have Fixed function keys for Settings, Messages
6.	Shall have Free programmable keys with status indication on the LCD display
7.	Shall have Pre-programmed keys for Call Log Contacts, call forwarding, Redial.
8.	Shall store local call log with 30 or more entries for each category (dialed, received, missed, forwarded calls)
9.	Shall support IEEE802.1Q for VLAN tagging and prioritization. VLAN ID configuration options: <ul style="list-style-type: none">• Manual/ Management Application• DHCP Option 43• LLDP-MED
10.	Shall support the following Security Protocols and features
11.	Signaling Encryption (TLS), RFC5746: TLS Renegotiation Indication Extension, Payload Encryption (SRTP, DTLS-SRTP), IEEE 802.1x supplicant (EAP-TLS und PEAP)

Note-

There will be no preferred make list in respect of Airport system work. The item of any make and model, meeting the technical specs as per technical specification mentioned in tender on part of Airport system will be accepted.

If any such condition appears in tender document for Airport system work, then same will be super shaded by above condition to avoid ambiguity.

Wall mount 15U / 12U Rack	
Sr No	Generic requirement
1	Should be 15U / 12U Height Rack and have 19" mounting bracket in front & rear and wall mountable with side panels, Gront Glass Door with lock. Dep
2	fans 90 CFM 230 VAC with 2 colling fans on top
3	PDU Horizontal 5 Amp with 6 sockets
4	1U Wire Manager; Mounting Hardware
5	3 Years Onsite warranty
Floor Mount 42U Network/Server Rack	
Sr No	Generic requirement
1	Modularity and Scalability, conforms to DIN 41494, Load rating go 850 Kgs, Aluminium and CRCA construction, depth:800mm / 1000 mm as required
2	Door Steel 800W, 42U, Perforated with Hex Perforation.
3	Castor Ft Brake 100Kg.
4	Fan housing Unit with 4 Fans 90CFM 230 VAC
5	PDU 5x15AMP with 10 Socket, Earthing Kit
6	2 years Onsite warranty

SECTION - 1: MASTER PLANNING AND ARCHITECTURE

1 INTRODUCTION

This report covers the master planning and design for the proposed Interim Terminal Building and associated facilities at Udhampur Airport, J&K.

2 Design Objectives

Terminal Building

The terminal planning designs to be prepared with regards to the following objectives:

a) For the public in general:

- i) Provide an attractive welcoming image
- ii) Provide a positive urban design impact
- iii) Provide a distinctive corporate image
- iv) Provision of links to parking facilities
- v) Safeguards from noise and air pollution

b) For the Operator:

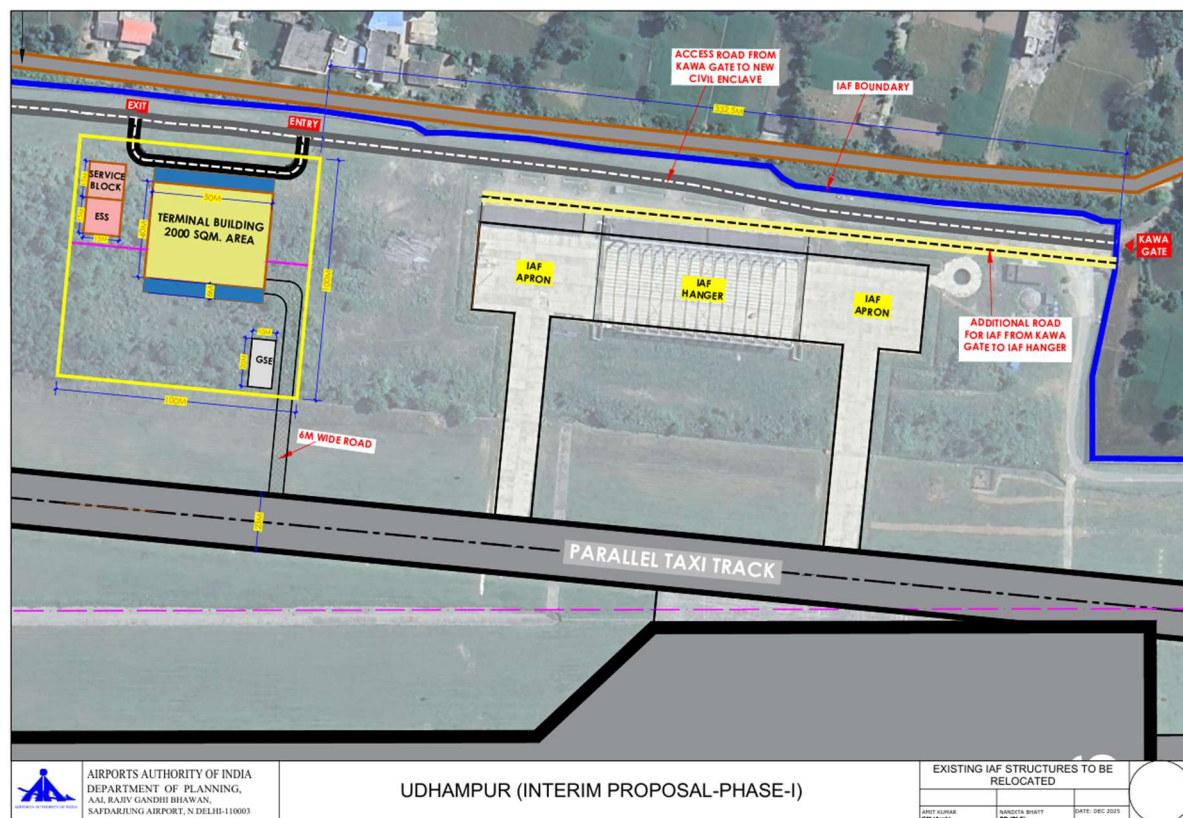
- i) Provision for ease of use in different conditions; (normal, peak, off peak, abnormal and emergency)
- ii) Provide a quality workplace and atmosphere for manned areas and service personnel
- iii) Provide facilities that are easy to manage and maintain
- iv) Minimize on manning levels and responsibilities
- v) Provision of flexible concept of circulation
- vi) Services provision to the best of standards but capable of upgrading to allow for increased levels of comfort or amenity
- vii) Provide advertising space at suitable locations
- viii) Ability to construct a part of the station for initial operation and easily extend facilities for future expansion.

c) For the Passengers:

- i) Passenger perception and behaviour are the effects of quality design.
- ii) Design for the facilities as measured by the following criteria;
 - Safety: Intrinsic safety of the proposals
 - Time: Perception of time, information, access time, waiting time, reliability, certainty
 - Materials: The look and feel of materials, the sensory qualities of sound, light, smell, air quality, cleanliness and lack of contaminants
 - Security: The risk of assault, perceived personal threat
 - Weather: Protection from rain and direct sunlight

- Comfort: Fresh air and coolness (including necessary environmental control systems)
- Access: Easy access for passengers with reduced mobility

3 Master Plan with EPC limit



4 DESCRIPTION OF PROPOSED FACILITIES

- The proposed facility shall be as mentioned at Annex-I of Schedule-B.
- The building architecture shall have a local context with reference to its geography, landmarks, culture, art and architecture.
- All the structures and facilities as marked under drawing and subsequent drawings are covered under the scope of this EPC contract.
- The dimensions given in the drawing and subsequent drawings is minimum, however any plus variation in the dimension due to architectural/ design requirement is covered under this EPC contract, and nothing shall be paid extra.

5 PLANNING PARAMETERS

- Terminal plan: Arrival & Departure is planned at ground Floor level along with provision of offices as per drawings.
- Departures: The check-in hall, passenger screening & security hold areas (SHA), retail/ concession areas and other passenger facilities are planned at Ground Floor Level as per drawings.

- c) Arrivals: The arriving passengers will enter the building through Bus gates. Other passenger amenities along with domestic-to-domestic transfers, baggage reclaim, concourse are planned as per drawings.
- d) Boarding gates: Adequate boarding gates are to be provided at the departure level as per drawings.
- e) External concourse: The space between terminal building façade and pick up kerbs (below canopy) provide external concourse and are covered under this EPC contract.
- f) Canopy: canopy to be planned for city side & air side under this EPC contract as per requirement.
- g) Service access: Services i.e. Electric substation, Septic Tank with soak pit, RO System, Under-ground tanks and pump rooms are to be provided as per drawing/requirement.
- h) Staff Parking: Surface Car Parking having provision of private car parking, staff car parking (including for PRM) and two-wheeler parking for AAI and airlines staff as requirement.
- i) The Terminal Building has to be designed such that Level of Service (**LOS**) to be maintained as per Aviation standards.
- j) Plinth levels of the buildings & other facilities are to be finalized by the contractor considering the HFL, runway level as applicable in co-ordination with the Engineer-in-charge. The earth filling, if required is included in the scope of the contractor and nothing extra shall be payable on this account.

6 Passenger Processing Facilities: (Terminal Building)

Internal finishing work to be executed as per the clause under **Annexure-I (Part 3) of Schedule D** or as per approved Architectural drawings and as per direction of Engineer-In charge.

7 Building Grid

Terminal Building:

Structural grid as shown in architectural drawings shall be followed. The structural system essentially comprises of Steel framed structure with structural steel truss to support the roofing system and façade (at required locations).

The external dimensions of the TB including the grid spacing as mentioned in the drawings are final and no deviation shall be acceptable by the Engineer-in-Charge / AAI.

8 Area Statement

As per drawings. All the structures and facilities as marked under drawings are covered under the scope of this EPC contract. The dimensions given in

the drawings is minimum, however any plus variation in the dimension due to architectural/ design requirement is covered under this EPC contract, and nothing shall be paid extra.

9 Building views

The building exterior depict the **"Design intent"**. EPC contractor shall strictly maintain the same during the detailed design and other stages of the design.

10 Building finishes

These shall be as provided as per the schedule of finishes.

11 FUNCTIONAL REQUIREMENTS OF THE TERMINAL BUILDING

A. General

- a) Overall spatial planning, grids, passenger processing facilities and flows (passengers, staff and goods) shall be maintained as shown in the design drawings. EPC contractor shall develop the design further at "Detailed design" and other stages of the design to coordinate with all other disciplines.

B. Fire & Life safety

- a) Building classification: The Building is classified under **Type -2 Construction as per NBC 2016- Part 4- table 2.**
- b) Fire and Life safety provisions as provided in NBC 2016- Part 4 shall be addressed in the design including but not limited to Travel distances, stair widths, emergency exits, smoke management, fire hydrants, automatic sprinkler system, fire alarm system, fire separation etc.

C. Security

- a) All security and safety systems/ elements as per BCAS requirements shall be provided in the design.
- b) This shall include stainless steel fixed bollards at the arrival and departure forecourt, security morchas at required locations.

D. Finishing works

- a) Detailed room-wise **Schedule of Finishes** as per **Annex-I (part-3) of Schedule-D, drawings** and scope of work at **Annex-I (Schedule-B).**
- b) Floor finishes for various area shall be as per the Finishing Schedule and shall be executed conforming to the Construction Specifications.

- 12 Control Joints in Flooring:** Flooring works in large open areas shall be provided with stainless steel control joints not less than spacing of 5 mtr. in either direction.

13 CLADDING

COLUMN CLADDING:

In the Passenger Terminal Building, cladding on all exposed columns shall be provided by Aluminium Composite Panel.

Note: While selecting any finishing item (like ACP cladding, false ceiling, Glazing, GFRC / Stone cladding etc.), contractor/consultant shall exercise caution considering the Wind Zone/ Location (inside or outside of Building) / Structural arrangement and ensure adequacy of the arrangements for stability of the structure. Shop drawings for such items shall be vetted from the structural consultant. The same shall be ensured by Engineer-in-charge through the consultant/ specialized agencies and executing agency of the project in association with manufacturer.

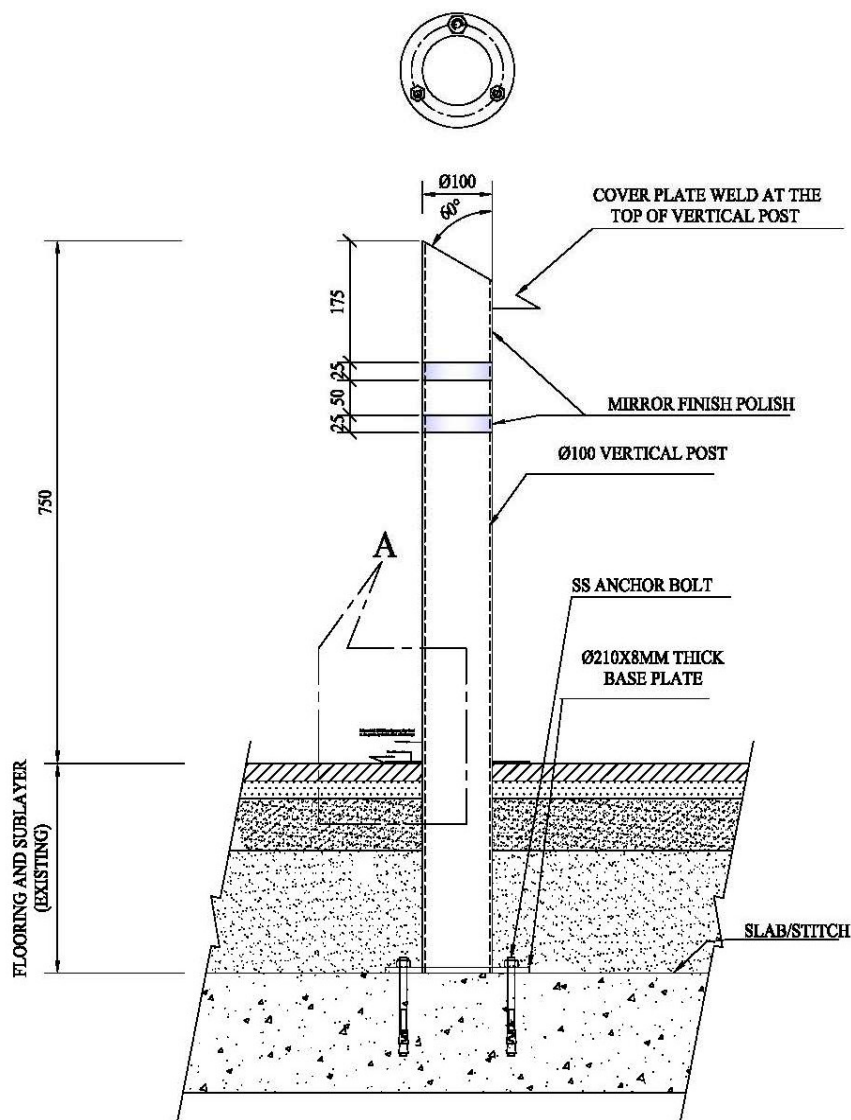
14 SANITARY FIXTURES

Plumbing and sanitary fixtures in toilets shall be provided as indicated below in addition to details mentioned in the drawing/Finishing schedule.

S.No	Sanitary Fixtures	Applicability
1.	White Rimless wall-hung European WC Concealed Flushing Cistern with half frame, dual flush (flow rate 2.0/4.0 LPF)	
2.	White China urinal with electrical / battery operated concealed automatic flushing system (flow rate 0.5 LPF)	
3.	CP Brass pillar cock with aerator and auto stop	
4.	SS liquid soap dispenser with push lever assembly with soap refill	
5.	C.P. brass angle valve with flange	
6.	SS toilet paper holder	
7.	CP Health faucet with 1 metre long Flexible Tube	
8.	stainless steel grab bar with wash basin disabled	Accessible Toilets
9.	SS Swing grab bar	

S.No	Sanitary Fixtures	Applicability
10.	Hand Dryer	All Passenger area toilets

- 15 SS Bollards:** SS Bollards made from 100 mm dia. SS Post and 750 mm high above finished floor level shall be provided as per drawing appended below on ground level in front of Terminal building on Kerb area at a distance of 900 mm c/c all along the length and width of Kerb area as per BCAS requirement.



SECTION - 2: STRUCTURE

1 INTRODUCTION

This report covers the structural design basis for proposed Construction of Interim terminal Building & allied works at Udhampur Airport (J&K).

2 REFERENCE CODES & STANDARDS

The documents and Code of practices that would be considered in carrying out analysis and the design of the structure are as follows: -

Following Indian Standard codes, unless otherwise specified, would be used for analysis, design and construction of various structures.

IS: 456 - 2000	Code of practice for Plain & Reinforced concrete
IS: 800 –2007	Code of practice for General Construction in steel
IS: 875	Code of practice for design loads for Building Structure (Part I to V)
IS: 1893 - 2016	Criteria for earthquake resistant design of Structures
IS: 1786 - 2008	High Strength deformed bars & wires
IS: 1161 - 1998	Steel tubes for structural purposes
IS: 3370 - 2009	Code of practice for concrete structures for the Storage (Part I to IV) of liquids
IS: 13920 - 2016	Ductile Detailing of Reinforced Concrete Structure subjected to Seismic Forces
IS: 2062 - 2011	Steel for general structural purposes
IS: 4326 – 1993	Code of practice Earth Quake Resistant Design and Construction of Buildings
IS: 2911-1998	Code of Practice for Design and Construction of Pile Foundation
IS: 2950-1973	Code of Practice for Design and Construction of Raft Foundation
IS: 8009	Code of Practice for Calculation of Settlement of Foundation

IS: 6403-1981	Code of Practice for Determination of bearing Capacity of Shallow Foundation on Rock
SP: 16 -1997	Design Aids for Reinforced Concrete to IS: 456
SP: 20 -1981	Explanatory Handbook on Masonry Code.
SP: 22 -1982	Explanatory Handbook on Codes for Earthquake Engineering
SP: 34 -1987	Handbook on concrete reinforcement detailing
IS: 15988: 2013	Seismic Evaluations and Strengthening of Existing Reinforced Concrete Buildings — Guidelines
IS: 11384—1985	Code of practice for Composite construction in Structural steel and Concrete
IRC: 6-2017	Standard Specifications & Code of Practice for Road Bridges.
	Section II - Loads and Stresses
	NBC: 2016 National Building code of India
IS 3370	Code for liquid retaining structures

Wherever in addition to IS CODES other international codes/ literature will be referred, the same shall be marked in respective design notes.

2.1 Units

SI units shall be used in the entire analysis and design.

3 STRUCTURE CONFIGURATION AND SYSTEM PROPOSED

3.1 Pre-Fab Steel Structure Terminal Building

The structural configuration for the Terminal Building consists of structural steel framing system for beam & columns with puffed panel roofing with Isolated / Raft / Pile foundation as per structural design requirements.

3.2 Ancillary structures

The Ancillary structures include an UG tank/Sump, septic tank, Pump room, Toilet Block etc. Structural configuration for the Ancillary structures consists of conventional RCC beam slab framing system with Isolated / Raft / Pile foundation as per structural design requirements. Wherever required the equipment foundations, retaining walls in RCC shall be provided. Underground tanks walls etc shall be constructed with liquid retaining RCC walls / frame and slab system, Bore-wells, water supply & Sewerage

system, Storm water drainage, Rain water harvesting, etc. as per site condition and drawings.

4 MATERIALS

The following materials shall be used for construction:

4.1 Structural Steel

Structural steel shall be MS rolled single / built-up sections of E-250 BR & 350 BR Grade, conforming to IS 2062.

M.S. tubular section ERW type (round, square or rectangular hollow tube sections) of YST 310 Grade conforming to IS 1161 / IS 4923.

Fire protection shall be provided for Structural steel, wherever applicable as per provisions given in NBC 2016.

4.2 Reinforced Concrete

Minimum grade of concrete recommended is M30 grade. For non-structural purposes, M10 Lean concrete to be adopted. The specific Grade of concrete for various structural elements will be determined as per requirement after detailed analysis and Design to be done by EPC contractor. Minimum cement content and water cement ratio of various structural elements shall be as per Table 5 of IS 456:2000.

Concrete Mix of M10 will be used for levelling concrete or as plum concrete only.

The cement Ordinary Portland Cement 43 Grade conforming to IS: 269-2015 or Factory Produced Portland Pozzolana Cement (Fly ash based) conforming to IS: 1489 (Part-I)-2015. Use of grade 53 cement not recommended.

4.3 Reinforcing Steel

High Yield Strength Deformed Bars (HYSD) Fe500D or more needs to be adopted.

a) For Foundations, Columns and Beams

Main reinforcement - dia. of bars greater than or equal to 12mm. Stirrups & links-dia. of bars 8mm min will be adopted.

b) For Slab

Main and Secondary reinforcement will be for dia. greater than or equal to 8 mm.

5 FIRE PROTECTION

Required criteria for Fire resistance compliance (for RCC and Structural steel) needs to be ensured by following various relevant guidelines / codal provisions given in the Indian standards, NBC 2016 etc.

6 DESIGN LOADS

Summary of various loading considered based on available Architectural drawings and the functional areas mentioned in the same is mentioned below, However, the magnitude/parameters mentioned are minimum/indicative and need to be re-confirmed with respect to the relevant Indian standard provisions/guidelines.

6.1 Dead Load (hereinafter referred to as DL)

Dead load shall mean the total weight of structures and/or foundations, and all materials permanently attached there to or supported thereby. The unit weight of materials shall conform to IS 875 – Part - I.

6.2 Super imposed dead load i.e. SIDL (Minimum)

- a) Floor Finish = 2.0 kN/m^2 (For 100mm of finish)
- b) Load on kitchen, Balconies and Toilet = 2.5 kN/m^2 (For 100mm Screed)
- c) Partition Wall Load = 1.5 kN/m^2
- d) Services (Including False Ceiling) = 1.0 kN/m^2

Wall loading in general would be considered as per floor to floor height considering effect of intermediate tie beam where ever applicable/permitted.

6.3 Waterproofing

- a) On all terraces having RCC framing for the roof slabs conventional brick-bat coba water proofing shall be adopted.
- b) The plumbing & sanitary services would be routed through core cut and under slung system. However, Minimum membrane water proofing of 100mm screed (Including floor finish) would be considered.

6.4 Live Loads (hereinafter referred to as LL)

Live loads shall mean the moving or movable external loads on structures, foundations and buildings produced by people, tools and furnishings of buildings etc. which are not permanently fixed thereto. These are applied as per IS 875 (PartII). Live load to be considered for all the structures is as follows.

- a) Floors = 5.0 kN/ m^2
- b) Escalators and Staircase = 4.0 kN/ m^2
- c) Retail = 4.0 kN/ m^2
- d) Toilets = 2.0 kN/ m^2
- e) Corridors = 4.0 kN/ m^2

- f) Office Area = 3.0 kN/ m²
- g) Lift machine room = 5.0 kN/ m² (to be confirmed with vendor)
- h) Roof Live load (Accessible) = 1.5 kN/ m²
- i) Roof Live load (Non-Accessible) = 0.75 kN/ m²

6.5 Earthquake loads (hereinafter referred to as EQ)

As per IS 1893-2016 the structure is considered to be located in **Zone V** (to be re-checked by contractor during design) of the seismic map of India. The structures are to be designed accordingly.

The average response acceleration co-efficient to be considered as per IS Code. The design and detailing will be done as per the norms specified in the relevant codes applicable i.e. IS 13920-2016.

6.6 Wind loads (herein after referred to as WL)

The wind loading will be as per IS 875(Part-3):2015 or any other relevant IS code.

Considering the building elevation and configuration of roof, external coefficient & other parameters would be workout as per criteria given in IS 875 (part 3):2015.

In addition to the above, following guidelines needs to be followed:

Pressure coefficient for the local effects should be used for calculation of forces on local areas affecting roof sheeting, glass panels and individual claddings including their fixtures as per IS 875 (Part3): 2015.

Dynamic effect on flexible slender structural element shall be investigated as per IS 875 (Part3): 2015.

Adequate diagonal bracings with strong end connections may be provided in steel framing in both the horizontal and vertical planes to improve their lateral load resistance.

In multi hazard prone areas with earthquake **Zone-III** and above, even if the design forces are governed by wind loading, ductile detailing provisions as given in IS 13920 shall be followed. The design forces would however be computed based on wind loading in such cases.

In all buildings where, wind loading is the dominant loading no increase in allowable stresses in steel over and above that specified in IS-800 is permitted.

6.7 Temperature loads (hereinafter referred to as TL)

The temperature load would be applied on the exposed surface only.

The temperature load needs to be worked out considering the relevant IS code provisions and using Average high temp, Average low temp and casting temperature. Temperature load shall be 2/3 of difference between maximum & minimum Temperature.

6.8 Shrinkage loads (hereinafter referred to as SHL)

The shrinkage load would be applied on all concrete surfaces in case if the construction joints as reflected in the Structural layouts not going to be followed.

7 LOADING COMBINATIONS

7.1 Types of loads

Unless otherwise specified as per the IS code guideline in the relevant IS codes, at least all the loads mentioned here, shall be considered in design:

DL	-	Dead load
LL	-	Live load
WL	-	Wind load
EQ	-	Earthquake load
TP	-	Temperature load
SHL	-	Shrinkage Load

7.2 Loading Combinations

Load Combinations to be applied for Analysis and Design of structure as per recommendation of IS 456 & IS 800 for Buildings & Steel Structure.

8 APPROACH FOR STRUCTURAL ANALYSIS

Commercially available Software STAAD / E-Tabs shall be used for static and dynamic analysis.

9 FOUNDATION DESIGN

Soil Investigation is to be carried out by the contractor. The report (if provided) as part of bidding document shall be used as reference only and it is mandatory for the Contractor to conduct the Soil investigation for detailed design. The value of differential settlement should be as per IS 1904, table no 1 (as applicable) or 35mm, whichever is less. Miscellaneous structures such as Retaining walls, UG tanks, and other liquid retaining structures, guidelines from IS3370 should be considered for Analysis and design with limited crack width of 0.2 mm considering soil condition encountered. Membrane type water proofing shall be considered (refer Schedule –D: Annex-I (Part –IV): Construction Specifications for waterproofing of basement including raft, retaining wall, water retaining structures and STP etc.).

10 FORMWORK

The Contractor shall design all form work, scaffolding, centering, etc., as per applicable codal provisions, for all governing load cases and submit detailed design calculations and drawings for clearance of the Employer's Representative / Engineer-in-Charge before commencement of this activity.

In all situations, centering / scaffolding/ staging for casting of these structures should be properly designed by a qualified and experienced person/agency having past experience in design of false work (centering for concrete structures and should be proof checked by similar experienced person / agency and it should be properly approved and issued to contractor by Engineer-in-charge. The provisions of clause-7 of IS: 14687 may be referred for design of false work.

A method statement for erection and dismantling of centering / scaffolding /staging & process of concreting shall be prepared by contractor and submitted to Engineer-in-Charge and the work shall be commenced only after approval of method statement by the Engineer-in-Charge. The provision of clause 9 of IS:14687 may be referred for erection of false work (centering), safety precautions and other operations pertaining to false work (centering).

The field engineers shall ensure that CPWD specifications and provisions of BIS codes are strictly followed.

A detailed program of field safety inspection of centering/scaffolding/formwork of such structures during different stages should be chalked out and strictly followed.

Provisions of safety net, fall arresting system including other safety gears for workers, working over these structures shall be made in contract and should be followed strictly.

SECTION - 3: FAÇADE SYSTEM

1 INTRODUCTION:

This report covers the design basis for Façade design for proposed Terminal Building. The member thicknesses/ sizes provided in this report are indicative and EPC contractor shall re-validate the same during the detailed design stage and make amendments as required based on codal and functional requirements.

2 FACADE SYSTEM DESIGN:

The facades of the terminal building exists not only to separate and shield occupants from exterior conditions but also, at the same time to allow them to stay connected with the outside world. Exterior conditions encapsulate natural seasonal weather conditions and also man-made conditions, both of which are listed as follows:

- a) Temperature
- b) Humidity
- c) Direct Sunlight
- d) Rain
- e) Wind
- f) Noise

However, on a more in-depth and developed basis, the façade must also satisfy various other considerations which are as under:

- a) Structural Integrity (Strength, Deflection, Earthquake & Natural Disasters)
- b) Energy efficiency (In-operation, Life cycle, Carbon foot print).
- c) Humidity
- d) Durability and Longevity of materials
- e) Human comfort (thermal, humidity, noise, natural lighting, glare, etc.) Direct Sunlight
- f) Initial capital and operation costs.
- g) Thermal Breakage Resistant.
- h) Design for safety.
- i) Easy to Maintain.
- j) Functional Flexibility.
- k) Aesthetics

Thus, the façade of the Terminal building must be designed to fulfill a myriad of functions and requirements.

2.1 Façade Design Concept:

Façade design shall be done keeping in mind climatic conditions of the Airport.

Balanced Façade will allow the building to perform better in terms of energy efficiency & day lighting requirement:

- a) Sufficient day light.
- b) Energy Efficiency.
- c) Minimize Glare & Radiation.
- d) Bringing Daylight to deeper areas.

Note:

While selecting any finishing item (like ACP cladding, false ceiling, Glazing, GFRC / Stone cladding etc.), contractor/ consultant shall exercise caution considering the Wind Zone/ Location (inside or outside of Building) / Structural arrangement and ensure adequacy of the arrangements for stability of the structure. Shop drawings for such items shall be vetted from the **IIT/NITs**. The same shall be ensured by Engineer-In-Charge through the specialized agencies and executing agency of the project in association with manufacturer.

3 FAÇADE DESIGN

Performance Requirements

3.1 FAÇADE LIFE & DURABILITY:

The Facade system installed and material (Like hardware's, stainless steel fittings, Glass and Aluminium alloy along with field water test for water leakage) tested as per technical specifications with appropriate maintenance shall be guaranteed for 15 years and expected structural stability of the facade components as 25 years in approved proforma on stamp paper of appropriate value.

The Works shall be appropriate & adequate for its intended purpose. The Works shall be designed, fabricated and installed to achieve the specified levels of performance throughout the design life in this section, under the general exposure conditions set out in the appendix to BS 7543, subject to any special conditions in this specification:

The Works shall be designed, supplied, installed and warranted by the Contractor to comply with the requirements of this section.

The Facade is to perform satisfactorily for the Design Life as per Clause 3.3.

The expected life of products used in the Facade shall be confirmed by providing the following information

- i. The economic life of the product/material in the environment in which it shall be used (this is not a warranty or guarantee);

- ii. Requisite maintenance procedures which must be followed in order to achieve the economic life of the product/material;
- iii. An assurance from the supplier/manufacturer that the product is suitable for its intended application;
- iv. Relevant product data including names of supplier and manufacturers.

During construction, the Engineer-In-Charge shall have the absolute right to have any deficient products or materials rectified or replaced at the Contractor's expense in order to achieve the expected life as stated in these documents. The Contractor will under no circumstance enter into a claim or variation for correction of a product or installation by virtue of the product or material being unfit for its intended purpose.

All materials which are exposed to sunlight, including materials exposed through glass, shall not be affected due to exposure to heat or ultraviolet radiation such that the material can no longer perform as intended, for the aforementioned period.

3.2 Performance Schedule:

a) Structural Adequacy

Structural adequacy of the Works shall be demonstrated by the Contractor against the following, wherever applicable:

- i. Wind loads
- ii. Dead loads
- iii. Live loads
- iv. Seismic loads
- v. Snow loads
- vi. Maintenance related loads
- vii. Any other sources of load that may reasonably be anticipated
- viii. Building movements
- ix. Thermal movements

Acceptable evidence of adequacy shall be submitted by the Contractor. This shall be demonstrated by one or more of the following to the satisfaction of the project administrator:

i.By calculation

ii.Test

iii.Manufacturers test data

b) Structural Serviceability

Serviceability deflection limits on Facade elements under working loads shall not exceed (out of plane):

Structural steelworks	Span/ 300
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Structural steelworks (cantilevered)	Span/ 150
Aluminum frameworks:	Span/ 250 or 15mm whichever is less (mullions and transoms supporting IGU)

Aluminum frameworks: (mullions and transoms) Other than IGU Glazing	Span/ 175 or 15mm whichever is less
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Aluminum members:	Span/ 175 (General framework cladding)
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Glass	Span/ 60 or 15mm whichever is less
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Aluminum cladding	Span/ 120 or 6mm whichever is less
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Glass under gravity load	Span/ 60 and avoid water ponding
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Note: the "span" as noted above is the shorter dimension or the cantilever of the element in question.

Acceptable evidence shall be submitted by the Contractor. This shall be demonstrated by one or more of the following:

- by calculation
- by test

c) Anchors

These shall be in accordance with the manufacturer's details and submitted to the Engineer-In-Charge for approval.

d) Embedment

Factor of Safety for proprietary cast-in embedment's to structural elements of the building shall be in accordance with the manufacturer details and submitted to the Engineer-In-Charge for notice.

Factor of Safety for custom made cast-in embedment's to structural elements of the building shall be minimum of 3.0.

e) Waterproofing

The works shall be designed and installed in accordance with the following philosophy of waterproofing approach:

- Pressure equalized with secondary drainage and ventilated spandrel for the unitized curtain wall system with water shed at each stack joint.
- The Façade including all joints between them and other elements of work, shall effectively prevent leakage of water into the interior of the building from the outer face of the assembly, under the action of wind pressure kinetic energy, gravity, surface tension, or capillary action. This shall be with any combination of wind and precipitation is likely to be experienced. It shall also prevent water entering into those parts of the façade that would be adversely affected by the presence of water. All joints within the Curtain Walls/ Glass Walls shall maintain their water tightness under the loads and movements specified herein

f) Air Infiltration

The works shall be designed and installed by the Contractor to comply with the following:

All elements of Facade - Limited to 0.4 L/m²/s at 300Pa

g) Thermal Performance

The works shall be designed and installed by the Contractor to comply with the ECBC-2017 (Energy Conservation Building Code)

h) Reflectivity and Shading

The works shall be designed and installed by the Contractor to comply with the following:

Laminated Insulated Glass Units for Curtain Walls/Glass Walls with low-e coating on surface #2, with matching appearance with proposed IGU):

- Colour – Green substrate
- Shading Coefficient – to comply with the ECBC-2017 (Energy Conservation Building Code)

i) Acoustic Performance

Noise level at offices: NC40 and provision for cross talk attenuation to suit the notional partitioning layout. This is based on open plan design.

Noise criteria reference values are the maximum noise level obtained with all plant operating on full or part load. In addition to above, noise spectra generated by building services plant should be smooth and free from discrete frequency peaks.

j) Movement Noise Control

The works shall take account of the effects of thermal and structural movements and of wind and air movement, so that creaking, rattling, whistling, 'slip-stick' noise and any other noises are eliminated.

k) Wind Noise Control

The works shall take into account, and avoid the possibility of the generation of tonal noise as a result of wind blowing through or over elements in the building facade.

Some amplification of wind noise might result if the elements generating the tonal noise are rigidly fixed to the building envelope and match a natural resonance in the structure. Even without amplification, structure borne noise may be transmitted to the interior as well as airborne noise.

To limit the generation of vortex shedding, the main mechanism for creating discrete frequencies, the following should be avoided:

- apertures and exposed elements with sharp edges and dimensions less than 80mm
- regular arrays of grillages, meshes, etc.
- small diameter wires or hollow sections with a diameter less than 50mm cavities which might be excited to organ pipe resonance when excited by vortices generated by other elements.

l) Electrical Continuity and Equipotential Bonding

The Works shall be designed and installed by the Contractor to achieve electrical continuity, with electrical bonding locations tied to main electrical system to comply with the following:

- Electrical connection shall be made between the main earth grounding terminal and the mounting from the Exterior Cladding System and ensure that the metallic structural framework of the curtain wall is electrically continuous by itself.
- The installation shall be carried out in accordance with the relevant National Standards covering electricity wiring.

The Contractor shall co-ordinate as necessary and arrive at the main lightning protection systems for the building and shall effect appropriate connection points for review by the Engineer-In-Charge. External tapes or visible connections shall not be acceptable.

m) Ventilation Requirement

Not applicable.

n) Fire

The works shall be designed and installed by the Contractor to comply with the following:

- All requirements of local codes and building authorities with regards to the fire rating of the works.
- 2-hour FRP fire stop materials with smoke seal shall be designed and installed by the Contractor to separate adjacent floors and compartments.
- The fire stop form a continuously sealed air-tight barrier between the building structure and the Facade.

Acceptable evidence shall be submitted by the Contractor to prove its compliance with all requirements of local codes and building authorities. This shall be demonstrated by one or more of the following:

- design information
- test certificates
- by test

o) Building Regulations

The works shall comply with all relevant statutory codes and regulations.

p) Building Movement:

Design, fabricate and install Aluminum Composite Panel and glass exterior enclosure systems withstand building movements including loading deflections, shrinkage, creep, the and similar movements. Design for simultaneous occurrence of all specified movements. No reductions shall be applied to individual movements or to combinations of movements. Building movement shall be accommodated by interlocking aluminum components not through slippage of glass relative to framing members.

q) Attachment to the Building Structure

The fixing shall resist dead loads, live loads, wind loads, vertical and lateral loads, and all building movements, individually and in combination. All fixings to accommodate the worst of tolerance limits under design loading.

Where behind the vapour barrier, hot-dip galvanized mild steel cast-in channels or cast-in plates with weld-on studs and anchor plates shall be used as cast in anchors for connecting the Facade systems to the building structure. Where beyond the vapour barrier, stainless steel Grade 316 counterpart is to be adopted.

Stainless steel Grade 316 masonry anchors may only be used where cast in anchors have been erroneously omitted and only with the approval of the

Engineer-In-Charge. Any such products must be proprietary and must be submitted for approval by the Engineer-In-Charge prior to them being used on the Project. Proprietary products with a track record of less than 10 years shall not be acceptable for use in this Project.

All site welding shall be inspected prior to post-painting which matches with existing finishes of the steel members.

r) Vibration Proofing of Fixings

All fixings shall be designed such that there shall be no risk of them working loose due to the effects of vibrations, or to the cyclic effects of load, deflections and thermal expansion. This shall be achieved by the use of locking nuts, locking washers or application of an approved locking fluid or tie wires.

s) Locked-in Stresses

The Contractor shall avoid in his design and detailing of fixings, the introduction of locked-in stresses that may be detrimental to the performance of the façade during the service life.

The stresses that are referred to are those that can develop in the unitized/semi-unitized panel caused by rigid fixings that do not allow thermal or other movements. Such rigidity and resistance shall be avoided by the careful positioning of fixings and preventing slots, which are intended to allow for movements, becoming filled.

t) Fixings

All fixings shall be concealed and shall not be visible.

u) Final Tolerances

The Works shall be designed and installed by the Contractor to comply with the requirements set out in this Specification.

3.3 Wind Load Calculations (For facade System):

The wind loading will be as per IS 875 (Part-3):2015. Wind load calculations should be as per the approved final structural design and as per technical and Functional requirement.

3.4 Dead and Live Loads

a) Live Loads (Imposed loads)

The Works shall be designed and installed by the Contractor to comply with the Indian Standard: Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Part 2 Imposed Loads.

SL No.	Usage Area	Intensity of Horizontal Load, KN/m Run
(1)	(2)	(3)
i)	Light access stairs, gangways and the like not more than 600mm wide	0.25
ii)	Light access stairs, gangways and the like more than 600mm wide; stairways, landings, balconies and parapet walls (private and part of dwellings)	0.35
iii)	All other stairways, landings and balconies, and all parapets and handrails to roofs except those subject to overcrowding covered under (iv)	0.75
iv)	Parapets and balustrades in place of assembly, such as theatres, cinemas, churches, schools, places of entertainment, sports, buildings likely to be over-crowded	2.25

b) Dead Loads

The Works shall be designed to comply with the Design Loads for Buildings and Structures IS : 875 (Part 1).

Material Self Weight (kN/m ³)	
Steel work	78.5
Aluminium	27.1
Glass	25.6

c) As per IS 1893-2016 the structure is considered to be located in Zone V of the seismic map of India.

d) Cleaning Loads

The façade shall sustain safely and without damage. A static load of 500N applied perpendicularly to the facade surface and framing through a square of 100mm side.

All components associated with the horizontal Aluminium clad features shall be designed to withstand, without damage, a uniformly distributed load of 0.75kN/m², or 1.0kN concentrated load over any square with a 300mm side, acting perpendicularly to the surface of the Aluminium cladding.

e) Thermal Loads

Resist cracking to glass, stone and ceramic materials caused by thermal stress within the design operating conditions range. Points to note are the perimeter heating trench, hot air curtains and surfaces behind glass.

f) Internal Load on Insulating Glass Units

Design the units to resist the combined effects of temperature, altitude, atmospheric pressure, together with the other specified loads.

g) Impact Loads

The Works shall be designed to comply with the Design Loads for Buildings and Structures IS: 875 (Part 2).

The maximum visually acceptable dent in the metal surface is 10mm in diameter and 3mm in depth.

h) Other Loads

The Works shall be designed and installed by the Contractor to cater for construction stage loads.

Any other loading conditions associated with the construction and serviceability of the completed Works shall be considered and accommodated.

i) Internal Trim Stability

Interior trims, including stools and sill boards shall not deflect more than 2mm when subjected to a concentrated force of 150N at any point not causing permanent deformation. The minimum thickness shall be 2mm subject to the Engineer-In-Charge approval on painted samples.

j) Temporary Construction Load

Sustain and safely transmit any temporary loading that may arise from lifting, storing, transporting, hoisting and installing cladding or other works that may affect the cladding.

k) Accommodation of movement generally

The Works shall accommodate the movements noted below without any reduction in the performance below the minimum levels required.

- i. Deflections due to design imposed loads.

- ii. Deflections under repeated cycles of the design wind loads.
- iii. Changes in dimension and shape arising from building movements, including settlement, shrinkage, elastic shortening, floor beam deflections, creep, wind sway, seismic activities, twisting and racking and thermal and moisture movement.
- iv. Due to movement of any joint in the supporting structure or building frame whether that joint is intended to permit movement or not.

The Contractor shall provide estimates of nominal, minimum and maximum joint widths accounting for tolerances and movements at all movement joints (see Fig 1) and shall confirm that the joints shown on the Drawings will accommodate them.

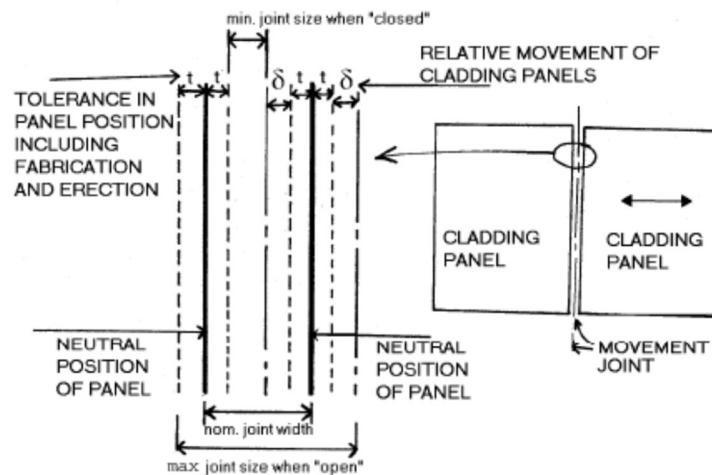


Fig. 1 Movements and Tolerances at Movement Joints

I) Accommodation of building movement

The Works shall accommodate the movements anticipated. The Works shall also be designed and installed by the Contractor to comply with the following:

- Allowance shall be made for both horizontal and vertical deflection of the structure due to differential settlement, wind effects, deflection of beams, and the long-term effects of concrete creep. The allowance shall be additional to that for concrete tolerance. The system shall be designed to accommodate the worst possible combination of effects to prevent internal stress, failure, deterioration or failure of weather seals as specified herein.
- The supporting elements of the curtain wall will continue to undergo deflection during the life of the building due to variation in live load and creep of the concrete of the concrete structure.
- In addition to accommodating the structural movements ($\pm 60\text{mm}$ for main roof truss), the vertical differential joint design must also take into account

thermal expansion, installation tolerances, fabrication tolerances, concrete placement tolerances and lateral sway of the structure.

- The Contractor shall design, supply and install cladding and curtain wall system to withstand expansion and contraction forces resulting from the temperature defined in the document without buckling, failure of a glass or joint sealants, undue stress on structural elements and fasteners or other detrimental effects.

m) Climatic Data

The Works shall be designed, supplied, installed and warranted by the Contractor to comply with the climatic conditions that may reasonably be anticipated for the region.

n) Internal and External Environment

The Works shall be designed, supplied and installed by the Contractor to comply with the following:

o) External conditions

The peak external design conditions shall be taken as follow:

Design outdoor dry bulb temperature: 35.6 °C (summer) & 14.4°C (winter)

Coincident wet bulb temperature: 25.6 °C (summer) & 12.2°C (winter)

Note:

p) Internal conditions

The internal design conditions for each area shall be in accordance with the following design parameters:

Air conditioned spaces

Hall: 24±2 °C DB, 60% RH

Concourse: 24±2 °C DB, 60% RH

Busgates : 24±2 °C DB, 60% RH

Lounge: 24±2 °C DB, 60% RH

Retails / Office: 24±2 °C DB, 60% RH

Circulation area: 24±2 °C DB, 60% RH

IT room: 20±1 °C DB, 60% RH

Data centre : 20±1 °C DB, 50±10% RH

Thermal component of joint movement shall be based upon a minimum material temperature increase of 50°C and decrease of 50°C relative to the time of installation.

q) Construction Tolerances

Unless otherwise directed, structural members shall be set out from the reference grids and datum levels and constructed such that the dimension between any two points on the structure as built or between any point on the structure and any reference grid or datum level shall agree with the required dimension, whether shown or calculable from the drawings as follows:

- Horizontal position (in plan) of exterior edge (perimeter) beams, exterior face of columns, edge of concrete slabs.....+25mm(outward);-25mm (inward).
- Vertical position (in section) of slab (at edge condition), edge beam, top of concrete upstand, bottom of concrete downstand, bottom of perimeter edge beam.....±25mm
- Deviation in plan for column location at any storey relative to required position ±30mm
- Horizontal position (in plan) of steel beams and columns.....±15mm.

Fixing brackets to connect the facade elements to the cast-in embedments shall be designed to cater for these construction tolerance in the way no remedial work shall be required.

SECTION-5: AT PARKING, PAVEMENTS, RAMPS, HARD STAND

1 INTRODUCTION

1.1 General

This report covers the design basis for At Grade Roads, Pavements, Ramps, Hardstand etc. for the proposed Interim Terminal building at Udhampur Airport. The design brief provided in this report are indicative and EPC contractor shall re-validate the same during the detailed design.

2 CODES AND STANDARDS

2.1 Following are the IRC codes shall be referred while finalizing Road Designs

- IRC:86-1983 - Geometric Design Standards for Urban Roads in Plains
- IRC:38-1988 - Guidelines for Design of Horizontal Curves for Highways
- IRC:SP:23-1983 - Vertical Curves for Highways
- IRC:SP:58-2011 - Guidelines for the Design of plain jointed rigid Pavement for Highways.
- IRC:37-2012 - Guidelines for the Design of Flexible Pavements
- IRC:6 (latest edition) - Standard specification of practice for Road Bridges.
- IRC:SP:42-1994 - Guidelines on Road Drainage
- IRC:SP:41:1992- Guidelines for the Design of at – grade intersections in Rural and Urban Areas

In the absence of any specific provision or any particular issue in the IRC codes, the relevant codes like AASTHO, other international codes /literature, etc shall be referred.

2.2 Pavement Design

- Rigid pavement is to be designed in accordance with the guideline specified in IRC: 58-2015 "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways.

2.2.1 Type of pavement

GRADE ROADS, PARKING, PAVEMENTS, RAMPS shall be rigid pavements or as specified in the relevant tender drawings.

2.2.2 Design requirements

Design Period and strategy

All rigid pavements shall be designed for a minimum design period of 30 years. For rigid pavement following minimum section shall be maintained. Design traffic of 10 MSA shall be adopted for Rigid Pavement.

(a) The pavement section is to be designed by the contractor to atleast cater the load of CFT. Minimum section to be followed is as below:

PQC-200 MM
DRLC-150 MM
WMM-200 MM
GSB- 200 MM

Median: Both side RCC M 25 grade concrete Kerb Stone.

2.2.3 Footpath:

RCC M 25 grade Kerb Stone on both side with kerb channel on road side. 60mm thick factory-made cement concrete interlocking paver block of M -30 grade made by block making machine with strong vibratory compaction, of approved size, design & shape, laid in required colour and pattern over and including 50mm thick compacted bed of coarse sand, filling the joints with line sand etc.

2.2.4 Road Marking:

2.5 mm thick road marking strips (retroreflective) of specified shade/ colour using hot thermoplastic material by fully/ semi-automatic thermoplastic paint applicator machine fitted with profile shoe, glass beads dispenser, propane tank heater and profile shoe heater.

3 GRANULAR SUB-BASE

Preparation of **granular sub-base** by providing close graded material, conforming to specifications mixing in a mechanical mix plant at OMC, carriage of mixed material by mechanical transport to work site, for all leads and lifts, spreading in uniform layers of specified thickness with mechanical means including neatly levelling & dressing on prepared surface and compacting with vibratory power roller to achieve the desired density, complete and as per direction of Engineer-in-charge

3.1 General

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-charge.

The thickness of a single compacted GSB layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 200 mm upon approval of the Engineer-in-charge.

3.2 Materials

The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag, or combination thereof depending upon the grading required. Use of materials like brick metal, kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and shall conform to the grading given in Table 1 and physical requirement given in Table 2. Gradings III and IV shall preferably be used in lower sub-base. Gradings V and VI shall be used as a sub-base cum drainage layer. The grading to be adopted for a work shall be as specified in the contract.

If the water absorption of the aggregate determined as per IS:2386 (Part 3) is greater than 2 percent, the aggregate shall be tested for Wet Aggregate Impact Value (AIV) (IS:5640). Soft aggregate like Kankar, brick ballast and laterite shall also be tested for Wet AIV (IS:5640).

Table -1. Grading for granular sub-base material

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55-90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	-	-	35-65	55-75
4.75 mm	25-55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20-40	30-50	-	-	10-20	10-25
0.85 mm	-	-	-	-	2-10	-

0.425 mm	10-15	10 -15	-	-	0-5	0-8
0.075mm	<5	<5	<5	<5	-	0-3

Table 2: Physical Requirement for Materials for Granular Sub-base.

Aggregate Impact Value (AIV)	IS:2386(Part 4) or IS:5640	40 Maximum
Liquid Limit	IS:2720(Part 5)	Maximum 25
Plasticity Index	IS:2720(Part 5)	Maximum 6
CBR at 98% dry density (IS:272-(Part 8)	IS:2720(Part 5)	Minimum 30 specified unless otherwise specified in the Contract

3.3 Strength of sub-base

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer-in-charge, this shall be verified by performing CBR tests in the laboratory as required on specimens re-moulded at field dry density and moisture content and any other tests for the "quality" of materials as may be necessary.

3.4 Execution shall be done as per construction specifications.

4 PARTICULAR SPECIFICATION FOR WET MIX MACADAM SUB-BASE/BASE

Providing, laying, spreading and compacting graded stone aggregate (size range 53 mm to 0.075 mm) to **wet mix macadam (WMM)** specification including premixing the material with water at OMC in mechanical mix plant, carriage of mixed material by mechanical transport to site, for all leads & lifts, laying in uniform layers with mechanical paver finisher in sub- base /base course on well prepared surface and compacting with vibratory roller of 8 to 10 tonne capacity to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge.

4.1 General

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water to a dense mass on a prepared sub grade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more

layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer-in-Charge.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 150 mm upon approval of the Engineer-in-Charge.

4.2 Materials

4.2.1 Aggregates

a) Physical requirements:

Coarse Aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirement set forth in table-1.

Table 1: Physical Requirements of coarse aggregates for Wet Mix Macadam for Sub base / Base course.

Test	Test Method	Requirements
Los Angeles Abrasion value or Aggregate Impact value	IS : 2386 (Part 4) IS : 2386 (Part 4) or IS:5640	40 per cent (Max.) 30 per cent (Max.)
Combined Flakiness and Elongation Indices (Total)	IS : 2386 (Part 1)	35 per cent (Max.) *

* 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 are to be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part 5).

b) Grading requirements

The aggregate shall conform to the grading given in table below:

Table 2: Grading Requirements of aggregates for Wet Mix Macadam

IS Sieve designation	Per cent by weight passing the IS sieve	Job Control Grading Band Tolerances Percent
53 mm	100	0
45 mm	95 – 100	±5
26.50 mm	-	-
22.40 mm	60 – 80	±8
11.20 mm	40 – 60	±8
4.75 mm	25 – 40	±8
2.36 mm	15 – 30	±8
600 micron	8 – 22	±5
75 micron	0 – 5	±3

The job control band tolerances in the Table 2 shall be applied to final gradation to establish a job control grading band. The full tolerance still applies if application of the tolerances results in a job control grading band outside the design range.

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

4.3 Execution

Execution shall be done as per construction specifications.

5. Providing and laying **dry lean cement concrete** with coarse and fine aggregate conforming to IS:383, the size of coarse aggregate not exceeding 26.5 mm, aggregate cement ratio not exceed 15:1, aggregate gradation after blending to be as per specification, cement content not to be less than 150 kg/cum, optimum moisture content to be determined during trial length construction, concrete strength not to be less than 10 MPa at 7 days, mixed in a batching plant as per mix design, transported to site, laid with a paver with electronic sensor, compacting with 8-10 tonne vibratory roller, finishing and curing etc complete as per specification and direction of the Engineer-in-Charge.

5.1 General

The work shall consist of construction of (zero slump) dry lean concrete sub-base for cement concrete pavement in accordance with the requirements of these specifications and shall conform to the lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-Charge. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations, in connection with work, as approved by the Engineer-in-Charge.

The design parameters of dry lean concrete sub-base, i.e. width, thickness, grade of concrete, details of joints, if any, etc. shall be as stipulated in the drawings or as directed by Engineer-in-Charge.

5.2 Materials

5.2.1 Source of Materials:

The contractor shall indicate to the Engineer-in-Charge the source of all materials with relevant test data to be used in the dry lean concrete work sufficiently in advance and the approval of the Engineer-in-Charge for the same shall be obtained before start of the work. If the contractor later proposes to obtain the materials from a different source during execution of work, he shall notify the Engineer-in-Charge for his approval before such materials are to be used.

5.2.2 Cement:

Any of the following types of cement may be used with the prior approval of Engineer-in-Charge.

S. No.	Type	Conforming to
i)	Ordinary Portland Cement	IS: 8112
ii)	Portland Slag Cement	IS: 455
iii)	Portland Pozzolana Cement	IS: 1489-Part-I

If the sub-grade is found to consist of soluble sulphates in a concentration more than 0.5 percent, the cement used shall be sulphate resistant and shall conform to IS:6909.

Supply of Cement shall be obtained either in bulk form or as per clause 3.1.2.5 of CPWD specifications Vol-I, 2009. Cement shall be subjected to acceptance tests prior to its use. Nothing extra shall be paid on this account.

5.2.3 Aggregates

5.2.3.1 Aggregates for lean concrete shall be natural material complying with IS: 383. The aggregates shall not be alkali reactive. The limits of deleterious materials shall not exceed the requirements

set out in table 1 of IS: 383. In case the aggregates are not free from dirt, the same may be washed and drained for at least 72 hours before batching, as directed by the Engineer-in-Charge.

5.2.3.2 Coarse aggregate: Coarse aggregates shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of coarse aggregate shall not exceed 26.5mm for lean concrete. No aggregate which has water absorption more than 2 percent shall be used in the concrete mix. The aggregate shall be tested for soundness in accordance with IS:2386 (Part-5). After 5 cycles of testing, the loss shall not be more than 12 percent if sodium sulphate solution is used or 18 percent if magnesium sulphate solution is used. The Loss Angeles Abrasion value shall not exceed 35. The combined flakiness and elongation index of aggregate shall not be more than 35 percent.

5.2.3.3 Fine aggregate: The fine aggregates shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS:383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter. The fine aggregates shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part 37).

5.2.3.4 The material after blending shall conform to the grading as indicated in Table 1.

Table 1: Aggregate gradation for Dry Lean Concrete

Sieve Designation	Percentage passing the sieve by weight
26.50 mm	100
19.00 mm	75-95
9.50 mm	50-70
4.75 mm	30-55
2.36 mm	17-42
600 micron	8-22
300 micron	7-17
150 micron	2-12

75 micron	0-10
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5.2.3.5 Water: Water used for mixing and curing of concrete shall be clean and free from injurious amounts of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456.

5.2.4 Storage of materials

5.2.4.1 Cement:

The Contractor shall provide adequate storage facilities to prevent deterioration of cement during storage due to climate and other causes. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirement at site. The containers shall be cleaned at least once every 3 months. Cement remaining in stores for more than one and half month from the date of manufacture must be retested before use and to be rejected, if it fails to conform to any of the requirements of the specifications.

5.2.4.2 Aggregates:

Stock piles shall be made immediately on receipt of aggregates at site of work. Aggregates shall be stacked separately according to the nominal sizes of coarse aggregates. For fine aggregates, separate stacks shall be made.

Aggregates shall be stacked on a hard surface so as to exclude the possibility of soil or grass being mixed up. When stacked in close proximity, the stock piles shall be separated by bulk heads to prevent the different sizes of aggregates from mixing together. Special care shall be taken to clean and wash the last layer of aggregates in contact with ground surface before use.

Before batching, the aggregates shall have been stock piled for at least 24 hours to allow for draining of water, if any. The Contractor shall make adequate provision for stock piling aggregates to the extent sufficient to meet the needs of the work taking into account the availability of supplies and rates of delivery etc. and nothing extra shall be paid for necessary double handling and transport of materials from stock piles to mixing plant etc.

5.2.5 Proportioning of Materials for the Mix

5.2.5.1 The mix shall be proportioned with a maximum aggregate cement ratio of 15:1. The water content shall be adjusted to the optimum as per clause 3.2 for facilitating compaction by rolling. The strength and density requirement of concrete shall be determined in accordance with clause 6 and 7 by making trial mixes.

5.2.5.2 Moisture Content: The right amount of water for the lean concrete in the

mainwork shall be decided so as to ensure full compaction under rolling and shall be assessed at the time of rolling the trial area. Too much water will cause the lean concrete to be heaving up before the wheels and to be picked up on the wheels of the roller and too little will lead to inadequate compaction, a low in-situ strength and an open-textured surface.

The optimum water content shall be determined and demonstrated by rolling during trial area construction and the optimum moisture content and degree of compaction shall be got approved from the Engineer-in-Charge. While laying the main work, the lean concrete shall have a moisture content between the optimum and optimum + 2 per cent, keeping in view the effectiveness of compaction achieved and to compensate for evaporation losses.

5.2.5.3 Cement Content: The cement content in dry lean concrete shall be such that the strength specified in clause 3.4 is achieved. The cement content shall not be less than 150 Kg per cum of finished DRLC.

5.2.5.4 If the actual quantity of cement required as per laboratory mix design varies from the quantity assumed above, the same shall be borne by contractor and nothing extra shall be payable.

5.2.5.5 Concrete Strength: The average compressive strength of each consecutive group of 5 cubes made shall not be less than 10 MPa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 MPa at 7 days. The design mix complying with the above clauses shall be got approved from the Engineer-in-Charge and demonstrated in the trial length construction.

5.2.5.6 Trial Mixes: The contractor shall make trial mixes of dry lean concrete with moisture contents like 5.0, 5.5, 6.0, 6.5 and 7.0 per cent using specified cement content and the specified aggregate grading but without violating the requirement of aggregate-cement ratio specified in clause 3.1. Optimum moisture and density shall be established by preparing cubes with varying moisture contents. Compaction of the mix shall be done in three layers with vibratory hammer fitted with a square or rectangular foot (as per relevant IS Code). After establishing the optimum moisture, a set of six cubes shall be cast at that optimum moisture for the determination of compressive strength on third and the seventh day. Trial mixes shall be repeated if the strength is not satisfactory either by increasing cement content. After the mix design is approved, the Contractor shall construct a trial section in accordance with relevant IS Code. If during the construction of trial area/patch, the optimum moisture content determined as above is found to be unsatisfactory, the contractor may make suitable changes in the moisture content to achieve the satisfactory mix. The cube specimens prepared with the change mix content should satisfy the strength requirement. Before production of the mix, natural moisture content of the aggregate should be determined on a day-to-day basis so that the moisture content could be adjusted. The mix finally designed should neither stick to the rollers nor become too dry resulting in ravelling of surface.

5.2.5.7 Trial Length: After finalizing the mix design, trial length/area as decided by the Engineer-in-Charge shall be prepared. After the construction of the trial length, the in-situ density of the freshly laid material shall be determined by sand replacement method. Three density holes shall be made at locations equally spaced along a diagonal that bisects the trial length. The average of these densities shall be determined. These main density holes shall not be made in the strip 500 mm from the edges. The average density obtained from the three samples collected shall be the reference density and is considered as 100 per cent. The field density of regular work will be compared with this reference density in accordance with construction specifications.

The hardened concrete shall be cut over 3m width and reversed to inspect the bottom surface for any segregation taking place. The trial length shall be constructed after making necessary changes in the gradation of the mix to eliminate segregation of the mix. The lower surface shall not have honey combing and the aggregates shall not be held loosely at the edges.

The main work shall not start until the trial length has been approved by the Engineer-in-Charge. After approval has been given, the materials, mix proportions, moisture content, mixing, laying, compaction plant and construction procedures shall not be changed without the approval of the Engineer-in-Charge.

5.3 Execution shall be done as per construction specifications.

6 PAVEMENT QUALITY CONCRETE (PQC)

Providing and laying Pavement Quality Concrete (PQC) produced in a batching and mixing plant having a Characteristic flexural strength i.e. flexural strength of 4.1 MPa at 28 days using Ordinary Portland cement of 43/53 grade or Portland Pozzolana Cement or Portland Slag cement conforming as per relevant IS codes, to be mixed at site, with 0.5% Super plasticizer by mass of cementitious material, fine aggregate, graded stone aggregates of 40 mm nominal size in appropriate proportion as per specification and job mix formula, laid in panels as per drawings/design as approved by the Engineer-In-Charge using Slip Form Paver or Fixed form paver including anti friction layer, joint filler board, making necessary provision for expansion, dummy and construction joint including filling with Polysulphide sealant of approved make, curing and making profile, complete as per direction of Engineer-in-Charge and specifications. The item for execution shall include all operations making pavement for intended use but not limited to following:

- (i) Polyethylene sheet (White in color) of thickness 400 micron conforming to IS: 2508 with 6mm thick fine sand layer.
- (ii) Providing and laying in position for expansion joint, 25mm thick pre-cut Synthetic joint filler board of approved make conforming to IS:1838(part 3)-2011, 45 mm from top (to be removed at the time of filling of Polysulphide sealant).

- (iii) Mechanically cutting dummy joints 3mm wide x 1/3rd thickness of slab which is subsequently widened to 10mm for the top 25mm depth and construction joints 10mm wide x 25mm deep as per specification.
- (iv) Providing and laying in position Polysulphide sealant of approved make conforming to BS-5212-1990 or IS: 11433-1995 in expansion/ construction / dummy joints including rounding off edges, applying 2 coats of approved primer compatible with the brand of Polysulphide and preparing the surface and applying masking tape along the edge of joint to prevent accidental spillage of sealant on top surface and to give neat finish to the sealant and removing the masking tape after application of sealant etc. as per the details below:
 - (a) Expansion Joints of size 25 mm wide and 10 mm deep over 30mm dia expanded closed-cell Polyethylene foam back-up/backer rod of minimum density 22 Kg/Cum, as per manufacturer's specifications and sketch at Appendix-'A'.
 - (b) Construction Joints of size 10 mm wide and 10 mm deep over 12mm dia expanded closed-cell Polyethylene foam back-up/backer rod of minimum density 22 Kg/Cum, as per manufacturer's specifications and sketch at Appendix-'A'.
 - (c) Dummy Joints of size 10 mm wide and 10 mm deep over 12 mm dia expanded closed-cell Polyethylene foam back-up/backer rod of minimum density 22 Kg/Cum, as per manufacturer's specifications and sketch at Appendix-'A'.
- (v) Making profile as per DGCA CAR, panel drawing showing dummy, construction, expansion joints location.

Note:

(a) Areas inaccessible to paving equipment shall be constructed by manual/hand guided method. Areas in which manual/ hand guided methods of construction become indispensable shall be got approved by the Engineer-in-Charge in writing in advance.

(b) The quantity of cement, type of cement and super plasticizer for one Cum. of finished concrete specified are for tendering purpose only. The contractor shall quote his rates assuming quantity of OPC cement as 360 Kg/Cum or 400 Kg/Cum of Portland Pozzolana Cement/ Portland Slag cement. In addition, if the actual quantity of cement & super plasticizer required as per laboratory mix design varies from the quantity assumed above, is covered under this EPC contract and nothing payable extra.

6.1 MATERIALS

6.1.1 CEMENT

- a) Ordinary Portland Cement 43 Grade conforming to IS: 269-2015.
- b) Ordinary Portland cement 53 grade conforming to IS: 269-2015.

Following extra precautions shall be taken:

- (i) Proper mix design may be done to account for shrinkage/microcracking due to higher heat of hydration.
- (ii) The temperature of aggregate, water and cement should be maintained at the lowest practical levels, so that temperature of concrete is below 30⁰ C at the time of placement.
- (iii) Aggressive curing of concrete to avoid cracking shall be done keeping surface continuously wet by providing wet hessian cloth etc, before continuous curing i.e. after 24 hours of laying.
- (iv) Use of 53 grades OPC shall be avoided in case of hot weather concreting.

Note:

- a) High alumina cement is not permitted to be used.
 - b) Agency should submit copies of purchase voucher to the Engineer-in- Charge and original to be produced for verification.
- Supply of Cement shall be obtained either in bulk form or as per clause 3.1.2.5 of CPWD specifications Vol-I, 2009. Tests on cement shall be done as per clause 16.1 under quality control and nothing extra shall be paid on this account.
 - SUPER PLASTICIZER
Super Plasticizer conforming to IS: 9103 may be used to improve the workability of concrete.

6.1.2 WATER

Water for mixing and curing concrete will ordinarily be obtained from a source which is used for drinking. Where water from such a source is not available, the contractor shall ensure that it is clean and free from injurious quantities of acid, alkalies, salts, alcohol, silt, oil, organic matter etc. and conforms to IS: 456 (latest revision). In order to ensure that the water does not contain impurities in injurious proportions, the contractor shall get the water tested in one of the approved testing laboratories at his own expense. Nothing extra shall be paid on this account. In such cases, the provisions laid down in clause 5.4 of IS: 456 (latest revision) shall be binding. Test on water should be repeated whenever there is change in the source.

6.1.3 COARSE AGGREGATES

These shall be natural materials conforming to IS: 383(latest revision) but with Los Angeles Abrasion value not more than 30 per cent. These shall be crushed or broken from hard stones obtained from approved quarry.

These shall be clean, strong, durable of fairly cubical shape and free from soft, friable, thin elongated and laminated/ disintegrated pieces. These shall also be free from dirt, organic, deleterious and any other foreign matter and adherent coatings and shall satisfy the physical requirement laid down in clause 16.1 under quality control. Nothing extra shall be paid for testing of material. Manufactured aggregate shall also be allowed

subject to meeting the requirement of IS 383.

a) Some aggregates may contain ferrous sulfides and iron oxides which can cause stains on exposed concrete surfaces. In areas where staining has been a problem or is suspected, the Engineer should verify that producers and aggregate suppliers have taken steps to prevent the inclusion of any ferrous sulfides or iron oxides in aggregate to be used in the project.

If there is a concern that these may exist, an indicator to identify staining particles is to immerse the aggregate in a lime slurry. If staining particles are present, a blue-green gelatinous precipitate will form within 5 to 10 minutes, rapidly changing to a brown color on exposure to air and light. The reaction should be complete in 30 minutes. If no brown gelatinous precipitate forms, there is little chance of reaction in concrete.

6.1.4 FINE AGGREGATE

The fine aggregate shall be coarse sand consisting of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS: 383 and clause 3.3.4 of IRC 15-2017 and shall satisfy the physical requirement laid down in clause 16.1 under quality control. Nothing extra shall be paid for testing of material. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica, organic and other foreign matter. Manufactured fine aggregate shall also be allowed subject to meeting the requirement of IS 383.

6.1.5 COMBINED GRADING OF AGGREGATES

The grading of all aggregates (coarse and fine aggregates) to be used on specific job shall be determined in the material testing laboratory (approved by AAI/Govt. Institutions i.e., IITs, NITs, Govt. Engg. Colleges) or in-house by Department of Structure as directed by the Engineer-In-Charge. The coarse and fine aggregates shall be mixed in suitable proportions so that the grading of the mixed aggregates shall be in the range indicated in the table below:

I.S. Sieve Size	%age passing by weight
45 mm	100
22.4 mm	55-60
11.2 mm	45-50
5.6 mm	35-40
2.8 mm	30-35
1.4 mm	20-25
710 micron	15-20
355 micron	8 -14
180 micron	0-5

If the combined aggregate grading calculated thereof does not meet the specified grading requirements, appropriate adjustment shall be made in the proportions of different aggregate fractions. Any deviation to the overall grading shall be made only with the specific approval of Engineer-In-Charge and nothing extra shall be paid for such adjustment. Design of mix shall be redone if there is a change in the source of coarse or fine aggregates or type of cement as per Para 1.1. Nothing extra shall be paid

for such testing and designing.

6.1.6 ANTI-FRICTION LAYER

6.1.6.1 Anti-friction layer shall be provided between the concrete slab and the DRLC surface. Before placing the anti-friction layer, the sub-base shall be swept clean of all the extraneous materials and a layer of 6mm fine sand shall be laid. On sand layer, polyethylene sheet (white in colour) of thickness 400 micron conforming to IS: 2508, with overlaps of not less than 300mm longitudinally and 300mm transversely shall be laid. Any damaged sheeting shall be replaced at the contractor's expenses. The anti-friction layer shall be nailed to the lower layer with concrete nails.

6.1.6.2 COMPOSITION

6.1.6.2.1 Natural Compound

6.1.6.2.1.1 The compound used for manufacturing natural film shall consist only of polyethylene resins complying with 6.1.7.2.1.2. Any additives, such as anti-oxidants, to impart additional qualities to the films, such as slip, may be added in quantity to the resins, as agreed to between the supplier and the purchaser.

6.1.6.2.1.2 The polymers for the natural film shall have a melt flow index between 0.10 to 15.0 g/10 min. The density for the compound from which the film is made shall be between 0.913 to 0.923 g/ml at 27°C (0.915 to 0.925 g/ml at 23°C).

6.1.6.3 Appearance - The film shall be uniform in colour, texture and finish. The material shall be substantially free from pin-holes and undispersed raw materials, streaks and particles of foreign matter. There shall be no other visible defects, such as holes, tears or blisters. The edges shall be free from nicks and cuts visible to unaided eye. The natural films shall be free from pin-holes.

6.1.6.4 Odour - The film shall be free from any objectionable odour.

6.1.6.5 Density – The density of the film, when determined in accordance with A-I of IS 2508 or Method 5 of IS:8543 (part 1/ set 2)-1979 shall be as prescribed in 6.1.7.2.1.2. however, in case of dispute the latter shall be the preferred method.

6.1.6.6 Melt Flow Index - The melt flow index of the film when determined in accordance with 7 of IS: 2530-19637 shall be as prescribed in 1.7.2.1.2.

6.1.6.7 Tensile Strength at Break - The tensile strength at break when tested as prescribed in A-4 of IS 2508 for all thicknesses of polyethylene film shall be not less than 11.77 MN/m² (120 kgf/ cm²) in lengthwise direction and 8.33 MN/m² (25 kgf /cm²) in crosswise direction.

6.2 HANDLING AND STORAGE OF MATERIALS

6.2.1 CEMENT

The Contractor shall provide adequate storage facilities to prevent deterioration of cement during storage due to climate and other causes. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirement at site. The containers shall be cleaned at least once every 3 months. Cement remaining in stores for more than one and half month from the date of manufacture must be retested before use and to be rejected, if it fails to conform to any of the requirements of the specifications.

6.2.2 AGGREGATES

- a) Stock piles shall be made immediately on receipt of aggregates at site of work. Aggregates shall be stacked separately according to the nominal sizes of coarse aggregates. For fine aggregates, separate stacks shall be made.
- b) Aggregates shall be stacked on a hard surface so as to exclude the possibility of soil or grass being mixed up. When stacked in close proximity, the stock piles shall be separated by bulk heads to prevent the different sizes of aggregates from mixing together. Special care shall be taken to clean and wash the last layer of aggregates in contact with ground surface before use.
- c) Before batching, the aggregates shall have been stock piled for at least 24 hours to allow for draining of water, if any. The Contractor shall make adequate provision for stock piling aggregates to the extent sufficient to meet the needs of the work taking into account the availability of supplies and rates of delivery etc. and nothing extra shall be paid for necessary double handling and transport of materials from stock piles to mixing plant etc.
- d) Grading of coarse and fine aggregate shall be checked as per clause 16.1 under quality control to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the mix design.

6.3 MIX DESIGN

6.3.1 The concrete mix shall be got designed by the Contractor in the material testing laboratory (approved by AAI/Govt. institutions i.e., IITs, NITs, Govt. Engg. Colleges) or in-house by Department of Structure as directed by the Engineer-In-Charge so as to obtain the target average flexural strength. The margin over characteristic strength is as below:

Characteristic flexural strength (beam) at 28 days, (f_{cr}) = 4.1 MPa Normal

variate for the desired confidence level, (Z) = 1.65

Assumed value of Standard Deviation, (s) = 0.4 MPa

Target average flexural strength at 28 days, $f'_{cr} = f_{cr} + 1.65 \times s$

$$f'_{cr} = 4.1 + 1.65 \times 0.4$$

$$= 4.76 \text{ MPa}$$

Say, 4.8 MPa

Water cementitious ratio by weight = 0.45 (Maximum)

Slump = 25 ± 15 mm for slip/fixed form paver
= 40 ± 10 mm for manual method

Any change in the source of materials or mix proportions including change of brand of cement proposed by the Contractor during the course of work shall be assessed by making laboratory trial mixes and same shall be incorporated in work with written approval of concerned Engineer-In-Charge.

In case services of Department of Structure, AAI is utilized for mix design and other testing if any, contractor shall be charged extra as per prevalent charges and same shall be deducted from contractor bills. Contractor quoted rates shall be deemed to be inclusive of same and nothing extra shall be payable.

6.3.2 The quantity of cement, type of cement and super plasticizer for one Cum. of finished concrete specified in the item are for tendering purpose only. Necessary cost adjustment shall be done as per formula laid down below:-

6.3.2.1 OPC 43 grade of Cement:

If the actual quantity of OPC 43 grade of Cement required as per laboratory mix design varies from 360 Kg/Cum, necessary cost adjustment for deviation in the quantity of OPC 43/53 grade of Cement shall be done as per the rate of OPC 43/53 grade of Cement in actual supply voucher from manufacturer/authorized dealer at the time of execution. In the case of authorized dealer the rate may be authenticated by the manufacturer. The rate of OPC 43/53 grade of Cement exclusive of GST shall only be considered for payment. In no case quantity of OPC 43/53 grade of cement shall fall below 330 Kg/Cum. Extra payable/deductible rate shall be calculated in following manner:

Cost of OPC 43/53 grade of Cement above/below 360Kg/Cum : 'X'

Add 1% Water Charges on 'X'

Add 15% CP & OH on total adding 1% water charges

Add 1% labour Cess on total after adding 15% CP & OH : Say 'A'

6.3.2.2 Portland Pozzolana Cement or Portland Slag cement:

If the actual quantity of Portland Pozzolana Cement or Portland Slag cement required as per laboratory mix design varies from 400 Kg/Cum, necessary cost adjustment for deviation in the quantity of Portland Pozzolana Cement or Portland Slag cement shall be done as per the rate of Portland Pozzolana Cement or Portland Slag cement in actual supply voucher from manufacturer/authorized dealer at the time of execution. In the case of authorized dealer the rate may be authenticated by the manufacturer. The rate of Portland Pozzolana Cement or Portland Slag cement exclusive of GST shall only be considered for payment. In no case quantity of Portland Pozzolana Cement or Portland Slag cement shall fall below 330 Kg/Cum. Extra payable/deductible rate shall be calculated in following manner:

Cost of Portland Pozzolana Cement or Portland Slag cement above/below
400Kg/Cum : 'X'

Add 1% Water Charges on 'X'

Add 15% CP & OH on total adding 1% water charges

Add 1% labour Cess on total after adding 15% CP & OH : Say 'A'

6.3.2.3 SUPER PLASTICIZER

If the actual percentage of Super plasticizer by mass of cementitious material varies from 0.5%, Extra payable/ deductible rate shall be calculated in following manner:

Extra/ less cost of super plasticizers over or below 0.5% of cementitious material
: 'X'

Add 1% Water Charges on 'X'

Add 15% CP & OH on total adding 1% water charges

Add 1% labour Cess on total after adding 15% CP & OH : Say 'A'

The rate of super plasticizers shall be as per actual supply voucher from manufacturer/authorized dealer at the time of execution. In the case of authorized dealer the rate may be authenticated by the manufacturer. The rate of super plasticizer exclusive of GST shall only be considered for payment.

6.3.3 At the time of tendering, the Contractor, after taking into account the type of aggregates, plant and method of laying he intends to use, shall allow in his tender for aggregate/cement and water cement ratios which he considers will achieve the specified strength. These ratios shall, however, not exceed the ratios stipulated in para 3.1 and shall produce a workability, which shall enable concrete to be properly compacted to its full depth and finished to the surface tolerance specified.

6.3.4 No concrete shall be laid nor any payment made thereof unless the concrete mix design is submitted by the Contractor and is approved by the concerned Engineer-In-Charge and communicated in writing. This mix design shall be provisional and subject to obtaining satisfactory results with trial mixes. Final approval shall be issued only after getting the satisfactory test report from trial mixes.

6.3.5 Laboratory charges for mix design, cost of materials, its cartage and other incidental expenses shall be borne by the Contractor.

6.3.6 Guidelines for Cement Concrete Mix Design for Pavements can be followed as per IRC: 44 -2017 and SP: 23-1982.

6.4 FIELD TRIAL MIXES

6.4.1 Preliminary trial mixes shall be made and tested. Trial mixes shall also be made if a change is intended subsequently in the source of supply of materials/quality of materials or in the proportions of the materials to be used.

6.4.2 Samples of concrete shall be taken at the concrete batching plant and work beams made, cured and tested in accordance with IS: 1199 and IS: 516, as per clause 6.4.3 given below.

- 6.4.3** Representative samples of materials to be used shall be taken and trial mix using the proposed proportions shall be made, two samples each on three different days. Each sample shall consist of 6 beam specimens, three for testing at 7 days and three at 28 days and a total of 36 beams shall be made in three days. The workability of each of these six trial mixes shall be determined. The test strength of the sample shall be the average strength of 3 specimens but individual variation should not be more than +15%. Otherwise, new trial mix corresponding to the initially approved sample will have to be made. The proposed mix proportion shall not be accepted if the average of 28 days beam strength of 6 trial mixes is not satisfying the provisions as per para 6.16.4.1. The mix shall be suitably modified if the strength do not meet the criteria as specified.
- 6.4.4** The mix design shall be got approved from concerned Engineer-In-Charge. The design mix, thus approved shall be intimated to the Contractor by the Engineer-in-Charge with full data and clear understanding that the mix proportion specified is provisional subject to the verification of level of control at the site.
- 6.4.5** 30 beams and 30 cubes shall be cast for deriving the relationship between flexural strength and compressive strength i.e. K-value, by the Engineer-In-Charge and the same shall be got approved from concerned General Manager Engg (Project)/work. This K-value shall be used for calculation of required core strength in clause 6.16.4.3.
- 6.4.6** During the progress of work, samples of concrete shall be taken at the concrete batching plant and work beams made, cured and tested in accordance with IS:1199 and IS: 516. Acceptance criteria for this shall be as per para 6.16.4.1.
- 6.4.7** All samples for tests shall be taken in the presence of the Engineer-in-charge and the contractor or their authorized representatives.

6.5 SLUMP TEST

- 6.5.1** Slump tests shall be carried out as per IS: 1199 (latest revision). A slump test shall be carried out as per clause 16.1 under quality control or more and frequently, if directed by the Engineer-in-Charge. Any batch from which slump test is being made shall not be transferred to the place of laying till the slump test has been completed and result approved. Not only the batch which gives a slump in excess of that specified shall be rejected but the concrete already laid immediately preceding the batch tested up to the nearest last transverse joint may be rejected by the Engineer-in-Charge or his representative, if he is satisfied that such preceding batches were sub-standard in this respect. The decision of the Engineer-in-Charge in this respect shall be final and binding on the contractor. Such rejected concrete shall be removed by the Contractor immediately and replaced with proper concrete at his own cost and expense.

6.6 BATCHING AND MIXING OF CONCRETE

- 6.6.1** A system approach should be adopted for construction of pavement, and the method statement for carrying out the work, detailing all the activities including indication of time cycle, equipment, personnel etc. shall be got approved from the Engineer-in-Charge before the commencement of work. The above shall include the type, capacity and make of batching and mixing plant beside the hauling arrangement and paving equipment. The capacity of paving equipment, batching plant as well as all the ancillary equipment shall be adequate for a paving requirement for day's work.
- 6.6.2** Batching and mixing of the concrete shall be done at a central batching and mixing plant of adequate capacity as per work program with automatic controls, located at suitable place which takes into account sufficient space for stock piling of cement, aggregate and stationary water

tanks. This shall be however, situated at an approved distance, duly considering the properties of the mix and transport arrangements available with the contractor.

- 6.6.3** Proportioning of a material shall be done in the batching plant by weight, each type of material being weighed separately. The cement from the bulk stock may be weighed separately from the aggregates and water shall be measured by volume. Wherever properly graded aggregate of uniform quality cannot be maintained as envisaged in the mix design the grading of aggregates shall be controlled by appropriate blending techniques. The capacity of batching and mixing plant shall be at-least 25% higher than the proposed capacity for the laying/ paving equipment.
- 6.6.4** The batching plant shall include preferably four bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk (after opening bags on platform) a separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dust during operation. Approved safety devices shall be provided and maintained for the protection of all personnel engaged in plant operation, inspection and testing. The batch plant shall be equipped with a suitable non resettable batch counter which will correctly indicate the number of batches proportioned.
- 6.6.5** Bins preferably with four adequate separate compartments shall be provided in the batching plant.
- 6.6.6** Batching plant shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices using load cells. The weighing device shall have an accuracy within + 1% in respect of quantity of cement and water and + 2% in respect of aggregates and accuracy shall be checked at least once a month.
- 6.6.7** Mixers shall be pan type, reversible type with single or twin shaft or any other mixer capable of combining the aggregates, cement and water into a thoroughly mixed and uniform mass within the specified mixing period and of discharging the mix without segregation. Each stationary mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The device shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device the mixer may be used for the balance of the day while it is being repaired provided that each batch is mixed for 90 seconds or as per the manufacturer's recommendation. The mixer shall be equipped with a suitable non resettable batch counter which shall correctly indicate the number of batches mixed.
- 6.6.8** The mixer shall be cleaned at suitable intervals. The pickup and throw over blades in the drum or drums shall be repaired or replaced when they are worn down 20mm or more. The contractor shall have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth or provide permanent marks on blade to show points of 20mm wear from new conditions. Drilled holes of 5mm diameter near each end and at mid-point of each blade are recommended. Batching plants shall be calibrated for the each ingredients up to its maximum quantity being used in the mix at site in the beginning and thereafter at suitable interval not exceeding one month.
- 6.6.9** Air-conditioned centralized computer control cabin shall be provided for automatic operation of the equipment.
- 6.6.10** The design feature of the batching plant should be such that it can be shifted quickly.
- 6.6.11** Concrete mixed as above is not to be modified by the addition of water or otherwise in order to

facilitate handling or for any other purpose.

6.7 PAVING EQUIPMENT

6.7.1 The concrete shall be placed with Slip Form Paver/Fixed form paver (with independent units to spread, consolidate from the mould, screed and float-finish, texture and cure) or Manual method as per the item/as approved by Engineer-in-Charge. If the concrete is to be laid by slip form paver, the paver shall be equipped with electronic controls to control the line and grade from either one side or both sides of the machine.

6.7.2 Vibrators shall operate at a frequency and spacing recommended by the manufacturer. The variable vibration setting shall be provided in the machine.

6.7.3 The contractor shall provide adequate no. of concrete saws with sufficient no. of diamond edge saw blades. The saw machine shall be either electric or petrol/ diesel driven type. A water tank with flexible hose and pump shall be made available for this activity on priority basis. The contractor shall have at least one standby saw in good working condition. The concreting work shall not commence if the saws are not in working condition.

6.7.4 Guide wires for Slip form Paver

- a) Guide wire shall be provided along both sides of the slab. Each guide wire shall be at a constant height above and parallel to the required edge of the slab as described in the contract/drawing within a vertical tolerance of + 2 mm. Additionally, one of the wires shall be kept at a constant horizontal distance from the required edge of the pavement as indicated in the contract /drawing within a lateral tolerance of +10mm.
- b) The guide wires shall be supported on stakes 5-6 meters apart by connectors capable of fine horizontal and vertical adjustment. The guide wire shall be tensioned on the stakes so that a 500 grams weight shall produce a deflection or not more than 20mm when suspended at the midpoint between any pair of stakes. The ends of guide wire shall be anchored to fixing point or winch and not on the stakes.
- c) The stakes shall be positioned and the connectors maintained at their correct height and alignment 12 hrs. on the day before concreting takes place until 12 hrs. after finishing of the concrete. The guide wires shall be checked and tensioned on the connectors at any section at least 2 hrs. before concreting that section.
- d) The contractor shall submit to the Engineer-In-Charge for his approval of line and level, the stakes and connectors which are ready for use in the length of pavement to be constructed next day. Such approval shall be obtained at least 12 hrs. before commencement of paving operation. Any deficiencies noted by the Engineer-in-Charge shall be rectified by the contractor who shall then reapply for approval of the affected stakes. Work shall not proceed until the Engineer-in-Charge has given his approval. It shall be ensured the stakes and guide wires are not affected by the construction equipment when concreting is in progress.

6.7.5 Side Forms and Rails for Fixed form paver

- a) All side forms shall be of mild steel channels of depth equal to the thickness of pavement

or slightly less to accommodate the surface irregularity of the sub base. The forms can be placed in series of steel packing plates or shims to take care of irregularity of sub base. They shall be sufficiently robust and rigid to support the weight and pressure caused by a paving equipment.

- b)** Side forms for use with wheeled paving machines shall incorporate metal rails firmly fixed at a constant height below the top of the forms. The forms and rail shall be firmly secured in position by not less than 3 stakes/pins for every 3 meter length so as to prevent movement in any direction. Forms and rails shall be straight within a tolerance of 3 mm in 3 meter and when in place shall not settle in excess of 1.5 mm in 3 meter while paving is being done. Forms shall be cleaned and oiled immediately before each use.
- c)** The forms shall be bedded on a continuous bed of low moisture content lean cement mortar or concrete and set to the line and levels shown on the drawings within tolerances of + 10 mm and + 2 mm respectively. The bedding shall not extend under the slab and there shall be no vertical step between adjacent forms of more than 2 mm. The forms shall be got inspected by the Engineer-in-Charge for his approval 12 hrs. before construction of the slab and shall not be removed until at least 12 hrs. Afterwards. No concreting shall commence till form work has been approved by the Engineer-in-Charge.
- d)** At all times sufficient forms shall be used and set to the required alignment for required length of pavement immediately in advance of the paving operations, or the anticipated length of pavement to be laid within the next 24 hrs.
- e)** Forms shall be fixed in advance as per specifications. Before any paving is done the site shall be shown to the Engineer-in-Charge in order to verify the arrangement for paving as per the relevant clauses of this specification. The mixing and placing of concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the pavement.

6.7.6 Steel Forms for Manual Method

- a)** Manual method may be adopted where execution with slip form paver is not feasible. All side forms shall be of mild steel. The steel forms shall be of mild steel sturdy channels sections and their depth shall be equal to the thickness of the pavement.
- b)** The side forms shall have a length of at least 3.0 meters except on curves of less than 45 meters radius where shorter length may be used. When set to grade and stacked in place the maximum deviation of the top surface of any section from a straight line shall not exceed 2 mm in the vertical plane and 5 mm in the horizontal plane. The method of connection between sections shall be such that the joint formed shall be free from difference in level, play or movement in any direction. The use of bent, twisted or worn out forms will not be permitted. At least three stake pickets for each 3.0 m of form and the bracing and support must be ample to prevent springing of the forms under the pressure of concrete or the weight or thrust of machinery operating on the forms.
- c)** The supply of forms shall be sufficient to permit their remaining in place for 12 hrs. after the concrete has been placed or longer, if in the opinion of the Engineer– in-Charge, it is necessary.
- d)** The top line of the forms is not to vary from the correct level or alignment and the levels

and alignment of the forms are to be checked and corrected as necessary immediately prior to the placing of concrete. The top edges and faces of the forms are to be carefully cleaned and maintained in clean condition.

- e) While removing the steel forms, care shall be taken to withdraw them gradually. Any damages to the bull nosed edges shall be made good while the concrete is still green, as directed by the Engineer-in- Charge.
- f) Setting of forms shall be according to the slab plan subject to the approval of the Engineer-in-Charge and concreting shall not commence until the setting of forms is approved.
- g) Forms shall be set at least 50 meters length in advance of the point where the concrete is being laid and shall not be removed until at least 12 hrs. of the placing of concrete or longer if in the opinion of Engineer- in-Charge, it is necessary. After setting, the working faces shall be thoroughly oiled using approved oil but before concrete is placed against them.
- h) Sufficient rigidity shall be obtained to support the forms in such a position during the entire operation of compaction and finishing that they will not at any time deviate more than 3 mm from a straight edge 3 meters in length. Forms which show a variation from the required rigidity or the alignment and levels shown on the plans, shall be reset or removed, as directed. The length and number of pins or stakes shall be such as to maintain the forms at the correct line and grade. All forms shall be cleaned and oiled each time before they are used.

6.8 HAULING AND PLACING OF CONCRETE

6.8.1 Freshly mixed concrete from the central batching and mixing plant shall be transported to the paver site by means of tippers/transit mixers of sufficient capacity and approved design in sufficient numbers to ensure a constant supply of concrete. Cover shall be used for protection of concrete against the weather. While loading the concrete, truck shall be moved back and forth under the discharge chute to prevent segregation. The tipping trucks shall be capable of maintaining the mixed concrete in a homogeneous state and discharging the same without segregation and loss of cement slurry. The feeding to the paver is to be regulated in such a way that paving is done in an uninterrupted manner with a uniform speed throughout the day's work. Tipping truck shall be washed at a regular frequency as prescribed by the Engineer-in-Charge to ensure that no leftover mix of previous loading remains stuck.

6.8.2 Concrete mixed in central mixing plant shall be transported to the site without delay and the concrete which in the opinion of Engineer-in-Charge, has been mixed too long before laying will be rejected and shall be removed from the site. The total time taken from the addition of water to the mix until the completion of surface finishing and texturing shall not exceed 120 minutes when concrete temperature is less than 25°C and 90 minutes when concrete temperature is between 25°C to 30°C. Tippers/transit mixers delivering concrete shall not run on completed slabs until after 28 days of placing of concrete.

6.8.3 In all cases the temperature of the concrete shall be measured at the point of discharge from the delivery vehicle.

6.8.4 The addition of water to the surface of the concrete to facilitate the finishing operations will not be permitted except with the approval of the Engineer-in-Charge when it shall be applied as a

mist by means of approved equipment.

6.8.5 If considered necessary by the Engineer-in-Charge, the paving equipment shall be provided with approved covers to protect the surface of the slab under construction from direct sunlight and rain or hot wind.

6.8.6 As soon as the side forms are removed, edges of the slabs shall be corrected wherever irregularities have occurred by using fine concrete composed of 1:1:2, cement: sand: coarse aggregate (10 mm down) with water cement ratio not more than 0.4 under the supervision of Engineer-in-Charge.

6.8.7 If the requirement for surface regularity fails to be achieved on two consecutive working days then normal working shall cease until the cause of the excessive irregularity has been identified and remedied.

6.8.8 Construction by Slip Form Paver: The slip form paving train shall consist of power machines which spreads compacts and finishes the concrete in a continuous operation.

- a) The slip form paving machine shall compact the concrete by internal vibration and shape it between the side forms with either a conforming plate or by vibrating and oscillating finishing beams. The concrete shall be deposited without segregation in front of slip form paver across the whole width and to a height which at all times is in excess of the required surcharge. The deposited concrete shall be struck off to the necessary average and differential surcharge by means of the strike off plate or a screw auger device extending across the whole width of the slab. The equipment for striking-off the concrete shall be capable of being rapidly adjusted for changes of the average and differential surcharge necessitated by change in slab thickness or cross fall.
- b) The level of conforming plate and finishing beam shall be controlled automatically for the guide wires installed by sensors attached at the four corners of the slip form paving machine. The alignment of paver shall be controlled automatically from the guide wire by at least one set of sensors attached to the paver. The alignment and level of ancillary machines for finishing, texturing and curing of the concrete shall be automatically controlled relative to the guide wire or to the surface and edge of an adjoining hardened slab.
- c) Slip form paving machines shall have vibrators of variable output with a maximum energy output of not less than 2.5 KW per meter width of slab per 300 mm depth of slab for a laying speed up to 1.5 m per minute or pro-rata for higher speeds. The machine shall be of sufficient mass to provide adequate reaction during spreading and paving operations on the traction units to maintain forward movements during the placing of concrete in all situations.
- d) If the edges of the slip formed slab slump to the extent that the surface of the top edge of the slab does not comply with the requirements, then special measures approved by the Engineer-in-Charge shall be taken to support the edges to the required levels and work shall be stopped until such time as the contractor can demonstrate his ability to slip form the edges to the required levels. The slumped edge shall have to be corrected by adding fresh concrete after roughening the surface.

- e) Upon the instructions of the Engineer-in-Charge, contractor shall scrape the concrete

surface when in plastic state with a 3.0 m long tube float fixed with a long and stable handle before texturing. Tube float shall be of an alloy steel tube of 50-60 mm diameter with a long and stable handle. The length of the tube float shall preferably be longer than half the length of slab i.e., half the distance between two transverse contractions joints. This operation shall be done to minimize surface irregularity caused due to varied causes like frequent stoppage of work, surface deformation due to plastic flow etc. The tube float shall be placed at the center of the slab parallel to longitudinal joint and pulled slowly and uniformly towards the edges. After the use of the float tube, it shall be frequently cleaned before further use. The slurry removed shall be discarded. This activity shall be advanced laterally by providing an overlap of half the length of two float. The removal of the cement slurry from the surface shall be sufficient enough such that the texture is formed on a firm surface and is more durable. This operation however, shall be carried out after removing bleeding water.

- f) In the case of construction by slip form paver, areas inaccessible to paving equipment shall be constructed by manual/hand guided method. Areas in which manual/hand guided methods of construction become indispensable shall be got approved by the Engineer-in-Charge in writing in advance. Work shall be carried out by skilled personnel as per methods approved by the Engineer-in-Charge. For construction by hand guided method in the limited area, no cost adjustment will be made.

6.8.9 Construction by Fixed Form Paver: The fixed form paving train shall consist of separate powered machines which spread compact and finish the concrete in a continuous operation. The paving train moves on the rails fixed on both sides of the pavement and compacting/finishing is simultaneously carried with the equipment fitted with paving train which moves on the rails.

- a) The concrete shall be discharged without segregation into a hopper of the spreader which is equipped with means for controlling its rate of deposition onto the sub-base. The spreader shall be operated to strike off concrete upto a level requiring a small amount of cutting down by the distributor of the spreader. The distributor of spreader shall strike off the concrete to the surcharge adequately to ensure that the vibratory compactor thoroughly compacts the layer. If necessary poker vibrator shall be used adjacent to the side forms and edges of the previously constructed slab.
- b) The vibratory compactor shall be set to strike off the surface slightly high so that it is cut down to the required level by the oscillating beam. The machine shall be capable of being rapidly adjusted for changes in average and differential surcharge necessitated by changes in slab thickness or cross fall. The final finisher shall be capable to finish the surface to the required level and smoothness as specified, care being taken to avoid bringing up of excessive mortar to the surface by over working.
- c) In the case of construction by fixed form paver, areas inaccessible to paving equipment shall be constructed by manual/hand guided method. Areas in which manual/hand guided methods of construction become indispensable shall be got approved by the Engineer-in-Charge in writing in advance. Work shall be carried out by skilled personnel as per methods approved by the Engineer-in-Charge. For construction by hand guided method in the limited area, no cost adjustment will be made.

6.8.10 SURFACE TEXTURE

6.8.10.1 Surface of the pavement shall be finished for the newly constructed concrete pavements such that texturing equipment shall not tear or unduly roughen the concrete surface during the operation. The texture shall be uniform in appearance and approximately

2.0mm in depth. Brush shall be applied when the water sheen has practically disappeared and the surface of concrete shall be brush-textured in a direction at right angles to the longitudinal axis of the carriageway to get satisfactory texture.

6.8.10.2 The texture depth shall be determined by the Sand Patch Test as described below. This test shall be performed at least once for each day's paving and wherever the Engineer-In-Charge considers it necessary at times after construction as under:

6.8.10.3 Five individual measurements of the texture depth shall be taken at least 2m apart anywhere along a diagonal line across a lane completed between points 50m apart along the pavement. No measurement shall be taken within 300mm of the longitudinal edges of a concrete slab constructed in one pass.

6.8.10.4 Measurement of Texture Depth – Sand Patch Method

The following apparatus shall be used:

i) A cylindrical container of 25 ml internal capacity.

ii) A flat wooden disc 64mm diameter with a hard rubber disc, 1.5mm thick, stuck to one face, the reverse face being provided with a handle.

iii) Dry natural sand with a rounded particle shape passing a 300 micron IS sieve and retained on a 150 micron IS sieve.

Method: The surface to be measured shall be dried, any extraneous mortar and loose material removed and the surface swept clean using a wire brush both at right angles and parallel to the carriageway. The cylindrical container shall be filled with the sand, tapping the base 3 times to the surface to ensure compaction, and striking off the sand level with the top of cylinder. The sand shall be poured into a heap on the surface to be treated. The sand shall be spread over the surface, working the disc with its face kept flat in a circular motion so that the sand is spread into a circular patch with the surface depressions filled with sand to the level of peaks. The diameter of the patch shall be measured to the nearest 5mm. The texture depth of concrete surface shall be calculated from $31000/(D \times D)$ mm where D is the diameter of patch in mm.

6.8.10.5 Texture depth shall not be less than a minimum required when measurements are taken as given in table nor greater than a maximum average of 1.25 mm.

TABLE : TEXTURE DEPTH

S No.	Time Test	Number of measurements	Required Texture Depth (mm)	
			Specified value	Tolerance
1.	Between 24 Hrs. and 7 days after the construction of the slab or until the slab is first used by vehicles.	An average of 5 Measurements	1.00	±0.25

2.	Not later than 6 weeks before the pavement is opened to traffic.	An average of 5 Measurements	1.00	±0.25
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6.8.10.6 After the application of the brushed texture, the surface of the slab shall have a uniform appearance.

6.8.10.7 Where the texture depth requirements are found to be deficient, the Contractor shall make good the texture across the full lane width over length directed by the Engineer-in-Charge, by texturing the hardened concrete surface in an approved manner.

6.9 CONSTRUCTION BY MANUAL/HAND GUIDED METHOD:

The pavement shall be constructed using side forms. The acceptance criteria regarding level, thickness, surface regularity, texture, finish strength of concrete and all other quality control measures shall be the same as in the case of machine laid down.

6.9.1 Placing of Concrete:

6.9.1.1 Concrete shall be deposited between the forms. Where a certain amount of redistribution is necessary, it shall be done with shovels and not with rakes. The concrete shall be compacted with the needle vibrator and vibrating screeds. Use of vibrator near side forms is essential to eliminate honey combing. To effect adequate compaction, the concrete shall be placed with appropriate surcharge over the final slab thickness. The amount of surcharge will depend upon the mode of placement of concrete and shall be determined by trial. In general, the required surcharge is about 20% of the required slab thickness.

6.9.1.2 The concrete is to be deposited and spread to such a depth that when compacted and finished, the slab thickness indicated will be obtained at all points and the surface will not at any point be below the level specified for the finished surface.

6.9.2 Compaction of Concrete

- a) Compaction shall be carried out by electrically operated needle and screed vibrators as stipulated hereafter. Needle vibrators should be used all over the area for obtaining initial compaction of concrete. These should be of diameter not less than 4.5 cm and if the vibrators are pneumatic, the pressure must not be below 4 kg/sq.cm. If electrically operated, they should have a minimum frequency of 3500 impulses per minute. Minimum number of petrol driven vibrators as specified by the Engineer-in-Charge with minimum frequency of 3500 impulses per minute shall be provided at each work head as a standby arrangement. The screed and internal vibrator shall conform to I.S.:2505 and I.S.: 2506 respectively.
- b) There should be at least three needle vibrators working in one bay. A vibrating screed consisting of a steel or timber section weighing not less than 15 kg per meter with a tamping edge of not less than 7 cm width and having a vibrator mounted thereon shall follow needle vibrators to obtain full compaction. The face of the wooden tamping edge of the screed shall be lined with M.S. plate rigidly fixed by means of counter sunk screws. Where screed vibrators are used for compaction, a standby unit shall always be

maintained ready for use, should the other one go out of order. Where electrically driven vibrators are employed, a stand by pneumatic unit shall be kept ready for use in case of power failure. At the discretion of the Engineer-in-Charge, for compaction at edges and joints, vibrators may be supplemented by hand tamping and rodding for securing satisfactory results. Under no circumstances, honey combing of concrete at joints or elsewhere shall be permitted.

- c) When using screed vibrator for compaction, it should not be dragged over the concrete. During the initial passes, it shall be lifted to the adjacent forward position in the steps. Subsequently, it shall be slowly slid over the surface with its axis slightly tilted away from the direction of sliding and the operation repeated until a close, dense surface is obtained.
- d) Work men shall not be allowed to walk on freshly laid concrete. All operations shall be carried out from suitable wooden bridges spanning the lane-width.
- e) **IMPORTANT PRECAUTION:** The vibration process shall be restricted just up to the stage of appearance of water/ cement slurry on the surface. After reaching this point vibration should be discontinued. It should be ensured that no over-vibration is resorted, as it leads to formation of thin cement slurry layer over the top surface which tends to peel off with passage of time by movement of traffic.

6.9.3 Finishing of Concrete

- a) Immediately after compacting of concrete and the construction of joints but before the concrete has hardened and while the concrete is still in a plastic state, the pavement surface shall be inspected for irregularities with a profile checking template and minor irregularities and score marks shall be eliminated by removing surplus material or by adding and working in freshly mixed concrete if necessary by means of long handled floats and scraping straight edges followed by further compaction and finishing. The long handled floats may be used to smoothen and fill in open textured area in the pavement surface, but the final finishing is to be done with scraping straight edges.
- b) The scraping straight edges are to be 3 meters long with flexible handles long enough to reach the other side of the slab when operated from one side of the pavement. They are to be placed parallel to the forms at the side of the pavements and worked backwards and forwards uniformly across the width of the slab. After this operation has been completed and the surface has been brought to the required finish, the straight edge is to be moved forward but not more than half its length and the process repeated.
- c) The straight edge testing and refloating is to continue until the entire surface:
 - (i) Is free from observable departure from the straight edge.
 - (ii) Conforms to the required levels and cross-section.
 - (iii) Conforms to the specified surface finish when the concrete has hardened.
- d) The foregoing work is to be carried out while the concrete is still plastic and workable and in such time sequence so as to ensure the removal of water and laitance from the surface.

6.9.4 BELTING

Just before the concrete becomes non-plastic, the surface shall be belted with two ply canvas belt not less than 20 cm wide and at least 1 meter longer than the width of the slab. Hand belts shall have suitable handles to permit controlled uniform manipulation. The belt shall be operated with short strokes transverse to the center line of pavement and with a rapid advance parallel to the concrete line.

6.9.5 BROOMING

- a) After belting and as soon as surplus water, if any, has risen to the surface, the pavement shall be given a broom finish with an approved steel or fiber broom not less than 45 cm wide. The broom shall be pulled gently over the surface of the pavement from edge to edge. Adjacent strokes shall be slightly overlapped. Brooming shall be perpendicular to the centre line of the pavement and so executed that the corrugations formed will be uniform in character and width and not more than 2.0 mm deep.
- b) Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions and small pockets such as may be caused by accidental disturbing of particle of coarse aggregates embodied near the surface. The rate of the contractor for the item of quality controlled concrete pavement includes the provision for belting and brooming operations and nothing extra shall be paid on this account.

6.9.6 EDGING

After belting/ brooming has been completed but before the initial setting of concrete, the edges of the slab shall be carefully finished with an edging tool of 6 mm radius, and the pavement edges shall be left smooth and true to line.

6.9.7 HONEY COMBING

As soon as the side forms are removed, any minor honey combed areas shall be filled with mortar composed of one part of cement and two parts of fine aggregate. Major honey combed areas or segregated concrete or other defective work or areas damaged by removal of the forms or concrete damaged by rain or due to any other reason whatsoever shall be considered as defective work and shall be removed and replaced by the contractor at his own expense. The total area of honey combed surface not exceeding 2.5 sq.cm. each, shall not exceed 4% of the area of the slab side. Engineer in charge's decision as to whether the concrete is defective or not shall be final and binding.

6.10 SURFACE ACCURACY

- 6.10.1 After the concrete has sufficiently hardened after about 12 hours and not later than 24 hours, the surface shall be tested again for high spots. All high spots shall be marked and those exceeding 3 mm shall be ground down immediately as directed by the Engineer-in-Charge after obtaining his written permission. Care shall be taken to see that the grinding does not in any way damage the concrete surface.
- 6.10.2 The final surface finish is to be such that when tested with a profilograph/ roughness indicator/ or a 3 meter long straight edge or an equivalent mechanical unevenness indicator placed anywhere within the same or adjoining slab in any direction on the surface,

there shall be no variation greater than 3mm.

6.10.3 If the surface irregularities exceeding 3 mm still remains despite grinding if permitted, as per para 10.1 the concrete shall be removed to its full depth and replaced. The area of concrete to be removed shall be complete slab between the nearest joints. Where the defective slab is less than 4.5 meter from the construction joint, the whole area upto the construction joint shall be removed to the full depth. The concrete so removed shall not be reused in the work. Fresh concrete shall be laid in the manner already described in these specifications and shall again be subjected to test for surface accuracy and other quality control measures. Nothing extra shall be paid for all these operations.

6.10.4 Every slab shall bear an impression not exceeding 3 mm in depth comprising the number allotted to the slab and the date on which it is laid. This impression shall be formed by the Contractor when the concrete is green so as to leave permanent mark on setting.

6.11 CURING OF CONCRETE

Initial curing shall be done by application of curing compound or by manual method as per clause 16.37.13.5 of CPWD specifications Vol-II, 2009. However nothing extra shall be paid for curing by application of curing compound.

6.11.1 Initial Curing by application of Curing Compound:

- a) Immediately after the surface texturing, the surface and sides of the slab shall be cured by the application of approved resin-based aluminized reflective curing compound or white pigmented curing compound which hardens into an impervious film or membrane with the help of a mechanical sprayer.
- b) Curing compounds shall contain sufficient flake aluminium in finely divided dispersion to produce a complete coverage of the sprayed surface with a metallic finish. The compound shall become stable and impervious to evaporation of water from the surface of the concrete within 60 minutes of application and shall be of approved type. The curing compounds shall have a water retention efficiency index not less than 90 percent in accordance with BS Specifications No.7542 or as per ASTM C-309-81 Type 2.
- c) The curing compound shall not react chemically with the concrete and the film or membrane shall not crack, peel or disintegrate within three weeks after application. Immediately prior to use, the curing compound shall be thoroughly agitated in its containers. The rate of spread shall be in accordance with the manufacturer's instructions checked during the construction of the trial length and subsequently whenever required by the Engineer-in-Charge. The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound during spraying. Arrangements should be made to spray the curing compound on the sides of the slab. The curing compound shall be sprayed in two applications to ensure uniform spread. In addition to spraying of the curing compound, the fresh concrete surface shall be protected for at least 3 hours by covering the finished concrete pavements with tents supported on mobile truss during adverse weather conditions as directed by the Engineer-in-Charge.

6.11.2 FINAL CURING

Final curing shall be done either by spreading of wet hessian and moisturing it regularly or by ponding method as given below. However, nothing extra shall be paid for curing by spreading wet hessian method. All joints shall be filled in with temporary filler like sand etc. in order to prevent the edges of joints from being damaged and entry of clay materials into the joints during final curing.

a) Final curing by spreading of wet hessian method

After two or three hours after application of curing compound, the pavement shall be covered including sides by moist hessian (minimum of two layers) and the same shall then be kept damp for a minimum period of 14 days after which time the hessian may be removed. During the curing period, the hessian shall be kept continuously moist.

All damaged/torn hessian shall be removed and replaced by new hessian on a regular basis.

b) Final curing by ponding method

After two to three hours after application of curing compound or upon removal of the burlap as the case may be, the slab shall be thoroughly wetted and cured by ponding as follows:

Exposed edges of the slab shall be banked with a substantial berm of earth. Upon the slab shall then be laid a system of transverse and longitudinal height of clay about 50 mm high immediately covered with a blanket of sandy soil free from stones to prevent the drying up and cracking of clay. The rest of slab within these boundaries shall then be covered with sufficient sandy soil so as to produce blanket of earth not less than 40mm deep after wetting. The earth covering shall be thoroughly wetted while it is being placed on the surface and against the sides of the slab and kept thoroughly saturated with water for 21 days and thoroughly wetted down during the morning of the 22nd day and shall thereafter remain in place until the concrete has attained the required strength and permission is given by the Engineer-in-Charge. Thereafter the covering shall be removed and the pavement cleaned and swept. If the earth covering becomes displaced during the curing period, it shall be replaced to the original depth and restarted.

- c) The contractor shall be liable at his cost to replace any concrete damaged as a result of incomplete curing or cracked on a line other than that of a joint as per procedure in IRC:SP-83.
- d) The Contractor shall employ his own security personnel to prevent workmen, cattle straying etc., on the pavement concrete.
- e) Concrete shall not be subjected to any load or weight of any plant until at least 28 days after laying, except for cutting the joints as directed by the Engineer-in-Charge.

6.12 CONTRACTION/DUMMY JOINTS

- 6.12.1 The spacing of transverse and longitudinal joints shall be 4.5 to 5 meter or as shown in the drawing. It shall be 10 mm wide and shall extend vertically from the surface of the slab to a depth equal to one-third depth of slab. The joint shall be formed by cutting with a joint cutting machine. **The initial cut or slot of not less than 3mm wide is to be formed by sawing the concrete with a joint cutting machine of approved design as soon as the concrete hardens. Normally in summer when ambient temperature is more than 30°C, initial cutting may be carried after 4-8 hrs. of laying and in winter when ambient temperature is less than 30°C, initial cut may be done at 8-12 hrs. of laying.** Top 25mm of this joint groove shall be subsequently widened to 10mm, after 14-16 days of casting concrete pavements. The details of Contraction/dummy joint shall be as given in Appendix –‘A’.
- 6.12.2 Before cutting the dummy joints, all necessary precautions shall be taken to ensure that the joint alignment is marked straight and true as per the drawings. The joint cutting machine will be handled only by an experienced person thoroughly familiar with this type of work. The joint should be cut along this alignment only. Any error in the joint cutting alignment shall be rectified by the Contractor at his own expense as directed by the Engineer-in-Charge, preferably using epoxy concrete as approved.
- 6.12.3 The groove shall be inserted with 12mm dia closed-cell Polyethylene foam back-up rod, 13mm below from the surface of the concrete and filling with Polysulphide Sealant conforming to grade B.S.: 5212-1990 or IS:11433-1995. Prior to filling with Polysulphide, the joints shall be cleaned by compressed air up to full depth and primed properly with appropriate Polysulphide primer up to back-up rod and masking tape shall be applied along the edges of joint to prevent spillage of sealant on top surface to give neat finish to sealant. The masking tape shall be removed after the sealant has been applied and tooled.
- 6.12.4 All joints shall be sealed as soon as practicable after 28 days of placing of slabs. Joints shall be sealed flush with the adjacent pavement surface. The pavement shall be opened to traffic only after joint sealing over the entire pavement has been completed. To prevent tackiness or pick up under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge, for which nothing extra shall be paid to the Contractor.
- 6.12.5 Each lot sealant shall be supported with manufacturer's test certificate. However one sample per 1000 kg. of sealant received at site or part thereof shall be collected by the Engineer-in-Charge or his authorized representative and sent for testing to any Government/ AAI approved Laboratory.
- The contractor shall note that as testing charges of sealant seem to be high, they shall confirm the testing charges and quote their rates accordingly. Nothing extra over and above the quoted rates is payable on this account and no plea on what so ever ground will be entertained later on.
- 6.12.6 In case of sudden rain or storm, the work can be concluded at the dummy joints but these will then be formed as construction joints.
- 6.12.7 Before sealing of joints, it may be ensured that the transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width. Any concrete or other foreign matter must be removed from the groove before sealing.

6.13 CONSTRUCTION JOINTS

- 6.13.1 Construction joints shall be provided as shown in the drawing and also at places whenever day's operations start and stops or where concreting is stopped due to unforeseen circumstances. The joints shall be straight and vertical through the full depth of the slab.
- 6.13.2 At all construction joints, bulk head shall be used to retain the concrete and care shall be taken in striking off and finishing the surface to the top face of the bulkhead. When work is resumed, the surface of concrete laid subsequently, shall conform to the grade and cross section of previously laid pavement. Where semi-mechanized method of construction is used, the concrete along the face of all joints shall be compacted with an internal vibrator inserted in the concrete and worked along the joint to ensure a concrete free from honeycombing. In case of mechanized construction, working and vibration/RPM of all the fixed vibrators shall be checked. There shall be two additional needle vibrators to compact the concrete near bulk head.
- 6.13.3 The Sealing of joints shall be done in the same manner as for contraction joints, by cutting a groove of 10mm wide and 25mm deep as shown in Appendix 'A'.

6.14 EXPANSION JOINTS

- 6.14.1 **Expansion joints are essential where cement concrete pavement is designed to abut with structures like bridges, culverts, etc. and at junction of building and pavement. Expansion joint shall also be provided at the intersection of runway, taxiway and Apron.** The expansion joint shall be straight, extend through the full depth of the slab and shall be of the shape and dimensions shown on the drawing. The slab edges adjacent to the joint shall be formed truly vertical.
- 6.14.2 Where semi-mechanized method of construction is used, the concrete along the face of all joints shall be compacted with an internal vibrator inserted in the concrete and worked along the joint to ensure a concrete free from honeycombing. In case of mechanized construction, working and vibration/RPM of all the fixed vibrators shall be checked. There shall be two additional needle vibrators to compact the concrete near bulk head.
- 6.14.3 Synthetic expansion joint filler board as per specification shall be used to fill the gap between adjacent slabs at expansion joint. The joint groove shall be filled with Polysulphide conforming to grade B.S.: 5212-1990 or IS: 11433-1995. Prior to filling with Polysulphide, the joints shall be cleaned by compressed air up to full depth and primed properly with appropriate Polysulphide primer up to back-up rod and masking tape shall be applied along the edges of joint to prevent spillage of sealant on top surface to give neat finish to sealant. The masking tape shall be removed after the sealant has been applied and tooled. The details of expansion joint shall be as given in Appendix – 'A'.

6.15 APPLICATION OF POLYSULPHIDE JOINT SEALING COMPOUND

5.15.1 Materials

- a) Sealant:** It shall be cold Polysulphide sealant of approved make conforming to BS: 5212-1990 or IS: 11433-1995.

- b) Back-up Rod/Backer Rod:** Type of material shall be Expanded closed cell Polyethylene foam and shall conform to ASTM C-5249-95 or ASTM D 3575.
- c) Primer:** It shall be applied on the concrete faces of the joints. It shall be single component primer suitable for use with Polysulphide joint sealant, as approved by the Engineer-in-Charge.
- d) Joint Filler Board:** The joint filler shall be Synthetic joint filler board of approved make. It shall be 25mm thick within a tolerance of +1.5mm and of a firm compressible material and complying with the requirements of IS:1838 (Part 3):2011 with a compressibility more than 25%. It shall be provided to the full width between the side forms. If two pieces are joined to make up full width, the joint shall be taped such that no slurry escapes to the joint. The physical requirement of filler shall be as per the table given below:

S.No	Characteristics	Requirement	Method of test, Ref. to IS
1	Resistance to handling	Filler strips shall not be deformed or broken by twisting, bending or other types of ordinary handling when exposed to atmospheric condition (see note)	-
2	Recovery	90% min.	10566
3	Compression	a) Load required to compress the specimen to 50% of its original thickness before the test shall be (i) 7 kgf/cm ² , min. (ii) 53 kgf/cm ² , max.	-do-
4	Extrusion	Amount of extrusion of the free edge shall not exceed 6mm	-do-
5	Water Absorption	1%, max.	-do-
6	Density	100 ± 10 kg/m ³ , min.	-do-
7	Weathering	a) shall show no sign of disintegration, delamination or separation after the test b) shall satisfy the requirement of recovery,	-do-

Note: Pieces of joint filler that have been damaged shall be rejected.

In order to ensure that sides of the PQC pavement in the portion of above expansion joint filler board do not get dirty and this space does not accumulate pieces of aggregates and other foreign materials, precaution is required to be taken as indicated in note 1 given below.

Note:

1. Expansion joint filler board should be provided upto the top of finished pavement surface. At the time of filling the joint with sealant material and back-up rod/baker rod, the required depth of joint filler board from the top upto the bottom of back-up rod/baker rod should be cut & removed. For easy removal of top filler board and to avoid damage to the filler board, a pre-cut in the expansion joint filler board shall be provided at a suitable depth so that back-up rod/baker rod & sealant could be filled after removal of the top cut portion of the filler board. Nothing extra shall be paid for the filler board from top upto the bottom of back-up rod/baker rod.
2. As the period for the test will be around three weeks, advance planning is required to avoid any delay on this account.

6.15.2 PROCEDURE

- a) **Preparation of Surface:** All the joint surfaces to which the sealant is to be applied should be clean, dry and free from any loose material, dirt, dust, scale, protective lacquer, grease.
- b) Expansion joint filler material must be checked to ensure that it is tightly packed and no gaps or voids exist at the base of the joint slot.
- c) Sealant should be prepared as per manufacturer's specifications.
- d) Before sealant is applied, primer shall be applied to secure better adhesion between sealant and the concrete surface. The surface shall be allowed to dry for at least 30 minutes but no longer than 3 hours before the sealant is applied.
- e) To prevent accidental spillage of sealant on the top surface and to give a neat finish, masking tape should be applied along the edge of joint before the sealant material is filled.
- f) Immediately after filling the joints, the sealant should be tooled either with a stainless steel or wooden spatula of the size of the joint to give a smooth surface. While tooling, the spatula should be wetted with a wetting agent like soap water. Masking tape shall be removed immediately after the sealant has been tooled. By tooling, the sealant is compressed with the result that air bubbles if any, are broken up and the sealant becomes free of voids and there is a proper adhesion of the sealant to the sides of the joints.

6.15.3 Sealant of approved make shall be filled only after complete curing of concrete i.e., after 28 days. Sealant shall be applied slightly to a lower level than the slab with a tolerance of 1 ± 0.5 mm as shown in Appendix – 'A'

6.15.4 Sealant of approved make shall be filled up for a depth as specified in item. The rate of application of sealant may be calculated on the basis of the following formula:

$$\text{Number of 1 Kilogram tins required} = 0.0015 \times L \times W \times D \text{ where}$$

$$L = \text{Length of joint in meters}$$

W = Width of joint in mm.

D = Depth of joint in mm.

6.15.5 Manufacturer's certificate shall be produced for establishing that the sealant is not more than six months old or the shelf-life of the sealant. For storage, preparation of sealant, health and safety precautions etc., manufacturer's specifications shall be applicable.

6.15.6 A typical sketch showing details of filling of joints is enclosed as Appendix -'A'.

6.16 QUALITY CONTROL

6.16.1 The following quality control tests shall be carried out at frequencies specified against each, as per the table given below:

S.No	Test	Test Method	Frequency	Acceptance Criteria
I	Cement			
	Physical and chemical tests	IS:4031, IS:4032	Once for each source of supply and every 200 tonnes or part thereof. Cement remaining in stores for more than one and half month from the date of manufacture must be retested before use and to be rejected, if it fails to conform to any of the requirements of the specifications. Each brand of cement brought to site shall be tested as per this frequency. Besides, the Contractor also will submit daily	As per relevant code as per Para 1.1

S.No	Test	Test Method	Frequency	Acceptance Criteria
			test report on cement released by the manufacturer.	
II	Coarse aggregate			
	a) Flakiness Index	IS:2386 (Part-I)	Before approval of the quarry and at every subsequent change in the source of supply and one test for every 2000 cum of aggregate	Not more than 25%
	b) Impact value or Los Angeles abrasion value	IS:2386 (Part-IV)	- do -	Not more than 30%
	c) Water Absorption	IS:2386 (Part III)	-do-	Not more than 3%.
	d) Deleterious materials	IS:2386 (Part II)	Before approval of the quarry and at every subsequent change in the source of supply.	As per table -2 of IS: 383
	e) Moisture content	IS:2386 (Part III)	Regularly as required subject to a minimum of one test per day	This data shall be used for correcting the water demand of the mix on a daily basis
	f) Grading	IS: 2386 (Part-	One test per	As per

S.No	Test	Test Method	Frequency	Acceptance Criteria
		I)	day on each size of aggregates	Table - 7 of IS: 383
	g) Soundness (i) Loss with Sodium Sulphate for 5 cycles (ii) Loss with Magnesium Sulphate with 5 cycles	IS 2386 (Part V)	Before approval of the quarry and at every subsequent change in the source of supply	Max. 12% Max. 18%
	(h) Presence of ferrous sulphide and iron oxide	As per clause 1.3.1	Before approval of the quarry and at every subsequent change in the source of supply.	No presence of ferrous sulphide and iron oxide
III	Fine Aggregates			
	a) Silt Content	CPWD Specification 2009 Vol. I, Page 78, Appendix –C	One test per 200 cum and part thereof	Not more than 8%
	b) Grading	IS : 2386 (Part-III)	-do-	Fineness modulus between 2.5 to 3.9
	c) Water Absorption	IS : 2386 (Part-III)	-do-	Not more than 3%
	d) Deleterious materials	IS: 2386 (Part-II)	Before approval of the quarry and at every subsequent change in the source of supply.	As per table 1 of IS 383
	e) Moisture	IS:2386 (Part-	Regularly as	This data

S.No	Test	Test Method	Frequency	Acceptance Criteria
	content	III)	required subject to a minimum of two test per day.	shall be used for correcting the water demand of the mix on a daily basis.
IV	Combined Grading of Aggregates			
	a) Grading	IS: 2386 (Part-I)	1 test per 150 cum and part thereof	As per Para 1.5
V	Concrete			
	a) Slump test of concrete	IS : 1199	At least once in 50 batches at each mixer or more frequently if directed by the EIC.	As per Para 3.1
	b) Flexural strength	IS : 516	One test consisting of six beam specimens and 6 cubes. Threespecimens shallbe tested after 7 days and another three shall be tested after 28 days for every 200 Cum of Concrete & part thereof	As per Para 16.4
	c) Surface accuracy	As prescribed	Regularly	As per Para 10
VI	Polyethylene sheet	IS:2508 Density Tensile strength at break Melt flow Index	One test per lot	As per IS:2508

6.16.2 Equipment as per list at Appendix-B shall be provided by the contractor in the field testing laboratory. Nothing extra shall be paid to him on this account. Records as required shall be maintained at site.

All test details in support of mix design shall be maintained as part of records of the contract and shall be signed both by the contractor and the Engineer-in-Charge or their authorized representatives. The contractor shall provide all labour, materials and equipment required for all tests to be carried out, at his own cost.

6.16.3 The Engineer-in-Charge reserves the right to test any concrete laid regarding quality, soundness, compaction, thickness strength and finish of the concrete at any time before the expiry of the "Defects Liability period" notwithstanding that necessary test had been carried out and found satisfactory at the time of execution.

6.16.4 QUALITY CONTROL AND STANDARD OF ACCEPTANCE OF STRENGTH OF CONCRETE

a) Samples of concrete shall be collected at the point of discharge on the pavement and beams cast as controlled specimens and tested in accordance with IS: 516 and IS: 1199. The concrete will be said to comply with the specified flexural strength, when the following conditions are met with.

(i) The mean strength determined from any group of four consecutive samples (each sample containing 3 beam specimen i.e. $4 \times 3 = 12$ beam specimens) at 28 days should exceed the specified characteristic flexural strength by at least 0.3 MPa i.e., 4.4 MPa.

(ii) The strength of any specimen is not less than the specified characteristic flexural strength minus 0.1 MPa i.e., 4.0 MPa.

b) Should the concrete fail to pass the specification for strength as described above, the contractor may, all at his own expense elect to cut cores (diameter of the core not less than 150mm) as per the direction of Engineer-in-Charge where the requirements are not met with. The points from where cores are to be taken and the number of cores required shall be at the discretion of the Engineer-in-Charge and shall be representative of the whole of concrete concerned. In no case, however, shall fewer than 3 cores be tested.

c) Cores shall be prepared and tested as described in IS 516. Concrete in the member represented by a core test shall be considered acceptable if the average of the results of crushing strength tests of the cores shall not be less than 0.8x0.85 times the corresponding Characteristic compressive strength of cubes and no individual core has a strength less than 0.8x0.75 times the corresponding Characteristic compressive strength of cubes where height to diameter ratio of the core is 2. Where height to diameter ratio of the core is not 2 necessary corrections shall be made in calculating crushing strength of cubes as per clause 12.21.1 of IRC:15-2017.

Sample calculation for required core strength is placed below for core cut with height to diameter ratio of core is 2:

Flexural strength $f_{cr} = K\sqrt{f_{ck}}$

—

$$f_{cr} = 4.1 \text{ MPa}$$

$$4.1 = K\sqrt{f_{ck}} \quad K \text{ --value as derived in clause 4.5}$$

$$f_{ck} = 16.81/K^2$$

$$\text{Average core strength required} = 0.8 \times 0.85 \times f_{ck} \text{ MPa}$$

$$\text{Individual core strength required} = 0.8 \times 0.75 \times f_{ck} \text{ MPa}$$

- d)** If however, the tests on cores also confirm that the concrete is not satisfying the strength requirements, then the concrete corresponding to the area from which the cores were cut should be replaced, i.e., over an area extending between two transverse joints where the defects could be isolated or over larger area as decided by the Engineer-in-Charge.
- e)** All defective and sub-standard work which includes concrete slab of sub-standard strength as established in above para shall be liable to rejection and shall be replaced by the contractor at his expense. Acceptance criteria for cracked concrete slabs shall be as follows (ref. clause 12.33 of IRC- 15-2017):
- (i) Fine crazy cracks (Plastic shrinkage cracks) with cumulative length of 3000mm in a slab can be accepted after repair as per IRC:SP-83. Beyond cumulative length of 3000 mm, it shall be rejected.
 - (ii) Slabs with cracks running transversely or longitudinally penetrating to full depth and length of the slab are to be rejected.
 - (iii) Slabs with any type of cracks which are penetrating to more than half the depth shall be rejected. (ref. clause 12.33 of IRC-15-2017).
 - (iv) When due to operational or any other reason, such replacement does not become possible (decision of Engineer-in-charge in this respect being final and binding on the contractor), the cost of removal and replacement of such rejected work shall be recovered from the contractor whether such rejected work is subsequently replaced by the Deptt. or not.

6.17 WEATHER LIMITATIONS

6.17.1 Concreting during rains: To prevent damage to freshly laid concrete during monsoon, or sudden rains, the Contractor shall provide an adequate supply of tarpaulins or other water-proof material. Any concrete damaged by rain shall be removed and replaced by the Contractor at his own cost as directed by the Engineer-in-Charge. If need be, necessary provisions shall be made to support the water-proof material clear of the newly-laid concrete surface to prevent smoothening or any damage due to the contact with tarpaulin. The whole unit should be weighted down appropriately to prevent from blown off by winds. The rate quoted shall include all these.

6.17.2 Concreting in hot weather: No concreting shall be done when the concrete

temperature is above 30°C. Besides, in adverse conditions like high temperature, low relative humidity, excessive wind velocity, imminence of rains etc. if so desired by the Engineer-in-charge, tents on mobile trusses may be provided over the freshly laid concrete for a minimum period of 3 hours as directed by the Engineer-in-charge. The temperature of the concrete mix on reaching the paving site shall not be more than 30°C. To bring down the temperature, if necessary, chilled water or ice flakes should be made use of. No extra payment shall be made for this arrangement.

6.17.3 Concreting in cold weather: No concreting shall be done when the concrete temperature is below 5°C.

6.18 MEASUREMENTS

6.18.1 For the purpose of ascertaining the quantity of concrete in the pavement length, breadth and thickness shall be measured as detailed below:

a) Length

6.18.1.1 Between the end of a pavement to the center line of the construction / expansion joints.

6.18.1.2 Between the center lines of consecutive construction/ expansion joints.

b) Width

(i) Between the edge of a pavement and the center line of the construction joints.

(ii) Between the center lines of construction joints and expansion joints.

(iii) Between the center lines of construction joints and expansion joints.

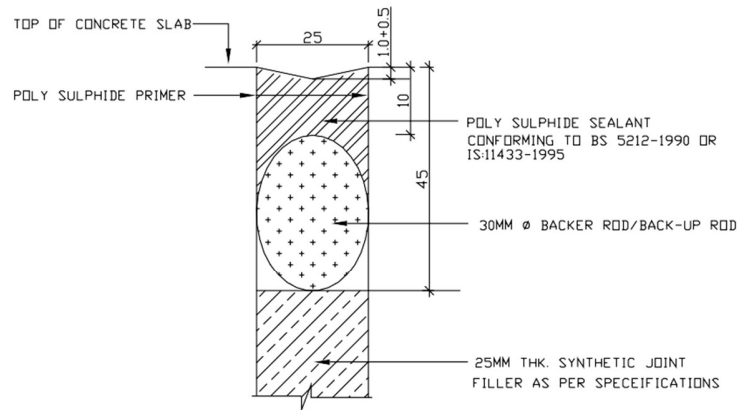
(iv) Between the center lines of consecutive construction joints.

c) Thickness

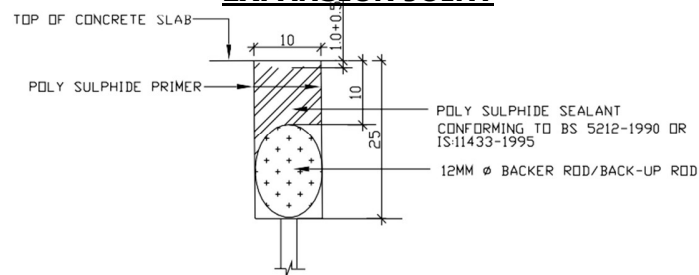
Levels shall be taken before and after construction, at the grid of points 5 metre centre-to-centre longitudinally in straight reaches for each panel and 2.5 metre centre-to-centre at curves. The levels shall also be taken transversely, at 0.75 metre from either edge of the panel and the remaining locations shall be at equi-distance but not more than 2 metre in the balance portion of panel. The average thickness of the pavement course in any panel shall be the arithmetic mean of the difference of levels before and after construction at all the grid points falling in that panel, provided that the thickness of finished work shall be limited to those shown on the drawings or approved by the Engineer-In-Charge in writing. As supplement to level measurements, the Engineer shall have the option to take cores/ make holes to check the depth of construction. The holes made and the portions cut for taking cores shall be made good by the Contractor by laying fresh mix/material including compacting as required at his own cost immediately after the measurements are recorded.

The finished concrete courses to be paid on volume basis by multiplying length, breadth and thickness as measured above and its volume shall be calculated in Cubic metres correct to two places of decimal. Measurements of concrete slabs shall be recorded in aforesaid manner jointly by the Engineer-in-Charge or his authorized subordinate and the Contractor or his authorized agent.

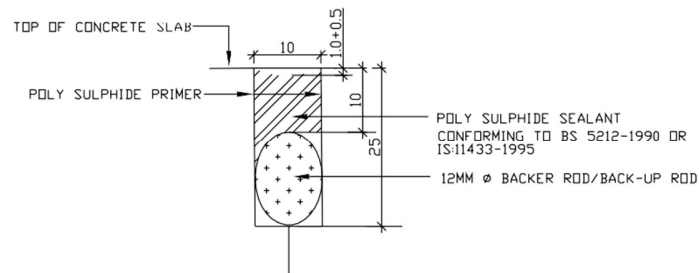
APPENDIX-A



EXPANSION JOINT



CONTRACTION / DUMMY JOINT



CONSTRUCTION JOINT

DETAILS OF FILLING OF JOINTS IN RIGID PAVEMENTS

APPENDIX-B

List of minimum equipment to be provided in the field testing laboratory by the contractor at his own cost.

1. Sieve analysis for combined grading of aggregates
Sets of I.S. Sieves of sizes 63mm, 45mm, 22.4mm, 11.2mm, 5.6mm, 2.8 mm, 1.4 mm, 710 micron, 355 micron and 180 micron.
2. Sieve analysis for coarse aggregates
Sets of I.S. Sieves of sizes 63mm, 40mm, 20mm, 12.5mm, 10mm, 4.75mm, 2.36mm.
3. Sieve analysis of fine aggregate
Sets of I.S. Sieves of sizes 10mm, 4.75mm, 600 micron, 300 micron and 150 micron
4. Silt content of sand
Graduated glass cylinders 500 C.C. capacity.
5. Bulkage of sand
 - a) Graduated glass cylinders 250 C.C. capacity
 - b) Graduated glass cylinders 500 C.C. capacity
6. Slump test
 - a) Slump cones
 - b) Slump rods 3/8" dia. 24" long bullet pointed.
 - c) Steel plates 24" x 24"
 - d) Steel scales
7. For making beam specimens for flexural strength
 - a) Beam moulds size 70x15x15cm (minimum 18 nos.)
 - b) Cube moulds size 15x15x15cm (minimum 18 nos.)
 - c) Tamping rods.
 - d) Table vibrator (size 1m x 1m)
8. Testing flexural strength of concrete:
100 tonne capacity equipment for compressive strength and 5-10 tonne equipment for flexural strength testing electrically operated.
9. Other miscellaneous items
 - a) Electronic weighing scale of different capacity
 - b) Glass measuring jar
 - c) Beakers
 - d) Towels, glass plates etc.
 - e) Apparatus for testing flakiness index, Impact value and Los Angeles Abrasion value of coarse aggregates.

SECTION - 6: LANDSCAPE

1. INTRODUCTION

1.1 Landscape Objectives

The landscape master plan has been developed in response to the environmental context, existing site features and requirements for efficient ongoing maintenance and sustainability. The objectives of the landscape design seek to complement and enhance the architectural design theme.

The design objectives include:

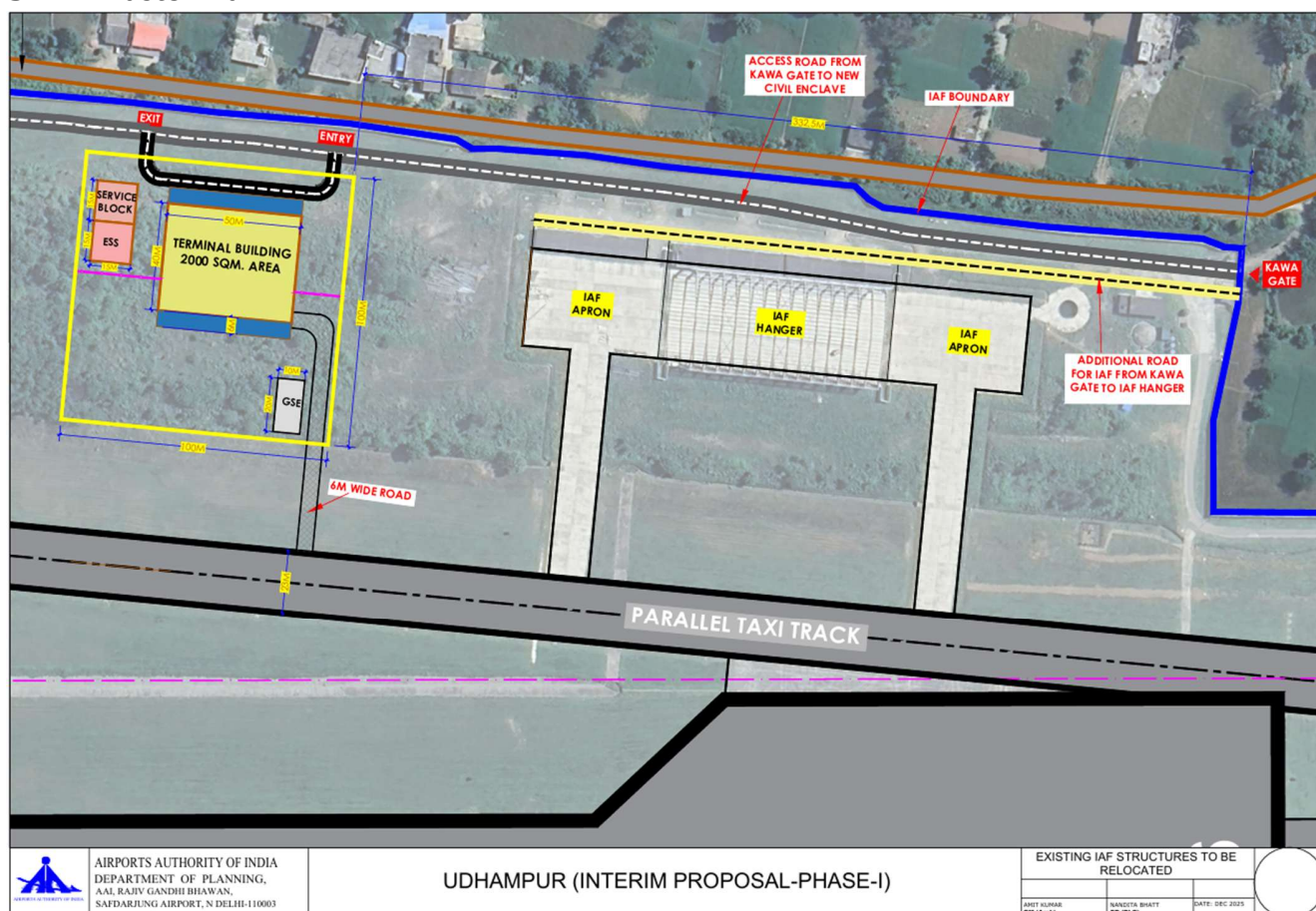
- a) Provide safe environs.
- b) Enable & encourage people to access parking facilities.
- c) Build a sense of identity through a distinct aesthetics.
- d) Generally, incorporate key principals of good Urban and Landscape Design.
- e) Create spaces with dominant landscape to enable ambient usage of spaces.

2. DESIGN PHILOSOPHY

The landscape design aims to create a high quality, attractive and contemporary precinct that will provide users with aesthetically pleasing and functional spaces. All open areas marked for landscaping within the Battery limit has to be developed in Landscape and green.

3. PROPOSED DESIGN

3.1 Master Plan



Landscape Master Plan to be designed with two Major Typologies as:

- 1) Active Landscape Zone: Maximum Public Access
- 2) Passive Landscape Zone: Visual Landscape Access

3.2 Landscaping in front of Terminal Building

EPC contractor shall submit proposal for approval by AAI.

4. SUSTAINABILITY

Environmental sustainability and green principles may be incorporated to ensure that landscape development does not hamper the existing ecology of the site and its surroundings land, vegetation and water sensitive design options may be explored during the design stage by incorporating a clear grading, drainage and planting strategy while developing the landscape concept. Cut and fill of the land may be minimized while locating the built blocks and circulation spaces. Gentler slopes with adequate green cover aids in erosion control thereby retaining the humus rich top soil. Storm water runoff within the

site may be filtered and either stored or allowed to recharge the groundwater table depending on the site conditions. As far as possible, it is desirable to use native and naturalized non- invasive species. IGBC Green Landscape rating system addresses green features under the following categories:

The various sustainable practices we will incorporate are;

- a) Site Planning & Management
- b) Selection of Species for Landscape
- c) Water Conservation
- d) Material Selection
- e) Health & Well-being
- f) Energy Efficiency
- g) Operation & Maintenance
- h) Innovation & Design Process
- i) Native plant species. Species that will survive in the climate and tackle high pollution will be looked into.
- j) Deep-rooted trees for no watering after 5 years.
- k) Conditioning of existing soil on site
- l) Conservation of top soil for reuse
- m) On site composting
- n) Smart irrigation and zone wise planning with sensors
- o) Solar and LED lighting

5. IRRIGATION

5.1 General

Irrigation shall be done with state of art irrigation systems with the primary goal to optimize use of water;

5.2 Design Considerations

- I. The Type of Irrigation System shall be planned & adopted as detailed herein:
 - a) Land irrigation system through ring mains with the help of garden hydrant points comprising valves and chamber for surface irrigation of landscape.
 - b) Drip irrigation system for shrubs, trees and plants distributing water through a network of valves, pipes, tubing, and emitters.
- II. Key factor to be considering in Plan Ring of Irrigation System.
 - a) The irrigation system shall be designed considering the wind direction slope and proposed grade, type of soil percolation and type of vegetation to be watered.
 - b) Spray irrigation to be designed to avoid dry spots and spray on to paved areas and unplanted surfaces.

- c) Spray irrigation is to be avoided in areas of width less than 3 meters.
- d) Irrigation hydrants shall be un-obtrusively located and generally at the edge of shrub planting and additionally in close proximity to a drainage chamber and catch basins to avoid water log.
- e) Hydrant points shall not be located inside chamber to minimize water log from leaking pipes causing various health related hazards. Hydrants shall be located 200 mm above the ground level.

III. Distribution System

- a) The entire distribution for irrigation system will be through network of independent pipes.
- b) The entire network of irrigation system will be divided in zones with the help of isolation valves and sub mains feeding garden hydrant and drip irrigation system.

6. PLANTS CONSIDERED

- a) Maximum native tree species have to be considered.
- b) Care has to be taken while selecting tree species to avoid Bird attracting trees as this being airport precinct.

7. PATHWAYS AND PEDESTRIAN MOVEMENT CORRIDORS

- a. Footpaths of minimum width 1.20 m may be provided along the length of road for any public or private building where pedestrian traffic is expected.
- b. Natural materials such as stone, or manmade materials such as tiles or cast in-situ concrete, of appropriate thickness may be used as paving finish in external areas.
- c. Adequate slope and drainage facility may be considered for all external paved surface integrating it with the pavement design.
- d. Surface treatment of the finishes may be such that it remains anti-skid throughout the seasons. Smooth finish is not recommended for external areas except to convey any design concept.
- e. Signage style and vocabulary along multiple open spaces and parks to guide users may be kept consistent for ease of understanding.

- f. Change in levels and steps may be depicted in different texture or colour as a visual clue.
- g. The cross slope of sidewalk may be designed so as not to exceed two percent (1 in 50). The longitudinal slope of path may not exceed 1 in 20, unless the longitudinal slope of the road exceeds this maximum, in which case the norms applicable to a ramp should be applied. Kerb ramps may be provided at pedestrian crossings.
- h. All ramps should have minimum width of 1.20 m, excluding edge protection. The cross slope of ramp should not exceed 1 in 50 and the longitudinal slope of ramp may not exceed 1 in 12. All ramps may have an unobstructed level landing both at top and bottom of the ramp. The landing may have the minimum width as that of the ramp. The landing may be minimum 1.50 m in length. Any ramp beside the road may be located in such a way so that vehicles cannot park blocking the access.
- i. Handrails may be provided for any ramp with a vertical height greater than 150 mm, to prevent pedestrians and wheelchair users slipping from the ramp. The ramp surface may be rough finished. All ramp and landing may be designed so that water does not collect on the surface of the ramp or landing.

8. DESIGNING FOR ROAD LANDSCAPES

- a) Kerbs may be provided on the edges of the driveways to adequately control drainage within the road, prevent moisture from entering the sub-grade, separate the road from the pedestrian area, and provide adequate lateral support for the pavement structure.
- b) The roads should provide clear access to fire fighting vehicles, ambulance, sanitation vehicles, etc., and also allow for safe movement for vehicles, pedestrians and wheelchair users. The road widths, alignments and service lanes, etc., may be such that they are adequate as per the relevant Indian Road Congress Standards.
- c) Lane markings, kerb edges, central median, etc., may be provided for smooth movement of the traffic and also to guide the vehicles to stay within the designated driveways.
- d) Driveways may preferably be shaded by trees.

- e) Pathways along vehicular roads may be physically separated by means of kerb, graded separation, barrier, railing, or other means to prevent ingress of vehicles.
- f) Roads may be designed with provision for appropriate street furniture (see 13 and other urban adjuncts for the convenience of the users). Benches, shelters, poles, signs, bus stops, etc., may be located on edge of the sidewalk with clear minimum width of 1.20 m to enable unhindered pedestrian circulation.

SECTION -7: PHE WORKS

1. PLUMBING SYSTEMS

1.1 Reference Standards

- National Building Code of India – 2016, Part-9
- Relevant Bureau of Indian Standards
- Energy Conservation Building Code 2017
- SP:35 (S & T) 1987
- BIS:10500 Domestic water quality requirement
- BIS :1742 Sewage and Sludge Collection system

1.2 Design Objectives

The design objectives include energy efficiency, green eco-friendly design, and centralized location of services installation to ensure easy maintenance, state of the art technology, fast-track installation and compliance to all statutory regulations. Public Health Engineering system for the project shall be designed keeping in view the following:

- Various types of water supply demand for the complex.
- Requirement of adequate and uniform pressure availability for domestic water lines in Toilets and various consumption points.
- Selection of efficient energy saving equipment.
- Adequate storage of water in underground water tanks.
- Efficient sanitary and storm water drainage system.
- Levels of roads/pavements and other services in the area.
- Landscape Layout.

1.3 Concept of the System

The following concept for Plumbing Services is envisaged:

- Water Treatment Plant to ensure the domestic water quality requirement with chemical and bacteriological parameters in acceptable limits as per WHO-World Health Organization, SP: 35 (S & T) 1987 and BIS: 10500 which are considered safe for human consumption.
- Adequate storage of raw water and domestic water for one days and static fire storage tanks.
- Storm/ rainwater drainage system from various levels of the building, roads collection and discharge.
- Rainwater harvesting system.
- Water supply distribution system shall be installed for potable as well as flushing system.

1.4 EXTERNAL SEWERAGE SYSTEM

To be designed by the contractor

1.5 STORM WATER DRAINAGE SYSTEM

Contractor shall design storm water system for entire EPC scope of Airport. EPC contractor however shall check and verify exact area before quoting for the work.

1.6 Source of Water

- Bore well water supply.
- Municipal water supply.

The potential source of water supply is from tube wells. The actual nos. of tube well required and their yield shall be assessed as per the total water demand for terminals. It is proposed to meet the total water demand for the terminal by drilling the tube wells at different location as per the recommendations of the Central Ground water Board and Survey by a specialized underground Geological Survey Agency and also as per the experience with the existing tube wells in the area.

1.7 Water Supply System

The water from municipal/bore-well supply will be brought into a fire which will serve exclusively as a static storage tank for fire fighting purposes. Space for water tanks with pumps room shall be identified in consultation with Architect. The over flow from the fire tanks shall feed into raw water tank and treatment of water shall be done for water taken from raw water tank. Treated water then stored in the Treated water Tank.

Discharge and Pressure requirement for different Fixtures:

Public Area Toilets	:	4.5/2.5 litre / minute
Flush Conventional Urinals	:	0.5 litre / minute
Kitchen Faucets	:	2.5 litre / minute
Lavatory faucets	:	2.5 litre / minute
Showers	:	6.0 litre / minute

Bore Well Water System

The Contractor shall provide required no. of bore wells to meet daily water requirement depending upon the yield of bore well. The contractor shall carry out resistivity survey of site to establish yield & no. of bore wells to cater daily water requirement of airport building (Both potable & non-potable water requirement to be considered while calculating no. of bore wells).

The system consists of bore wells, submersible pumps, pipelines and valves. Contractor shall obtain necessary permits from the relevant authority. The bore well location shall be approved by the Engineer.

1.8 Water Demand Calculation

1.8.1 The water requirement for the domestic use in the Terminal Building, proposed to be based on the provision of NBC 2016 and prevalent practice in the industry. Water demand shall be calculated based on the details mentioned in Scope of Work.

1.9 Water Storage

One day water storage capacity shall be proposed by EPC contractor for each individual services for domestic, flushing, irrigation/Horticulture etc.

1.10 Design Parameters

The Sewage system shall be designed as per following design criteria stipulated in the "Manual for Sewerage & Treatment" published by the Central Public Health and Environment Engineering Organization, Ministry of Urban Development, Govt. of India, BIS-SP/35(S&T)-1987 and NBC-2016.

1. BRIEF OUTLINE SPECIFICATION FOR MAJOR EQUIPMENT'S

I. GI Pipes & Fittings

The pipes shall be galvanized mild steel welded (ERW) screwed and socketed conforming to the requirements of BIS: 1239. The Galvanizing shall conform to BIS:4736, the zinc coating shall be uniform, adherent reasonably smooth and free from such imperfections as flux, ash and drop inclusions, bare patches, black spots, pimples, lumpiness, runs, rust strains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the pipe.

The fittings shall be malleable iron and comply with all the requirements of the pipes.

II. CPVC Pipes

The pipes shall be CPVC (Chlorinated Poly Vinyl Chloride) material for hot & cold water supply piping system with pipes as per CTs SDR -11 at a working pressure of 320 PSI at 23 deg C and 80 PSI at 82 deg.C, using solvent welded CPVC fittings i.e. Tees, Elbows, Couplings, Unions, Reducers, Brushing etc. including transition fittings (connection between CPVC & Metal pipes / GI) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / structural metal supports as required /directed at site including cutting chases & fitting the same with cement concrete / cement mortar as required, including painting of the exposed pipes with one coat of desired shade of enamel paint. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of manufacturer & Project Manager.

III. Valves

- a) Valves 50 mm and above shall be cast iron lever operated butterfly valve as per IS: 13095 of PN-16 rating.
- c) Valves 50 mm dia and below shall be lever operated valves, screwed type of gun metal body as per IS:318 with SS ball and SS stem with mild steel lever tested to 35.5 Kg/cm² of PN-16 rating.
- b) Non-return 50 mm and above valve shall be dual plate wafer check valve of PN-16 rating.
- d) Non-return valve 50mm and below shall be gunmetal swing check valve confirming to IS: 778 Class-2 tested to 24.5 Kg/cm².

- **Pressure Reducing Valve set**

Pressure reducing valve set shall be complete with diaphragm type pressure reducing, isolating valves, pressure gauges on inlet and outlet, pressure relief valve on outlet and filter on inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self-aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure.

- **Pressure Relief Valves**

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

VI. Pressure Gauge

The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type pressure gauge with a scale range from 0 to 16 kg / cm square. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.

V. Water Fittings

Unless otherwise specified all Gunmetal valves such as ball valves, gate valves, check & safety valves shall be fitted in pipe line in workman like manner. Necessary unions shall be provided on both ends of the valves for easy replacement. The joints between fittings and pipes shall be leak-proof when tested to desired pressure rating. The defective fittings and joints shall be replaced or redone.

VI. Connections to Various Mechanical Equipment

All inlets, outlets, valves, piping and other incidental work connected with installation of mechanical equipment supplied by other agencies will be carried out by the contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturers' instructions and the directions of the Owner's site representative. The equipment to be supplied by the other agencies consists mainly for Process and Kitchen. The work of connections to the various equipment shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirement of equipment suppliers, under the directions of the Owner's site representative. The various aspects of connection work shall be executed in a similar way to the work of respective trade mentioned elsewhere in these specifications.

VII. Connections to Water Tanks

There shall be all inlets, outlets, washouts, vents, ball cocks, overflow control valves and all such other piping connections including level indicator to water storage tanks as called for.

Ball valves/butterfly valves shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

VIII. Pipes Hangars, Supports, Clamps Etc.

All vertical pipes shall be fixed by galvanized clamps and galvanized angle brackets 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).

Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully reset on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.

Clamps shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per drawings or contractor's shop drawings. Clamps shall be fixed in accordance to manufacturer's details / shop drawings to be submitted by the vendors.

DESIGN BASIS REPORT (DBR)
(E & M WORKS)

Construction of Interim Terminal Building and other allied works at Udhampur Airport (J&K) on EPC Mode.

Following is the brief description of the project for the EPC contractor to develop all engineering calculations and detailed design:

- The E&M Services (Electrical, Fire Fighting, Fire Alarm, VRV/VRF/SPLIT AC & other utilities and services etc. required for the airport development shall be conceptualized based on the architectural plans, design standards and criteria parameters to produce a concept which shall be integrated. All service routes shall be in trench/ trenches, concealed or buried underground as far as possible. Considering the sustainability and hassle-free maintenance provision of trench should be made to lay all the underground systems such as pipes, cables etc.

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, Testing & Commissioning of complete Internal & External Electrical works including substation equipment's, HT & LT works, Low Voltage (LV), Firefighting system, Automatic addressable Fire alarm & detection system, VRV/VRF/Split AC and other works as required for smooth functioning of the proposed Airport. Works shall be designed and executed as per latest codes of practice for Electrical installations and meeting the requirements of Indian Electricity Rules/ Act, applicable I.S. Codes/ Rules and relevant Standard/CPWD Specifications, Special requirements etc. as per latest up to date norms. The rating and capacity of equipment indicated herein below are minimum, to be provided. However, during detailed designing, if required and found necessary, the capacity/rating of the equipment may be upgraded by the EPC Contractor and nothing extra shall be paid on this account.

The Items / activities covered under Internal & external electrification Works shall be including in the following for Terminal Building, ESS(Sub-station), Toilet Block, Parking etc.

- 1)** Main Distribution Boards, Sub Distribution Boards, Meter boards (having prepaid meter for commercial establishment) and final distribution boards, panels/feeder pillars for external development and any other panel as required.
- 2)** Double source (cables) to be provided for HT panel, LT panel and other sub panels.
- 3)** HT, LT Cables from Main Distribution Boards to SDBs, Panels in terminal building, ESS(Sub-station), Car Parking, Toilet Blocks, and other equipment panels, street lighting cables etc.
- 4)** Sub main Cables from SDBs to final distribution boards etc. Voltage Drop for feeders shall not exceed 2 % at design load & voltage drop for branch circuit shall not exceed 3 % at design load.

- 5)** Wiring and conduiting of all light, light plug points, fan points, & general power points, AC Point, points for misc. equipment's like geysers, hand driers, drinking water fountain with water coolers & RO, air curtains exit & entry points, Automatic motorized sliding door, sanitary napkin hygiene panel (4 IN 1) wall mount, Signages, Public Address System, etc. including modular type light and power accessories, raceways, under floor boxes as required etc. complete in all respects. Raceways shall be provided in floors wherever required as per site conditions where ceiling is not available. The Heavy duty MS conduit shall be laid on surface wherever above false ceiling, while in case of concealed conduiting heavy duty PVC conduit shall be provided for Electrical. Heavy duty GI conduit shall be provided for IT and Airport system services. Complete circuit shall be of the same material (GI/MS/PVC) bases on the above requirement.
- 6)** Lighting systems including internal and external LED Light fixtures, terminal building canopy lighting, occupancy sensors & ceiling fans, street light poles for connecting road and Car parking etc.
- 7)** Conduiting, GI raceways / trunking etc. for all electrical and GI (heavy duty) Conduiting, GI Raceways for AS/IT systems as required in concealed or in surface as per site condition.
- 8)** Lightning Protection System (LPS) of the buildings as per IS / IEC 62305, IEC 62561 & IS 3043. LPS shall be provided on Terminal Building, and ESS building (Substation) etc.
- 9)** Providing Automatic Fire Suppression system (LPCB) for all LT Panels
- 10)** Supplying, installation, testing and commissioning of Automatic room flooding Fire Suppression system for Server room and UPS room, fire extinguishers and First aid box with adequate medical supplies.
- 11)** Providing Automatic Transfer facility having bypass arrangement in Main LT Panel for changeover from DG supply to normal supply & vice-versa. Also, sub panels shall be having dual supply incomers for redundancy.
- 12)** Earthing of electrical installation complete in all respect.
- 13)** Scope of work shall include supply, installation, testing & commissioning of complete electrical system installation as described above.
- 14)** EPC to calculate the Electrical Load considering Terminal building, ESS(Sub-station), External Services & Toilet Block, perimeter light & future load and the existing installations etc. as per direction of EIC.
- 15)** EPC agency shall provide & make provision of all electro-mechanical equipment. DG sets, Transformer, HT & LT Panels.
- 16)** Supplying, installation, testing and commissioning of 11KV/0.433 KV substation equipment comprising HT panel (5 nos VCB), transformers, HT & LT cable, bus

trunking, LT panels (for complete electrical and mechanical installations, AS & IT installations) automatic power factor correction panel, active harmonic filters, SPD (surge protection system), essential panel, earthing, required inter-connections, LPS, substation safety equipment's including IT cabling from substation to the buildings fed by the substation.

17) Supplying, installation, testing and commissioning of silent type DG sets (1 working + 1 standby), AMF panel, bus ducting, cables from DG sets to essential panel, DG set enclosure room sound insulation/ventilation/smoke exhaust as required, earthing of DG set system, control cabling, fuel tank/piping, DG set exhaust piping/exhaust chimney as per CPCB norms, civil works connected with DG sets including foundation as required.

18) Supplying, installation, testing and commissioning of centralized online minimum capacity 40 KVA, 02 nos (1 main + 1 standby) 3 phase UPS system with 30 minutes back up including batteries, interconnecting cables, battery racks etc. for emergency lighting(15 %of total lighting) & Computer outlet points, Check-in-counter, PTZ camera, PA system, signage complete in all respect. In addition to this additional UPS (minimum 10 KVA two numbers in redundant 1+1 configuration) for server, (minimum 10 KVA two numbers in redundant 1+1 configuration) for FIDS and 01 no 02 KVA UPS for ESS block is to be provided.

19) Adequate LED lighting system to have required standard of illumination and all internal electrical installations including lightning protection system to be installed.

20) Supplying, installation, testing and commissioning of Automatic addressable fire detection & alarm system for Terminal Building & ESS block (Sub-station).

21) Supplying, installation, testing and commissioning of firefighting system i/c hose reel, down comer system, terrace level tank, pump etc. for terminal building as per NBC code and technical specifications electrical.

22) Supplying, installation, testing and commissioning of Automatic room flooding Fire Suppression system for Server room and UPS room with adequate first aid box etc. Fire extinguishers of adequate capacity as per NBC should be placed in Terminal Building, Substation, Utility, Switch room etc.

23) Supplying, installation, testing and commissioning of illuminated Mandatory building sign and other Information Signages.

24) Supplying, installation, testing and commissioning of other passenger amenities i/c Automatic Hand dryers (In each toilet), Sanitary Napkin Hygiene Panels (4 IN 1) wall mount, Automatic Sliding Doors, Air Curtains, Supply & installation of Baby diaper changing stations, Baby Protection Safety Chairs appropriate arrangements may be provided. The Sanitary Napkin Hygiene Panels (4 IN 1) wall mount shall be provided

in each ladies toilet. Baby diaper changing stations and Baby Protection Safety Chairs shall be provided in each Child care room.

25) Supplying, installation, testing and commissioning of water cooler with Drinking water fountain & RO in Terminal Building, ESS and Car parking Minimum Qty 05 nos or more as per site requirements.

26) Supplying, installation, testing and commissioning of VRV/VRF system (91 TR minimum) including indoor/outdoor units, piping, electrical power distribution/wiring, electrical panel, treated fresh air system for terminal building etc. as per site requirements. In addition 50% standby for outdoor unit for each circuit/Zone is to be provided along with all accessories.

27) Supplying, installation, testing and commissioning of Inverter split type Air Conditioner 5 star for VIP lounge, UPS/Battery room, Child Care Room, server room & CCTV room as per site requirements. Minimum Qty. 04 nos (For 2 TR) & Minimum Qty. 08 nos (For 1.5 TR) or more quantity as per site requirements. Including standby units in VIP lounge, UPS/Battery room, server room & CCTV room as per site requirements.

28) Public address system in terminal building as per direction of Engineer-in-Charge.

29) Conduiting, piping, raceway etc. for IT & AS System works as per requirement of AS & IT.

30) The terminal Building shall have minimum 02 no. of aviation obstruction lights including standby or as per the site requirements.

31) Supplying, installation, testing and commissioning of Departure conveyor belt for 04 Nos Check-in-counter and 01 No Arrival Conveyor belt.

32) Supplying, installation, testing and commissioning of Hydropneumatics pump (3 X 50 LPM), Suitable capacity pump for filling Fire tank from UG tank, Fire Pump as per NBC.

33) Any other electrical works not mentioned above but required as per site conditions.

a. Note: The rating and capacity of equipment's indicated herein are minimum, to be provided. However, during detailed designing, if required and found necessary, the capacity/rating of the equipment may be upgraded by the EPC Contractor and nothing extra shall be paid on this account.

b. Conservation of energy, water and optimization of resources with environment Friendliness are important factors in the design concept. Apart from the latest state of the art technologies available preferably in India with Fire safety, Energy Efficient and failsafe systems with least maintenance problems are the major Considerations for the design of systems.

- c. Electrical:** The electrical load is estimated as minimum 315 KVA or more as per site requirements. The Substation is planned with 02 Nos 315 KVA (1W+1S) Oil type transformers (11/0.433 KV) capacity, located at Ground Floor Level of the ESS (substation area) as per approved Drawing. The entire power is provided with 100% backup through 2 Nos 350 KVA (1W+1S) DG sets. The capacity of the equipments is minimum and indicative. The EPC contractor has to design and calculate as per actual design requirement. However, during detailed designed if the loads increases, the contractor has to provide all necessary equipment, switchgears, cables etc. complete in all respect and comply the same without any additional cost
- d.** AAI will have to apply for 11 kV connection from electricity board. Supply shall be received at HT metering board. The supplying & laying of HT cables (Main and Standby) from HT meter to HT panel, transformer & further are also in the scope of EPC agency.
- e.** Lighting in terminal building offices, conference room, VIP rooms, Toilets, Child care room, Sub-station (ESS) area etc. shall be provided with additional backup using UPS as per site requirement.

Calculation of Estimated Load, Demand & Diversity factor:

While Calculating the estimated load of complete building following demand & diversity factor shall be considered:-

S.No.	Description	Estimated/ Connected Load (kW) CL	Demand Factor (DF)	Maximum Demand Load(kW) (CL*DF)
1	Internal Lighting Load	-	0.8	
2	External Lighting Load	-	1.0	-
3	General Power Load	-	0.4	-
4	Firefighting Equipment Load	-	1.0	-
5	Plumbing Equipment Load	-	0.8	-
6	VRV/VRF and Split AC System	-	0.7	-
7	Ventilation System	-	0.8	-
8	Workstation, Printer, Photocopier etc.	-	0.8	-
9	AS & IT Equipment	-	1	-
10	GLF, Apron equipment	-	1	-
11	Any other Load	-	0.5	-
	Total Load	X		Y
	Maximum Contract Demand in KW with Diversity Factor @ 0.8			(0.8 * Y)
	Add for Future Load @20%			20%*(0.8 Y)
	Net Maximum Contract Demand in KW(z)			1.2*(0.8*Y)

Transformer Selection

S. No.	Description	KW/KVA	Remark
1	Total Maximum Contract Demand Load	Z	KW
2	Total Maximum Contract Demand in KVA at 0.9 Power Factor (A)	A = (Z/0.9)	KVA
3	Required Transformer Rating in KVA with 90% Loading (B)	B = (A/0.9)	KVA
4	Selected Rating & No.	B	KVA (01 working +01 Standby)

DG SELECTION

S. No	Description	KW/KVA	Remark
1	Total Maximum Contract Demand Load	Z	KW
2	Total Maximum Contract Demand in KVA at 0.8 Power Factor (C)	C = (Z / 0.8)	KVA
3	Required DG Rating in KVA with 80% Loading (D)	D = (C/0.8)	KVA
4	Selected Rating & No.	D	KVA (01 working +01 Standby)

Closed Circuit Television (CCTV)

Design Criteria

The Electronic security and surveillance shall be an integrated security management system, which shall include various sub-systems. The system shall broadly include closed Circuit Television monitoring and recording system.

CCTV has been designed taking into consideration of Combat terrorism - It's an unfortunate fact that airports are targets for terrorist activity. For that reason, it's vitally important that airports employ extremely strict security measures. Video surveillance systems play a key role in protecting against acts of terrorism. The proper system will provide authorities with invaluable tools in their efforts to maintain the highest possible levels of security.

CCTV System shall be proposed as per BCAS guidelines with upto date amendments. approval from BCAS will be in the scope of OEM/SI/Contractor

The Closed-Circuit Television System is intended for comprehensive round the clock surveillance of the office, parking area and service area of the Terminal Building from security control room. The following areas shall be monitored by the system as given below:

- 100a coverage in public areas with no dark spot
- Entry points/ Roads approaching towards Departure hall
- Exit points/Roads of Departure Hall
- Bus b Taxi bays & parking
- Kerb Area City Side
- Check IN Hall
- Security Hold Area
- Frisking Area
- Boarding gates
- Airside
- Corridors
- Retail area
- Kiosk
- Arrival Air side
- Arrival Hall
- Baggage Claim area
- Arrival City Side
- Entry Points/Road Approaching towards Arrival of Terminal Building
- Exit points/road leaving from arrival
- Stair cases

- Lounges
- Minimum 04 nos. of PTZ Cameras in the Isolation Bay Area with both fiber and redundant wireless connectivity should be installed to have complete view of the Isolation Bay; if available.
No other camera other than High Definition PTZ Dome Camera with IR 500-meter meeting specifications will be accepted as detailed in tender.
- Other areas specified by the user

IP based CCTV System shall use video signals from various types of indoor/outdoor CCD/CMOS or better technology colour cameras installed at different locations, process them for viewing, recording and replay and simultaneously on all workstations/monitors at Security Operational Control Center (SOCC) Cameras recording shall be at H.265 or better standard. Joystick Controller/Mouse-Keyboard shall be used for Pan, Tilt, Zoom, Camera Selection and other functions of desired cameras. When both the viewing stream and the recording stream are set at the same FPS and resolution, the camera shall send on the network a single multicast stream this shall help reduce network Bandwidth. - The Surveillance System Server shall support H.265 or better bandwidth optimized multi-streaming.

The CCTV software application should allow retrieval of data instantaneously or any date/time interval chosen through search functionality of the application software. In case data is older than 30 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like CD/DVD/Blu-Ray Recorders or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system which can be audited at a later date

The system shall support video analytics either on edge base or server base analytics (in case server based analytics is considered additional server shall be consider for the same) It shall have object tracking facility. If any object is found to be stationary for a pre-defined period the system shall track the event and alert the operator. This facility may be provided on select cameras at Entry point, Boarding gates, and Arrival area and as defined by the tenderer. The system should have the features for identifying, vehicle detection features, unattended baggage identification, length monitoring and intruder detection

CAMERA SERVER software shall run on Commercial-off-the-shelf (COTS) Servers (Camera Servers & Database Server). Each Camera Server shall be able to handle 50 or more cameras. Camera/ Database Server will work as failsafe/redundant Server for each other.

Camera Server shall offer both video stream management and video stream storage management. Recording frame rate & resolution in respect of individual channel shall be programmable

System shall ensure that once recorded, the video cannot be altered; ensuring the audit trail is intact for evidential purposes.

Camera Server shall offer both video stream live view management and video stream storage management. Recording frame rate IN resolution in respect of individual channel shall be programmable.

System shall ensure that once recorded, the video cannot be altered; ensuring the audit trail is intact for evidential purposes.

System shall provide sufficient usable storage of all the camera recordings for a period of continuous THIRTY (30) days on Serial Attached SCSI (SAS)/SATA at minimum 2MP (1980X 1080 resolution) 25 FPS resolution or better quality using necessary compression techniques for all cameras (Extended capacities of Cameras i.e. present capacity +25% spare).

Network Attached Storage (NAS) shall be supplied for the complete storage for all cameras for 24x7 in real time mode for a period of 30 days with additional 25% free space for future addition of cameras. Server base solution for CCTV should be in N+1 redundancy.

All the indoor cameras & control equipment shall be suitable for operation from 0° C to 50° C and relative humidity up to 80% noncondensing. Cameras & other equipment, meant for outdoor installations, shall be suitable to work from (-) 10° C to (+) 50° C with RH up to 90% non-condensing. This temperature range may be achieved with or without heater.

IP Camera shall be used for image capture. Indoor cameras shall be either with varifocal lens or with Pan/Tilt 6 Zoom lens as per site requirement. All Cameras shall be Day/Night Wide Dynamic Range (WDR) Colour Cameras as per specification

All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

Facility of camera recording in real-time mode 25 FPS or lower FPS as well as in any desired combination must be available in the system.

Facility of Edge storage (SD Card) of 256 GB Or better may also be available in each camera with the facility to transfer edge storage recording to main storage i.e. NAS/SAN, after resumption of link in case of network failure.

Database Server shall keep track of all configurations & events. This shall help in proper System administration & management of redundancies etc. Suitable provision shall be made to keep database backup in same or other Server.

Monitoring of Cameras shall be at Security Operation control center (SOCC) may be restricted to operation of certain cameras only as per user defined & system

administrator should be able to configure the system, accordingly. Cameras shall be viewed on Video Monitors & suitable numbers of video Monitors to be consider to view minimum 50a cameras at one time & next 50a of cameras on next scroll. Min 2 Spot monitor per floor to be consider so that operator can view the detailed of any camera /type of camera on Spot monitor. SOCC must have sufficient table chair, console, Joystick, Spot Monitors to be consider so that minimum 4 Nos. of operator can comfortably sit in the SOCC 6 view 6 operate the cameras.

All the workstations in LAN should be provided with software to view and control Et retrieve the recorded video images from the CAMERA SERVER/NAS/SAN seamlessly.

The Surveillance System shall support full two-way audio between the Video client viewers and remote cameras/devices.

The software shall support interoperability with IP camera standards including, at a minimum, the Open Network Video Interface Forum (ONVIF).

Integrated IT network shall be used for all IP based application.

The IT network of Terminal building should have 3 tier network architecture i.e Core switch, Distribution switch & Edge switches

The Core IT Network equipment, application server & Storage for all IP based application shall be located centrally in DATA CENTER / SERVER ROOM. The Integrated IT network shall be designed for the following minimum facilities and application:

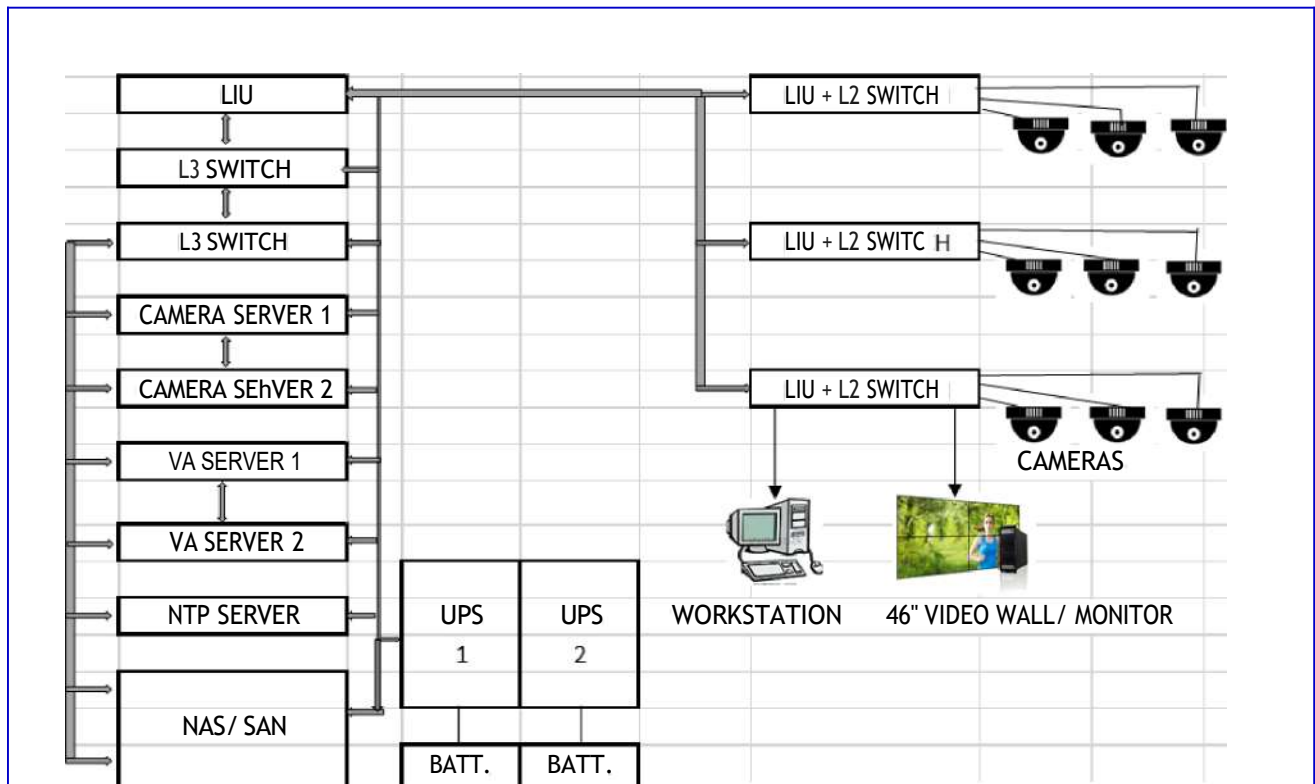
- CUTE/CUSS
- CCTV
- Biometric Access control System (BCAS Guideline)
- FIDS (Flight Information Display System)
- Internet Facility for users
- Passive Cabling for Wi-fi facility for passenger

UPS Power shall be required for smooth 6 continuous running of cameras, monitors, the UPS power shall be feed through centralized Extra Low Voltage (ELV) UPS.

UPS will feed the following equipment:

- Distribution Switches
- Edge Switches
- CCTV System
- FIDS
- Wi-fi
- Access Control System

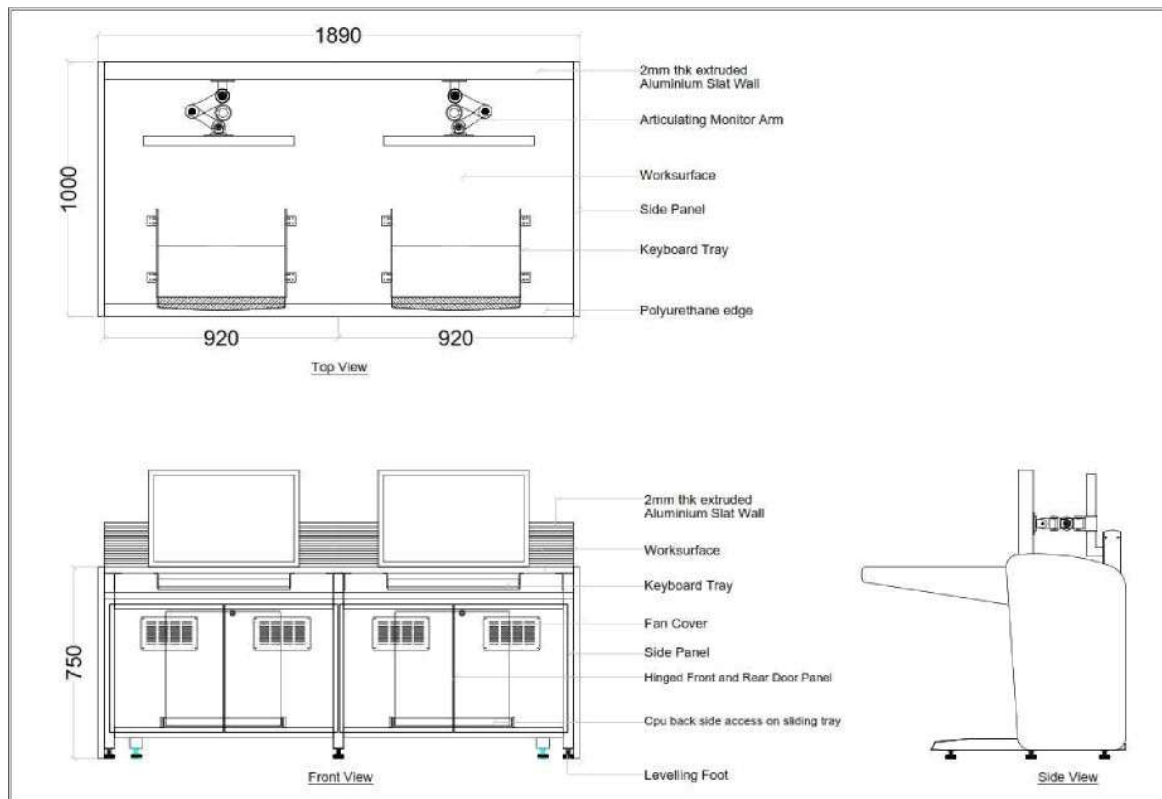
Surveillance CCTV System Schematic Diagram



Typical diagram of Two-Operator Console For SCC'I'V System Control Room

E'zont-sade

Rear-side



Flight Information Display System (FIDS)

Design Criteria

The Flight Information Display System (FIDS) shall be installed at Airports for display of Passenger Information, Flight Information, Baggage Belt Information, Check In-Counter/Boarding Gate Information, Multimedia Advertisement, Weather Information, etc.

The Flight Information Display System (FIDS) shall primarily consist of following sub-systems:

Flight Information Display System - To provide visual display of Airport's Flight Schedule & Status, Gate, Baggage Belt information, etc. on LED Display Board, 42"/43"/65" LED Display Monitor, etc. through FIDS Application Software and Database on Hot/Standby Servers and Data Entry Application on Client Workstation, Administrative Application for Control and Monitoring of various devices, Page Design Application on Server/Workstation, etc.

65" LED Display monitors shall be used at the Departure/ Arrival main Gate & kerb ARRIVAL/Departure Area.

42/43" LED Display monitors shall be used in the Departure hall, Arrival hall, Arrival Belt Boards, Security, transit hall, various offices, Check-in Counters, Boarding Gates etc.

Display monitors shall be mounted on wall/floor through Stainless steel pole/mount. The Pole diameter shall be of approx. 04 inches dual pole.

The FIDS shall be scalable and expandable pre-wired (hardware EI software) to add standard client PC/Laptop and Standard Display Monitors to expand the system as and when desired by AAI.

Each line on an FIDS indicates a different flight number accompanied by:

- the airline name/logo and/or its IATA or ICAO airline designator
- the city of origin or destination, and any intermediate points
- the expected arrival or departure time and/or the updated time (reflecting any delays)
- the gate number
- the check-in counter numbers or the name of the airline handling the check-in
- the status of the flight, such as "Landed", "Delayed", "Boarding", etc.

Due to code sharing, one single flight may be represented by a series of different flight numbers, although one single aircraft operates that route at that given time. Lines may be sorted by time, airline name, or city.

FIDS are designed to displayed on LED screen as per detailed specification

The Flight Information Display System (FIDS) shall be installed for

- to direct the passenger flow within the term
- Passenger Information
- Flight Information
- Baggage Belt Information
- Check In-Counter
- Boarding Gate Information
- Departure City side
- Arrival Air & City Side

Weather Interface allows the airport to display weather information for the different destinations providing an additional service for the passengers

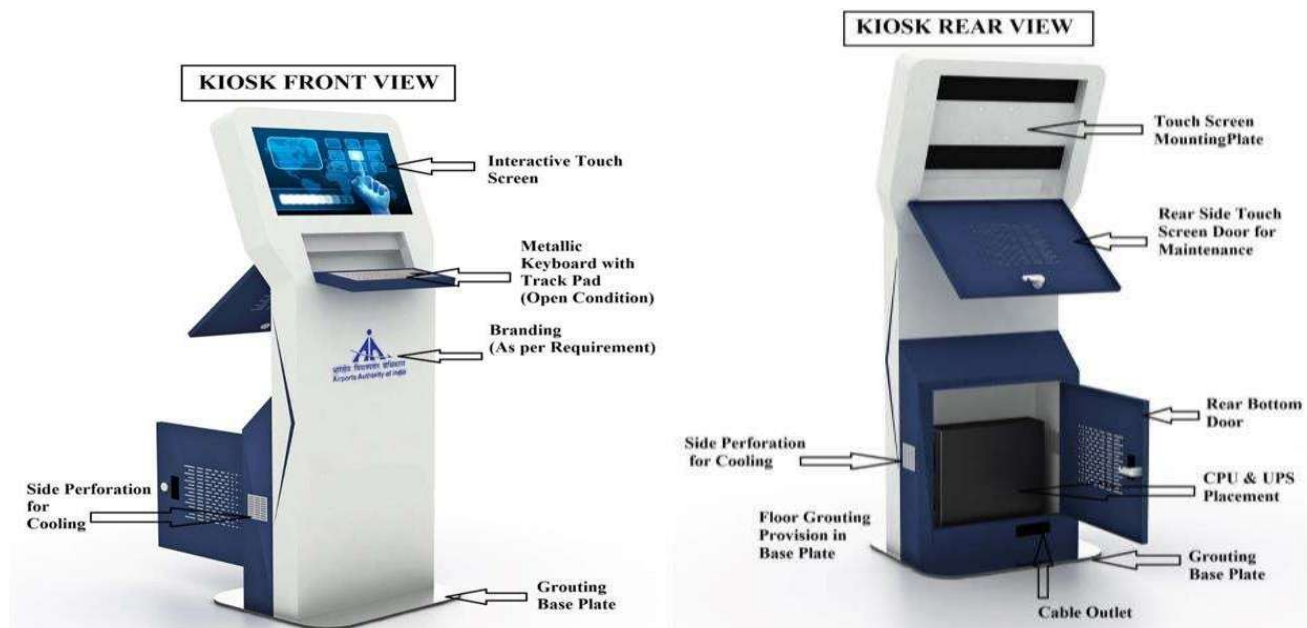
FID System shall be provided with two servers configured to operate in Automatic Failover configuration without any need of any manual intervention. During change over there shall be no loss of database transaction System shall provide audio-visual alarm for Error, Failure and Changeover of FIDS main or standby server, to system administrator or a designated client terminal automatically.

FIDS shall be provided with client-server architecture with latest version of UNIX or LINUX or Microsoft Window Server as operating system of Server/Cluster server, and Windows or Linux as operating system of client terminals.

FID Control Kiosk for Departure/ Arrival /Security Hall

Kiosk shall have provision to accommodate up-to one 21" to 23" touch screen, one metallic keyboard with track pad, Kiosk shall have sufficient space to accommodate the CPU, UPS & PDU (power distribution unit for powering all equipment with two spare 6A Power ports) and shall be accessible through rear door. The entire design shall be modular; consisting of interchangeable and replaceable parts. Touch/Non-Touch screen shall have separate door for the accessibility/maintenance and all locks shall feature 2-point locking arrangement. Design shall be extremely rugged to ensure a minimum life of 10 years for structural stability, moving and non-moving parts.

The "FID Data Entry Terminal Kiosk" shall be supply in the Arrival, Departure halls, Security Gates etc as per AAI requirement. The typical design of FID Data Entry Terminal Kiosk is as under



Integrated IT network shall be used for all IP based application.

The IT network of Terminal building should have 3 tier network architecture i.e Core switch, Distribution switch Et Edge switches

The Core IT Network equipment, application server 6 Storage for all IP based application shall be located centrally in DATA CENTER / SERVER ROOM. The Integrated IT network shall be designed for the following minimum facilities and application:

- CUTE/CUSS
- CCTV
- Biometric Access control System (BCAS Guideline)
- FIDS (Flight Information Display System)
- IPBAX (Telephone Exchange)
- Internet Facility for users
- Passive Cabling for Wi-fi facility for passenger
- Kiosk

UPS Power shall be required for smooth & continuous running of cameras, monitors, Video Wall.

UPS will feed the following equipment:

- Distribution Switches
- Edge Switches
- CCTV System
- FIDS
- Wi-fi
- Access Control System
- Kiosk

Scope of Work for IT Systems:

1. Passive & Active networking works at Airport Terminal:

- a) The New Terminal Building to be integrated with Modern IT enabled passenger services to improve passenger convenience and throughput of the building. Latest IT enabled services should be integrated in a planned way.
- b) Supply, Installation, Testing and Commissioning of Active networking components such as Firewalls in HA Mode, Routers in HA mode, Core Cum Distribution switch in HA Mode, Wireless controller in HA Mode, Access Network Switches 24/48 Non POE / POE+ etc. and associated equipment as per the proposed solution architecture.
- c) Supply, Installation, Testing and Commissioning of Passive networking components such as UTP, OFC cabling, connectors, patch panels, FO and associated equipment as per the proposed solution architecture.
- d) Provision of Raceways, Cable Trays and conduit shall be provided for the passive cabling works by Engg-Electrical as per requirement.
- e) Supply, Installation, Testing and Commissioning of Wireless Controller in HA Mode & associated Access Points and associated equipment as per the proposed solution architecture.

2. SITC of Server/ Data Center Room and associated works as per the proposed solution architecture.

1. Introduction

- 1.1 The following details specify the scope of work, design & technical specification for all the IT Works in the building & other works outside building within campus as mentioned in the scope. It comprises the systems listed out in this document and defines a turnkey solution.

1. Scope of Work

- 2.1 Set up of LAN, WLAN & WAN by providing Passive and Active Networking Components.

(A) Passive Cabling Works:-

- I. At the Airport campus Integrated Local Area Network shall be provided for all the Voice, Data & Video Data requirement for all the agencies working at the airport.
- II. The Contractor has to provide Integrated LAN Points for CCTV, WLAN, Access Control System, FIDS, IPBX, BMS and PoS, CUTE, CUSS, Access control system or any other applications required AAI Network for all users at Airport.
- III. The Airport Campus will be having passive works like laying of OFC backbone, UTP cabling and their associated components for data and voice, installation of racks, conduit.
- IV. The contractor shall lay the OFC along with all required accessories to provide AAI network connectivity to all the associated buildings where AAI Staff is seated.

(B) Active Networking Equipment: -

- I. Active Networking Equipment (Router, Next generation Firewall, Core Switch cum Distribution Switch, Access Switches, Wireless Controller, Wireless Access Points, AAA server).
- II. Edge Switches, PoE+/ Non-PoE shall be provided for end node connectivity. PoE+ switches are required for CCTV, Wireless Access points, Voice, FIDS, PA , BMS , Cute/ CUSS , POS, Access Control System etc.
- III. Active Networking Equipment's are required to establish WAN, LAN, WLAN at the airport premises for All Applications including Bio-Metric Access Control system and other applications for all users at Airport. Users of these applications are distributed across various floors of the Airport building and surroundings.

2.2 Setup of Server Room/ Data Center

Server Room/ Data Center:- Required space for Central Server Room and the locations of switches shall be marked in the drawing. Requisite no. of Racks (Servers & Network Racks) alongwith PDU, Networking and. Other Security Devices, Online Modular UPS with half an Hour Battery Back up, Dedicated Earthing shall be provisioned by the vendor. Dual Power Sources etc shall be provided in the Server Room by the vendor.

2.3 Set up of Biometric Access Control System :

Cabling for Access Control System as per BCAS guidelines: Count of Data points shall be considered for locations where data node is required for Biometric Access Control system to be installed and cabling shall be laid for the same accordingly.

3. Design Recommendations

- 3.1 **Active Networking Components:-** The key requirement for Airport campus is to design the LAN network for the building which is redundant, robust, scalable & secure. The building LAN would also be connected via redundant 10G OFC cables with the Core cum Distribution Switch. The requirements mentioned above for Airport campus also require critical applications to deliver information and data in real time.

All Active components outside Server Room shall be provided with UPS supply. Additional optical Fibre Cable shall be laid to back office, Custom/immigration offices to be connected directly with ISP in case of International Terminal.

3.2 The key features of network may be briefly outlined as:

- (A) **Guaranteed Application Response:** The network backbone shall ensure that there is no delay in the flow of information and data, irrespective of file size or amount of network traffic at any given point in time.

- (B) **Scalability:** The network shall be scalable as well as flexible so that future expansions can be made. The system shall be scalable in respect of the modules and functionality both in respect of downsizing and upsizing; facilitating its installation at larger or smaller airports, as the case maybe. The architecture shall support increasing number of users and transaction volume without compromising on the overall response time.
 - (C) Energy efficient network hardware with small network footprint for ensuring lower cost of operation and Green technology that reduced carbon footprint.
- 3.3 The 2-tier Network Architecture has been recommended for simplifying the design, implementation, and management operations:

3.3.1 Access Network Zone / Access Layer:

- A. The Access Layer consists of 24 port and 48 port Non-PoE switches and 24 port PoE+ switches as per requirement, which will give 1G connectivity to the end-points in the building eg. PC, Laptops, Network Printers/Plotters, Access Points etc, CCTV, FIDS etc. Each location may have at least one PoE switch in each stack for connecting Access Points, IP phones etc. in addition to dedicated PoE+ switch to cater CCTV requirement.
- B. The Ethernet switches shall have interconnection to Core cum Distribution switches which are located in the Data Centre/Switch Room through 6 Core Single mode/ Multimode 10G Fibre Connectivity.
- C. The access switches will have min nos. 10G SFP+ uplink ports which will be used to connect the switches to the distribution network. The Connectivity between Edge switches shall be through stacking module or 10 G SFP+ Modules.

3.3.2 Core Layer:

- A. The Core cum Distribution layer comprises of a set of two Layer-3 Ethernet switches (HA mode) configured to operate in a redundant cluster to which all the uplinks to Access switches, Security Gateway and Server zone switches, Storage connect.
- B. Core Switches interconnection shall be through stacking/10G/40G fibre connectivity.

3.4 Setup of Server Room:

- 3.4.1 Central Server Room & Hub Room at field locations shall be setup. Central Server Room shall be provisioned with Network/Server Rack having Online Modular UPS with half an hour battery backup etc.
- 3.5 Passive Cabling Components —
 - 3.5.1 Fiber Cable (6 Core SM/MM) laying in redundant mode (through different route and mesh topology) and laying of UTP Components (Min. CAT6A Cabling U/UTP Solution) is required.
 - 3.5.2 Contractor shall provide an "end to end connected I/O Node" in effective & operational areas of the building. Contractor shall be responsible to provide all the data node for all requisite application as per the site requirement.

- 3.5.3 LAN points redundancy shall be applicable for important LAN Devices i.e workstations, CUTE/CUSS , Check-in Desk , Boarding & Arrival gates & SOCC .
- 3.5.4 The LAN Structured cabling should be of CAT 6A UTP or latest. All user nodes of passive cabling should be on CAT 6A (10G).
- 3.5.5 The IT network backbone shall have redundancy in fiber optic cable with combination of STAR Topology within Terminal Building & associated areas & ring topology for cameras & security points at City side . All the structured cabling should be ANSI/IEIA/TIA approved for appropriate work. The passive cabling shall be laid as per BICSI standard.
- 3.5.6 Fiber route markers with arrow showing the route as per site requirement are required.
- 3.5.7 Cables should be appropriately labeled. The labeling scheme must identify the associated physical locations (building, room, cabinet, rack, port, etc.). cables and connecting hardware should be labeled

General Guidelines

A. Terms & conditions

- Preference will be given to Make in India / MSMEs shall be followed.

B. General Guidelines regarding Offered Products

1. All Edge PoE/POE+ Switches shall be provided with Redundant Power Supply as per the requirement and vendor will ensure to provide minimum power budget as specified in the specifications with/ without redundant power supply.
2. All Networking Components shall be provided with minimum 3 years onsite OEM warranty/ defect liability period.
3. Ethernet (UTP/Copper) cable shall not be used between switch to switch connectivity. Only fiber cable shall be provisioned for connectivity. Stacking modules/ cables can be used for switch to switch connectivity if these are installed in one rack.
4. Single Mode/Multimode OFC shall be provided as per the site requirement. All the accessories like LIU, patch cord etc. shall be provided as per type of OFC (single mode or multimode).
5. CCTV shall have a dedicated POE Edge switch(s) i.e. separate VLAN segment for CCTV. The dedicated POE Edge Switch used for CCTV, shall not be used for any other end node of any other IP based application. Min. 8 Port PoE+ Managed Industrial Grade Access Switch with 2x10G SFP & 1PV6 Logo ready/ Certified can be used for City side/remote location connectivity.
6. VLANs need to be created, as per the site requirement and on the basis of user group / application based and access between VLANs shall be provided as per the security of the data and systems.
7. All switches shall be installed in closed and secure environment. No Open Rack should be provided.

8. Quantity and Capacity of the Racks, shall be as per site requirement however 42U Network Rack shall be provided for server/ data center room in addition to racks requested for specific application server and storage.
9. LAN provisioning for Government agencies such as Immigration, Customs and others would depend upon AAI policy and guidelines for International Airport.
10. The capacity given in the specification is minimum and Contractor has to provide as per requirement.
11. All Electrical / Power Requirement shall be designed accordingly. Online UPS power supply for 24x7 to all Active Networking Equipment's is mandatory.
12. Online UPS supply should be provided to all Active Networking Components installed at Field/Remote Racks for uninterrupted service during power down.
13. OEM of all offered products should have Technical Support Center presence in India.
14. There should be compatibility of network with existing equipment's at the airport (if applicable).
15. All Covered Cable Trays/ cable raceway, concealed Conduit and other accessories like HDPE/GI Pipe/Channel Conduit shall be provided for the passive cabling works by Engg-Electrical Contractor as per site requirement.
16. CableTray/ HDPE/ GI Pipe/ Conduit/ Channel conduit shall be conforming to the specifications similar to respective engineering items.
17. The offered equipment by the Contractor shall be fully complied with the specifications to full fill the requirements. Higher specifications suitable to requirement can be accepted. The offered products should be complied by the standards given in the specifications or its equivalent standards in respective category.
18. The design and selection of the offered IT networking components by the Contractor shall be consistent with the requirements of long-term trouble-free operation with highest degree of reliability and maintainability.
19. The offered equipment by the Contractor shall be designed for continuous operation(24-hours a day and 365-days a year).
20. All offered equipment's should be standard proven product already available in the market. Offered Item should not be end of life or end of sale.
21. MAF & a letter from OEM shall be submitted in regards of warranty support & Non — Refurbished items, and no End of Life/End of sale against the offered product. OEM has to ensure that the support shall be provided for the offered products during the concurrency of the contract.
22. All types of spares and spare modules of the offered equipment shall be readily available with the Contractor during life-time of the equipment, for maintenance, repairs and up keep of the equipment during warranty & CAMC period, if applicable.
23. The offered equipment by the Contractor shall furnish the details of EMI and Safety Standards met by his equipment and built-in safety features.
24. The offered equipment shall be constructed on a modular basis, using plug-in type units and components to the extent possible. Parts subject to failure, wear, corrosion or other deteriorations or requiring occasional inspection, adjustment or replacement shall be made accessible and capable of convenient inspection and removal.
25. All offered/supplied Hardware system/component and Software by Contractor shall be licensed, as applicable, in favour of Airports Authority of India and valid for lifetime of the offered system.
26. Contractor has to offer/supply Passive Cabling Components as specified in the NIT or better and latest upgraded model/version if available in the market at the time of execution.

27. Items mentioned in document is minimum. Contractor has to provide all requisite accessories/items which are not included in the document to achieve the functionality of the NIT.

C) General Guidelines Regarding Contractors

- 1) Installation/Configuration shall be carried out by technically well qualified and certified personnel as per the requirements.
- 2) Contractors shall not outsource any part of the contract to any other vendor/third party contractor without prior permission of AAI.
- 3) Liability, if anything, arising out of such third party contracts to any other vendor by contractor shall be to the contractor's account.
- 4) AAI shall not be liable on behalf of contractor to any other third party contractor/ Government of India/State/Regulatory Authorities.
- 5) Any liabilities arising out of such third party contracts by contractor or its men working at site shall be only to contractor's account and shall be deducted out of its running bills.
- 6) Contractor shall submit Police Verification Certificates and obtain necessary Airport Entry Permits, for allowing its men to work at AAI restricted premises.
- 7) Vendor has to survey for final bill of quantity before implementation of work or procurement or approval from AAI Site In-charge.

5 Site Acceptance Test (SAT) & Commissioning

- 5.1 It shall be the responsibility of the Contractor firm to submit the system test procedure for conducting the post-installation site acceptance testing. The procedure submitted by the Contractor firm shall be drafted in line with the standard practices followed in the industry and shall be in accordance with the test procedures & practices specified by the OEM. The acceptance test procedure on approval by AAI shall become the document for acceptance of the equipment after installation at the site.
- 5.2 The draft copy of system test procedure shall be made available to AAI before THIRTY calendar days of the schedule site acceptance date.
- 5.3 The Contractor firm shall supply, install, test and commission all hardware and software as per the requirement of the tender with the system. Contractor firm shall supply Technical documents (hard and soft

copy - one set each) at site. The system shall be commissioned after successful completion of— SAT approval, operational & maintenance training and all the works under the scope of the tender.

6 Patents, liability & compliance of regulations

6.1 Contractor firm shall protect and fully indemnify AAI from any claims for infringement of patents, copy right, trademark or the like.

6.2 Contractor firm shall also protect and fully indemnify AAI from any claims from Contractor firm's workmen/ employees, their heirs, dependents, representatives, etc. or from any other person(s) or bodies/ companies, etc. for any act of commission or omission while executing the order.

6.3 Contractor firm shall be responsible for compliance with all requirements under the laws and shall protect and indemnify AAI completely from any claims/penalties arising out of any infringements by Contractor firm or its workmen/ employees.

7 Documentation & Training

Two set each of soft copy and hard copy of Installation, Operations including theory of operation, Technical Manual, Maintenance manual; Troubleshooting of the system, procedure for loading of the system and applicadon software, etc. shall be supplied at site. The

Technical and Maintenance manual will cover:-

- (a) Details of each active and passive component, serial no., IP address, Login Id and Password, version reports, configuration reports, Detail Bill of Material, spares, Acceleration Matrix to log a complaint etc.
- (b) General technical description, Block Diagram, Schematic/ flow diagrams (I/O level), Drawing of Passive Cabling laid in the building shall be required.
- (c) Preventive maintenance procedures & Support Escalation Matrix
- (d) Fault analysis - schematic diagrams Technical & operational manuals with user Operational Training

NOTES

1. ALL DIMENSIONS ARE IN MM.

2. DRAWINGS NOT TO BE SCALED, ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.

3. DISCREPANCY IF ANY, SHOULD BE BROUGHT TO THE NOTICE OF DEPTT. OF PLANNING.

No.

PRINTS ISSUED TO

DATE

LEGEND:-

SOLID ACRYLIC POLYMER OF LG HAUST'S GRD CRYSTAL BEIGE OR EQUIVALENT

SOLID ACRYLIC POLYMER OF LG HAUST'S S025 FERRY RED OR EQUIVALENT

REVISIONS

DATE

No.

STANDARD DRAWING

PROJECT TITLE

-

DRAWING TITLE

CHECK IN COUNTER DETAILS

AIRPORTS AUTHORITY OF INDIA

DEPARTMENT OF PLANNING

ARCHITECTURAL CELL

RAIL GROUND-MAIN TO THE SAKSHI AIRPORT, NALDEHAR

SCALE

1:10

DATE

5/07/19

DRG.NO.

DET-011

5/07/19

JOB NO.

1000

962

290

190

220

100

775

250

1200

125 HIGH FALSE FLOOR

540

924

245

240

300

125

BTP

ATB

404

1000

962

325

100

775

250

1200

SOLID ACRYLIC POLYMER OF APPROVED COLOUR ON 19MM BOARD AS/SPEC.

+225

+100

±00

SOLID ACRYLIC POLYMER OF APPROVED COLOUR ON 19 MM BOARD AS/SPEC.

SOLID ACRYLIC POLYMER OF APPROVED COLOUR ON 19 MM BOARD AS/SPEC.

892

300

234

8

125

100

775

250

1200

FRONT ELEVATION

COUNTER TOP OF SOLID ACRYLIC POLYMER OF APP. COLOUR PASTED ON 19MM COMM. BOARD AS/SPEC.

BTP

500

405

404

ATB

875

750

50

75

125

125 HIGH FALSE FLOOR

DRAWER

500

50

892

300

234

8

125

100

775

250

1200

REAR ELEVATION

LAMINATE FINISH OF APPROVED SHADE ON 19 MM BOARD AS/SPECS

BTP

500

300

325

50

50

100

400

145

220

100

775

250

1200

125 HIGH FALSE FLOOR

CPU

UPS

DRG 1

SECTION AT A-A

DRG-14

SECTION AT B-B

NOTES

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No.

PRINTS ISSUED TO

DATE

LEGEND:-

SOLID ACRYLIC POLYMER OF LG HAUST'S GRD CRYSTAL BEIGE OR EQUIVALENT

SOLID ACRYLIC POLYMER OF LG HAUST'S S025 FERRY RED OR EQUIVALENT

No.

REVISIONS

DATE

STANDARD DRAWING

PROJECT TITLE

-

DRAWING TITLE

CHECK IN COUNTER DETAILS

AIRPORTS AUTHORITY OF INDIA

DEPARTMENT OF PLANNING

ARCHITECTURAL CELL

RAJ. GUNDB-PAW TO THE SANGHAR IMPORT. A. DEL-49

SCALE

1:10

DATE

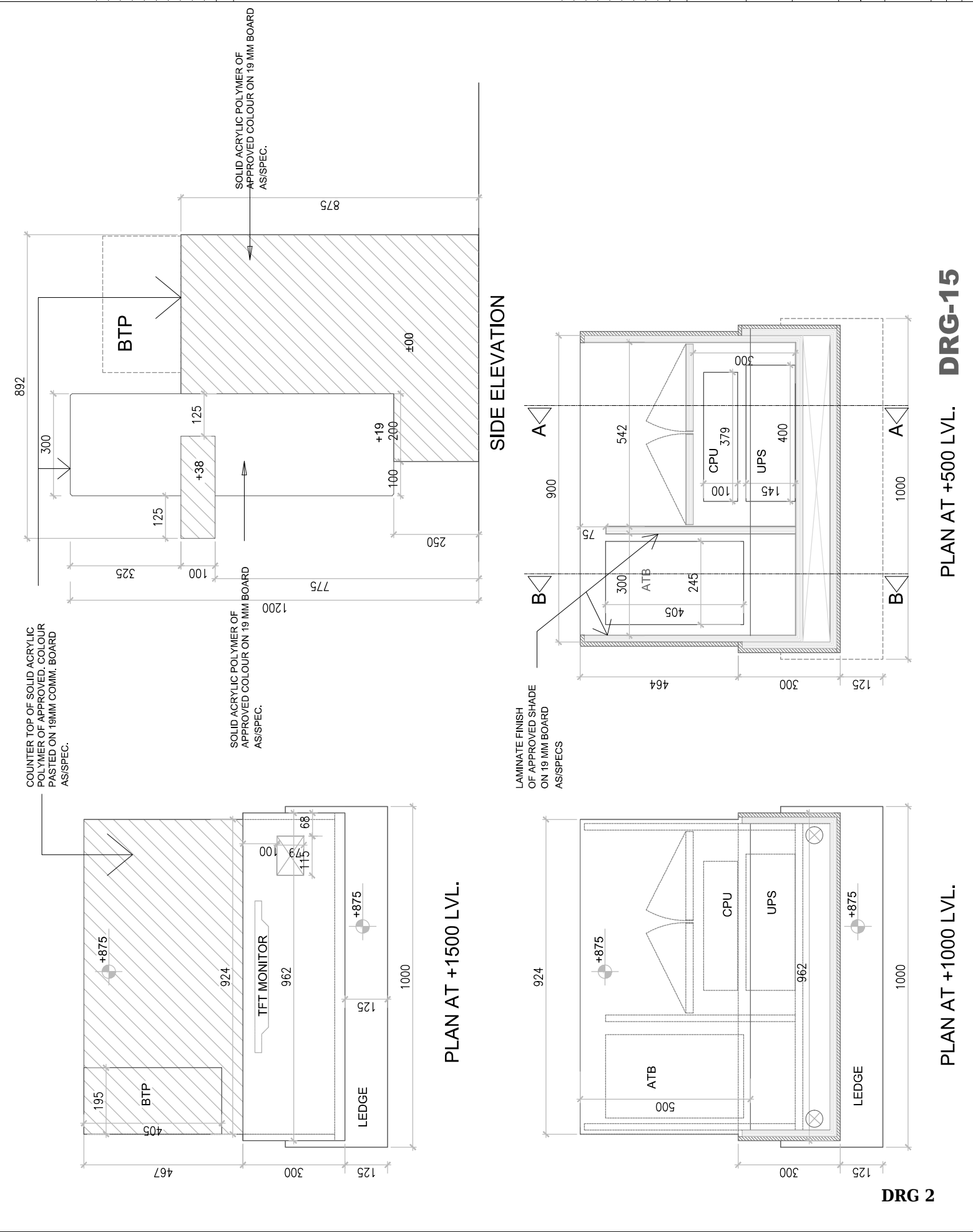
5/07/19

DRG.NO.

DET-CL-507

AR

JOB NO.



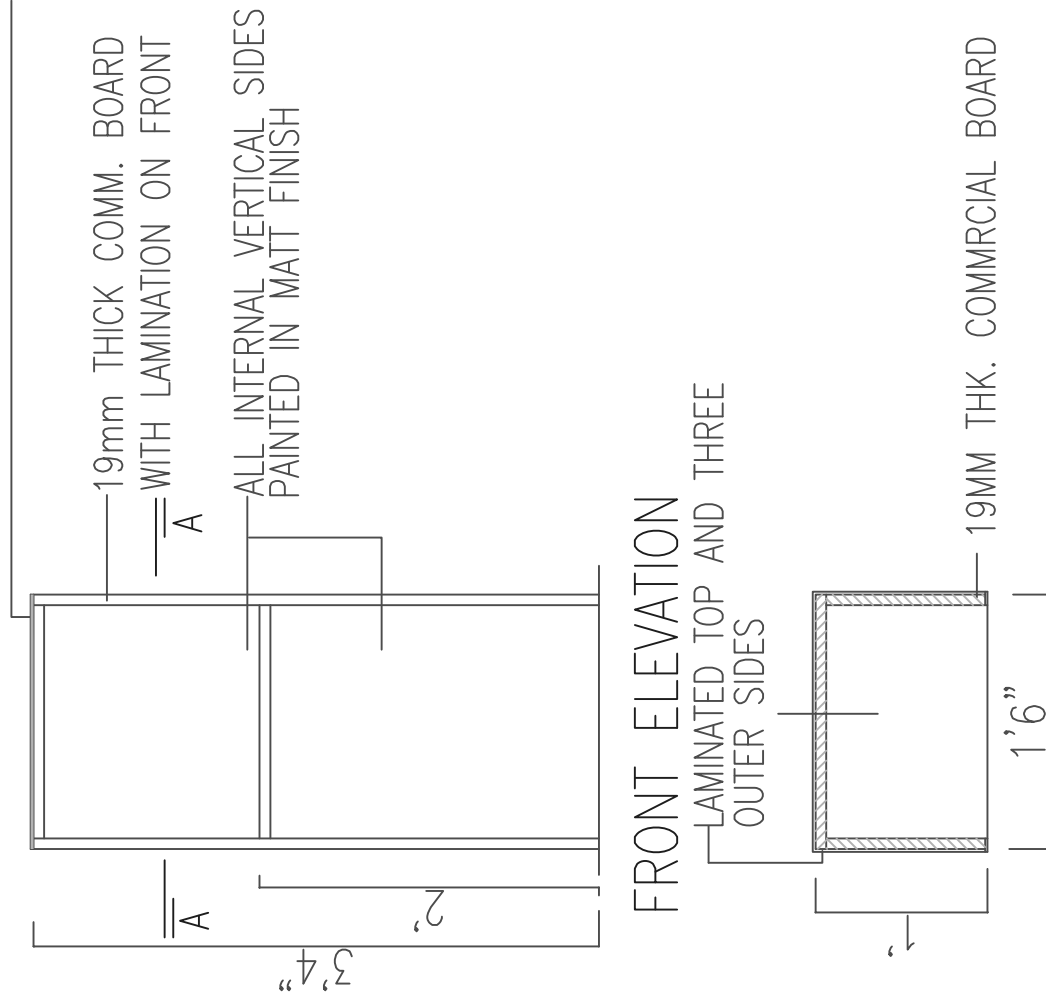
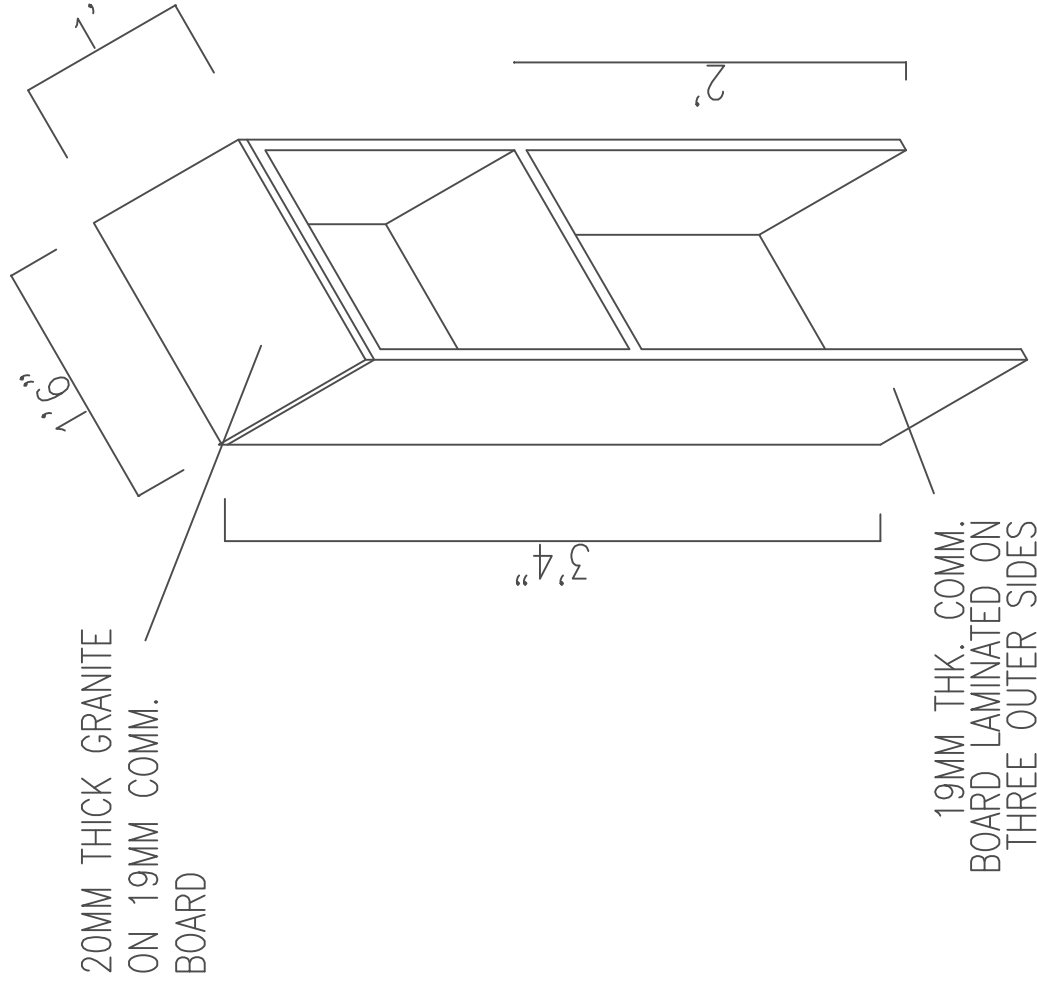
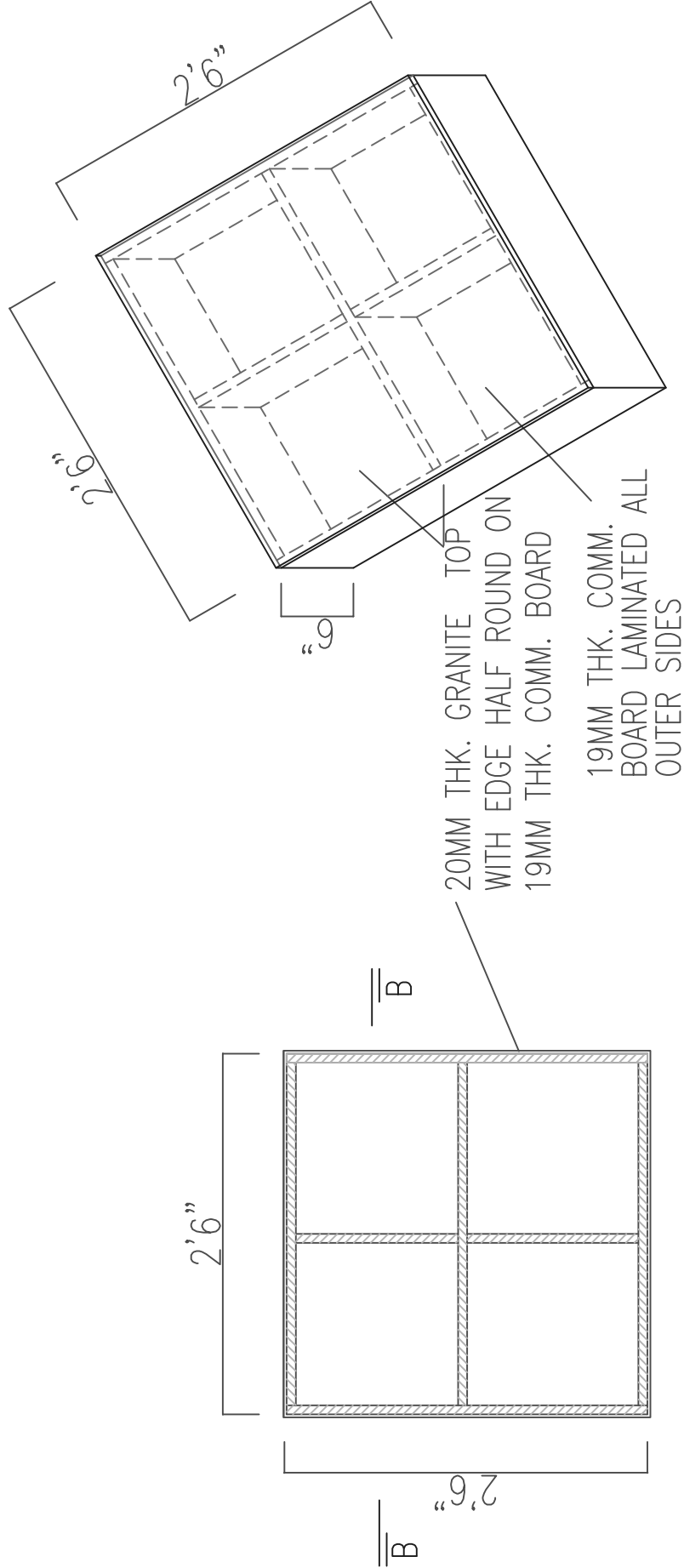


TABLE FOR STAMPING BOARDING PASSES

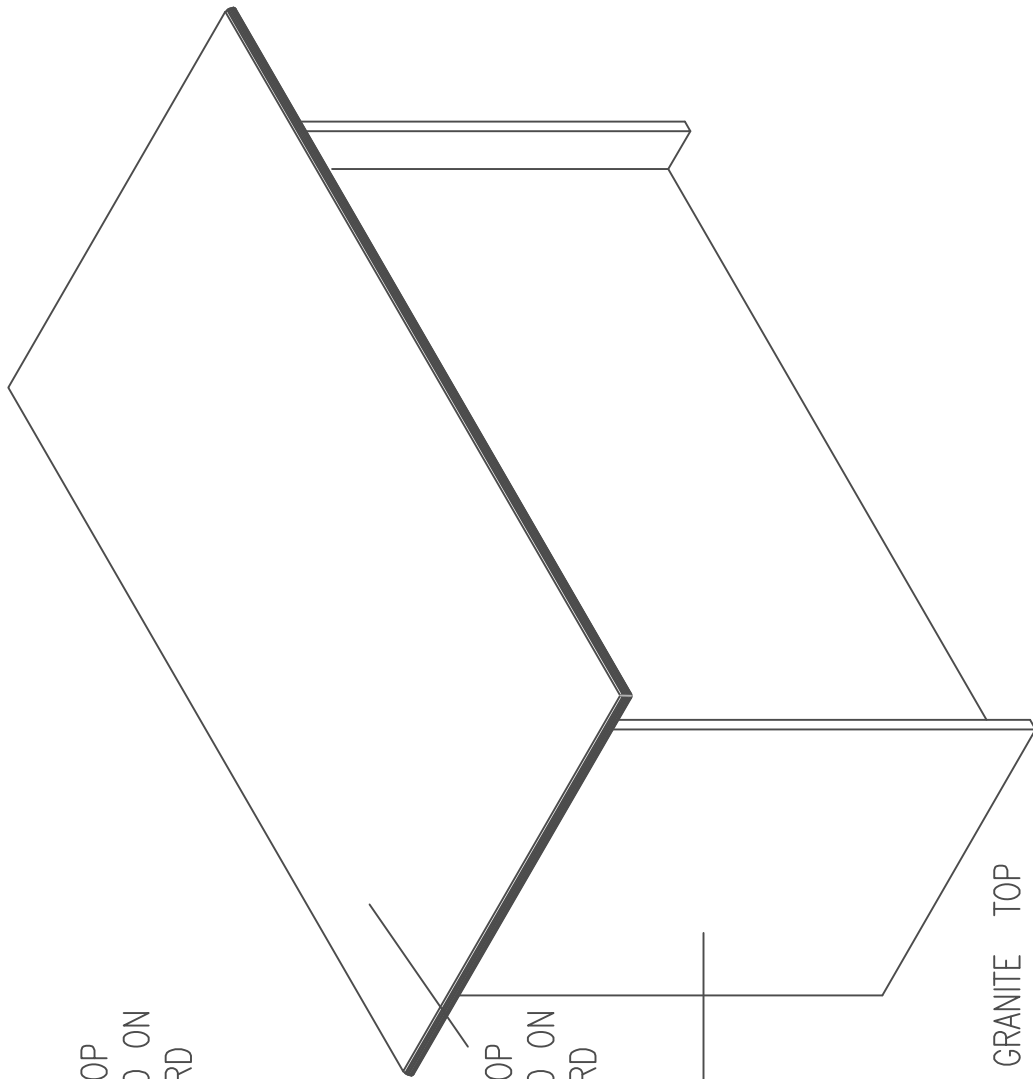


FRONT ELEVATION



SECTIONAL PLAN AT AA

STAND FOR HHMD CHECK



20MM THK. GRANITE TOP
WITH EDGE HALF ROUND ON
19MM THK. COMM. BOARD

19MM THK. COMM.
BOARD LAMINATED ALL
OUTER SIDES

20MM THK. GRANITE TOP
WITH EDGE HALF ROUND ON
19MM THK. COMM. BOARD

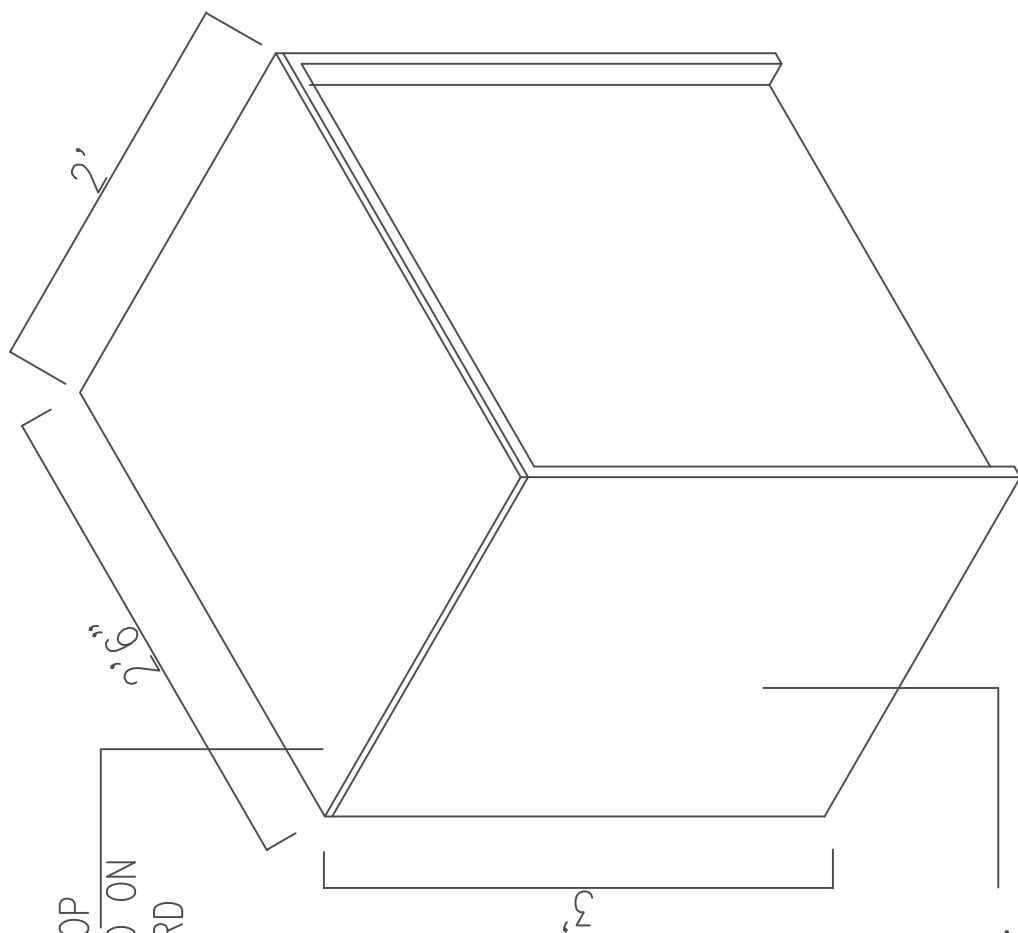
19MM THK. COMM.
BOARD LAMINATED ALL
OUTER SIDES

SECTIONAL ELEVATION BB

||B
4'6"
4'

20MM THK. GRANITE TOP
WITH EDGE HALF ROUND ON
19MM THK. COMM. BOARD
19MM THK. COMM.
BOARD LAMINATED ALL
OUTER SIDES
19MM THK. COMM. BOARD

SECTIONAL PLAN AT AA



20MM THK. GRANITE TOP
WITH EDGE HALF ROUND ON
19MM THK. COMM. BOARD

19MM THK. COMM.
BOARD LAMINATED ALL
OUTER SIDES

A

2'6"

FRONT ELEVATION

2'6"

19MM THK. COMM.
BOARD LAMINATED ALL
OUTER SIDES

19MM THK. COMM. BOARD

2'

SECTIONAL PLAN AT AA

TABLE FOR NON VALUABLE
METAL ITEMS

1. ALL DIMENSIONS ARE IN MM
2. DRAWINGS NOT TO BE SCALED ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED
3. DISCREPANCY IF ANY SHOULD BE BROUGHT TO THE NOTICE OF DEPTT. OF PLANNING.

[illegible]

COLOUR OF P.U.
COATING AT THE NECK
AND THE NAME PLATE
AS PER USAGE AND
LOCATION AND AS PER
OPERATIONAL
CIRCULAR NO. 4 OF 2014
No. OPS.720/81/4548
dated 13.10.2014

NON RECYCLABLE
WASTE- DARK GREY

KITCHEN FOOD /
COMPOSITE GARDEN
WASTE- GREEN

CAN & PLASTIC -
BLACK

No.	REVISIONS	DATE
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PROJECT TITLE	STANDARD DETAIL
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DRAWING TITLE

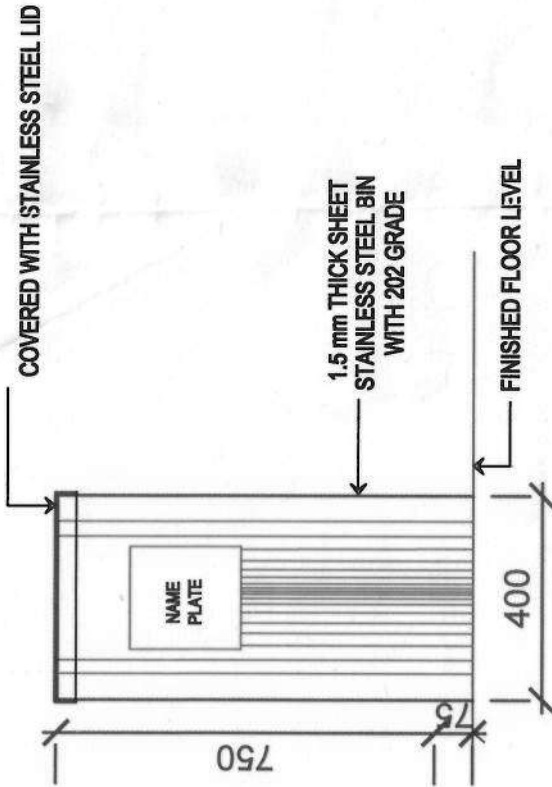
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(WITHOUT WHEELS)



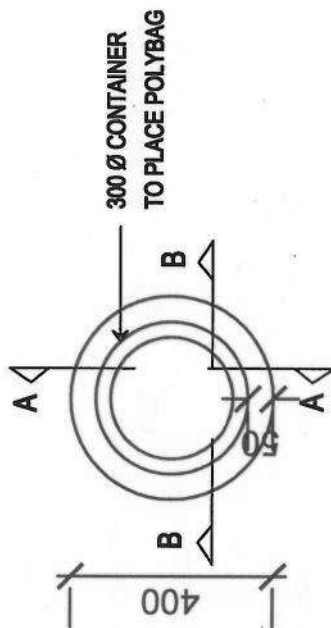
AIRPORTS AUTHORITY OF INDIA
DEPARTMENT OF PLANNING
ARCHITECTURAL CELL

AM (Dg Pg)	CG M (ARC)
RAJESH BALL	SUJOT DUTY
CM (ARON)	
AG (JOSHI)	
ED (ARON)	
G. B. S. S. S. S.	

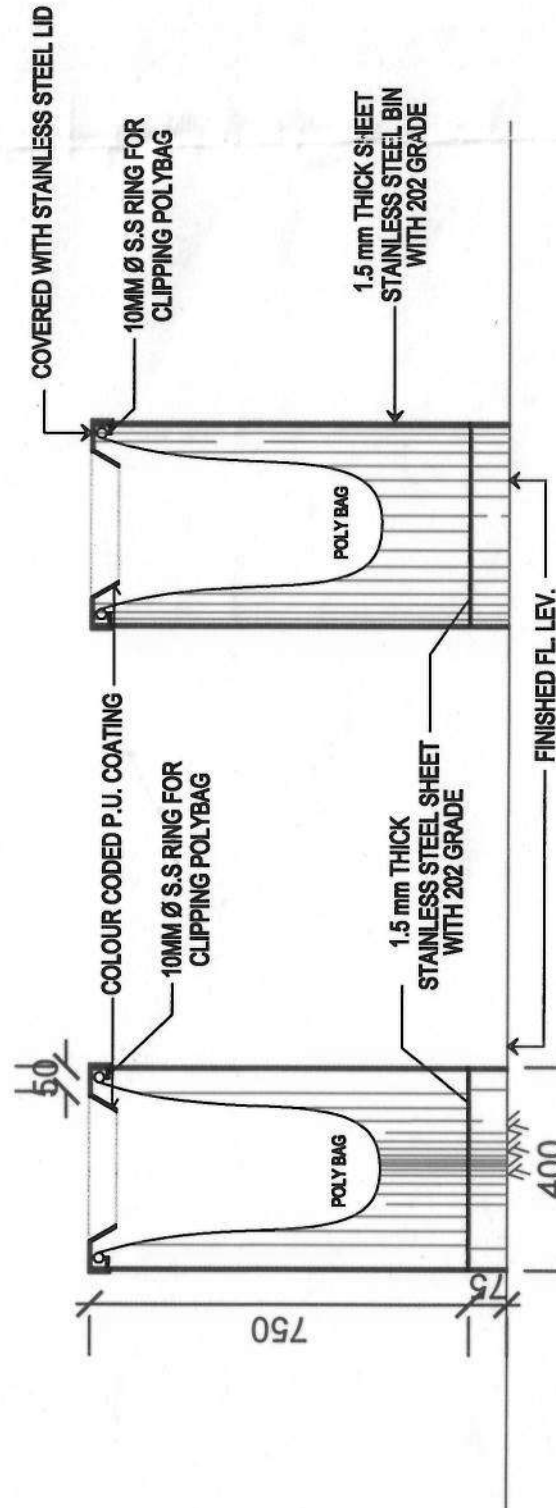
SCALE	DATE	11.05.2016
DRG. NO.	PLG/A9/STD/DB/01	R
JOB NO.		



ELEVATION



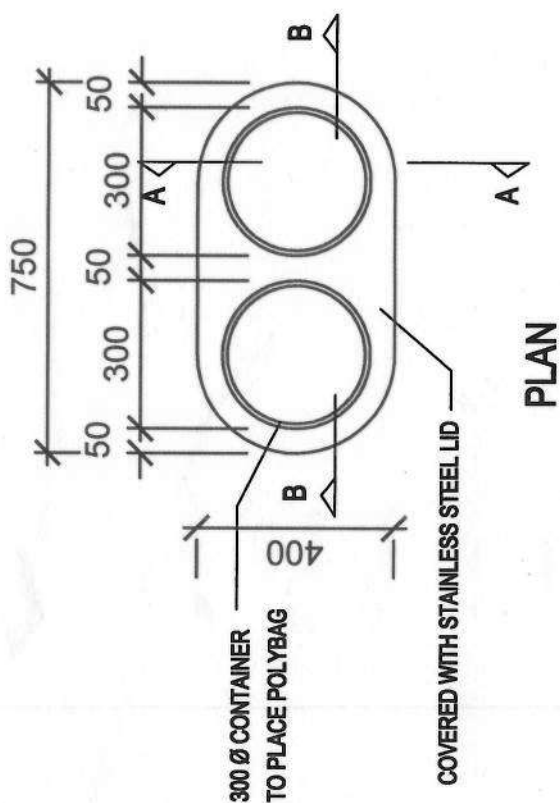
PLAN



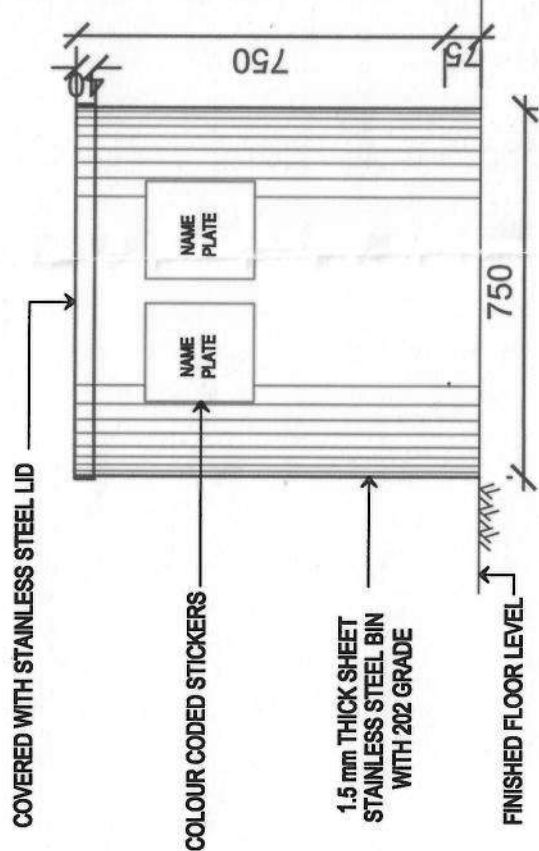
SECTION AT AA

SECTION AT BB

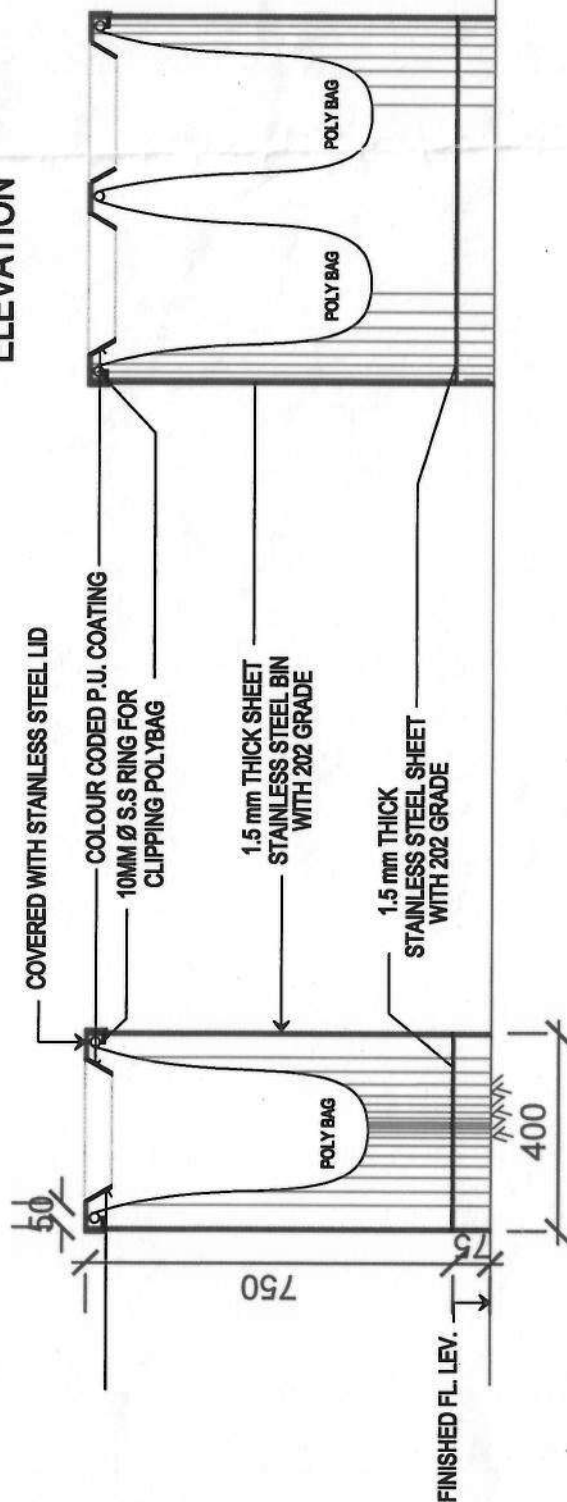
1. ALL DIMENSIONS ARE IN MM
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3. DISCREPANCY IF ANY, SHOULD BE BROUGHT TO THE NOTICE OF DEPTT. OF PLANNING



PLAN



ELEVATION



SECTION AT AA

SECTION AT BB

PROJECT TITLE	STANDARD DETAIL
DRAWING TITLE	DESIGN FOR DOUBLE DUSTBIN (WITHOUT WHEELS)
AIRPORTS AUTHORITY OF INDIA DEPARTMENT OF PLANNING ARCHITECTURAL CELL AIRPORTS & NAVIGATION DIVISION	
PROJECT NO.	DATE
APD/CPY/PLG/STD/DB02	11.07.2016
BY	FOR
S.D. JADAVI	S.D. JADAVI
SCALE	PLG/A9/STD/DB02 R
DRG NO.	JOB NO.

9/15

1. ALL DIMENSIONS ARE IN MM
2. DRAWINGS NOT TO BE SCALED ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED
3. DISCREPANCY IF ANY, SHOULD BE BROUGHT TO THE NOTICE OF DEPTT. OF PLANNING

No.	PRINTS ISSUED TO	DATE
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COLOUR OF P.U.
COATING AT THE NECK
AND THE NAME PLATE
AS PER USAGE AND
LOCATION AND AS PER
OPERATIONAL
CIRCULAR NO. 4 OF 2014
No. OPS.720/81/4548
dated 13.10.2014

NON RECYCLABLE
WASTE- DARK GREY

KITCHEN FOOD /
COMPOSITE GARDEN
WASTE- GREEN

CAN & PLASTIC -
BLACK

No.	REVISIONS	DATE
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PROJECT TITLE	STANDARD DETAIL
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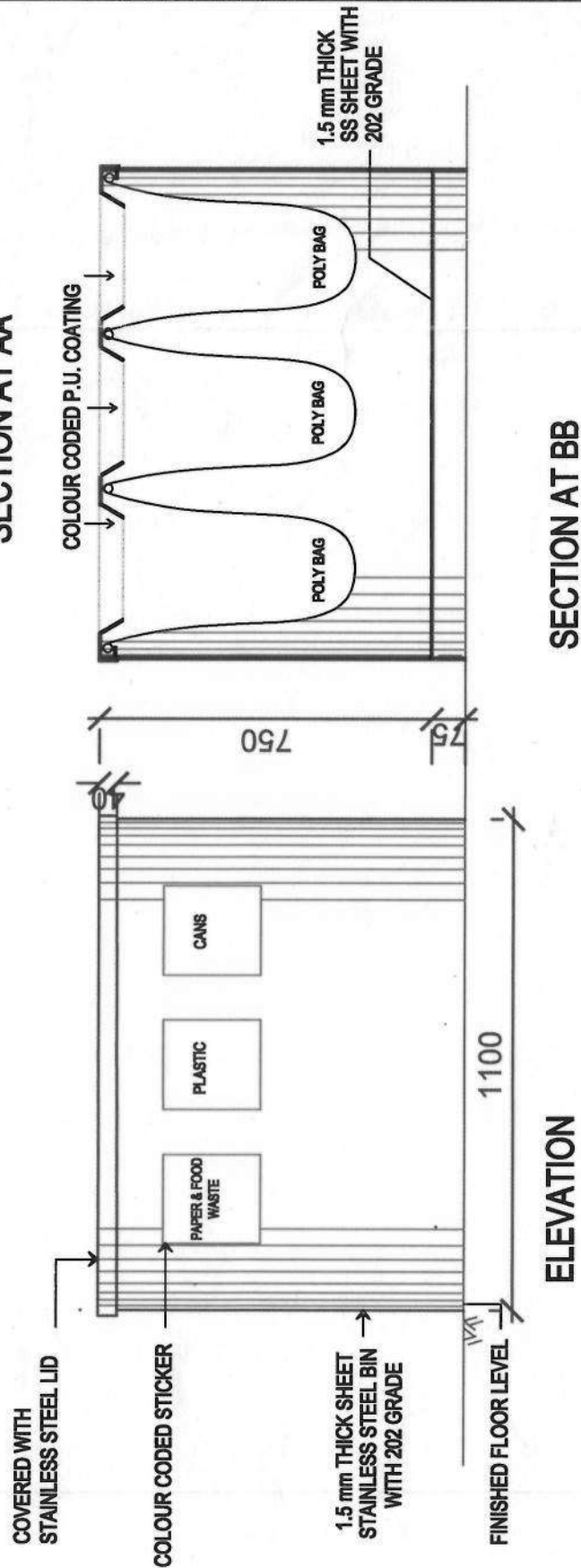
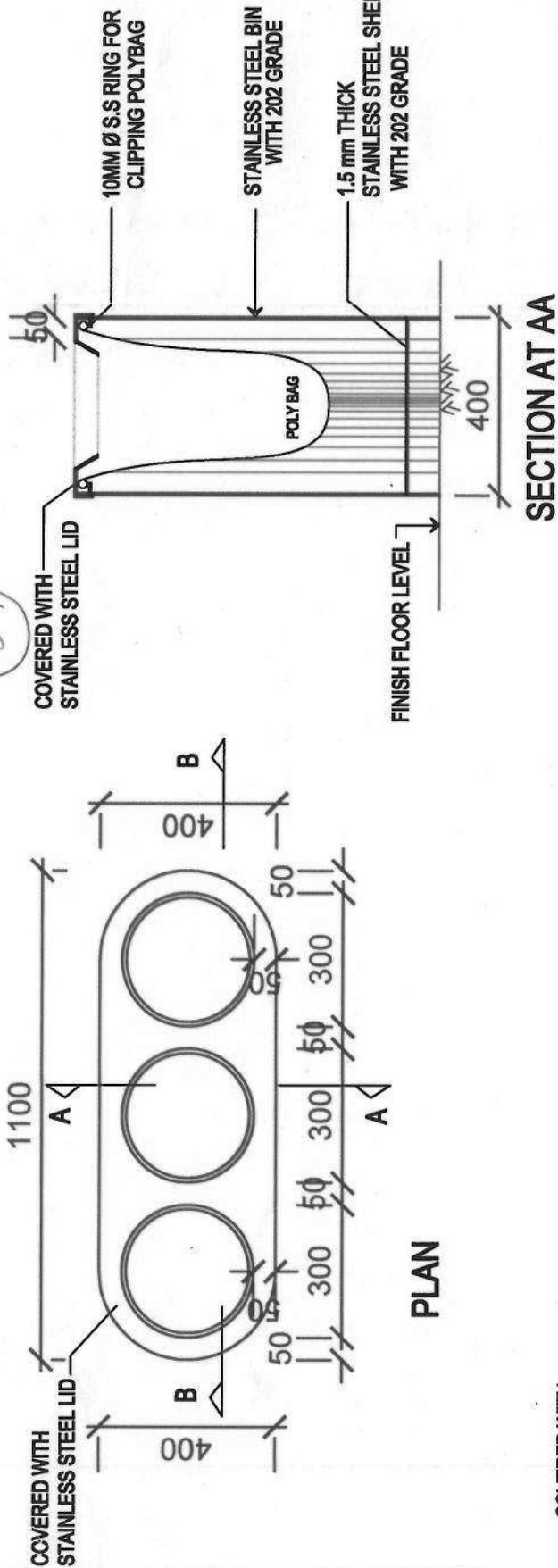
DRAWING TITLE
DESIGN FOR TRIPPLE DUSTBIN
(WITHOUT WHEELS)



AIRPORTS AUTHORITY OF INDIA
DEPARTMENT OF PLANNING
ARCHITECTURAL CELL

AM (19 Sep)	0 GM (acc)	
RAISONNABLE	0 GM (acc)	
GM (acc)		
A G JOSE		
ED (acc)		
S. BING		

SCALE	DATE 11/05/2015
DRG NO	PLG/A9/STD/DB/03 R
JOB NO.	



DRG-22

DRG 9

11/11

1. ALL DIMENSIONS ARE IN MM
2. DRAWINGS NOT TO BE SCALED ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED
3. DISCREPANCY IF ANY, SHOULD BE BROUGHT TO THE NOTICE OF DEPT. OF PLANNING.

[illegible]

COLOUR OF P.U.
COATING AT THE NECK
AND THE NAME PLATE
AS PER USAGE AND
LOCATION AND AS PER
OPERATIONAL
CIRCULAR NO. 4 OF 2014
No. OPS.720/81/4548
dated 13.10.2014

NON RECYCLABLE
WASTE- DARK GREY

KITCHEN FOOD /
COMPOSITE GARDEN
WASTE- GREEN

CAN & PLASTIC -
BLACK

No.	REVISIONS	DATE
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PROJECT TITLE	STANDARD DETAIL

DRAINAGE TITLE

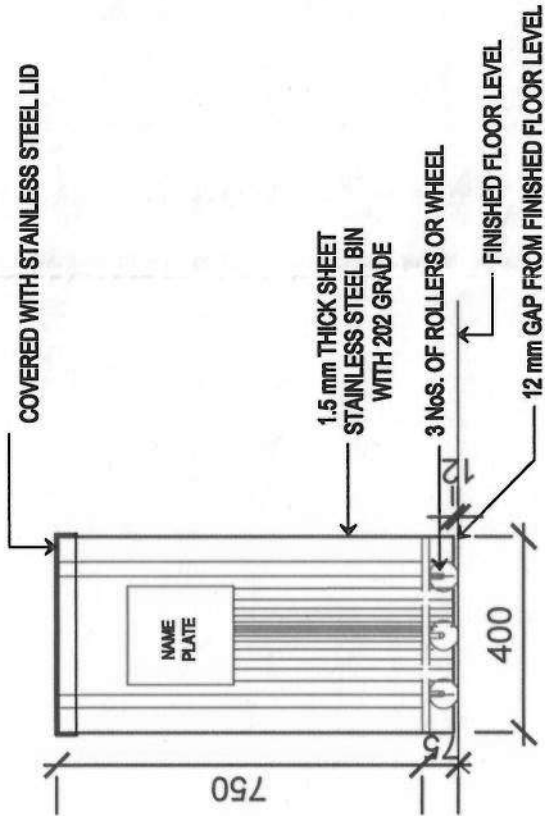
DESIGN FOR SINGLE DUSTBIN
(WITH WHEELS)



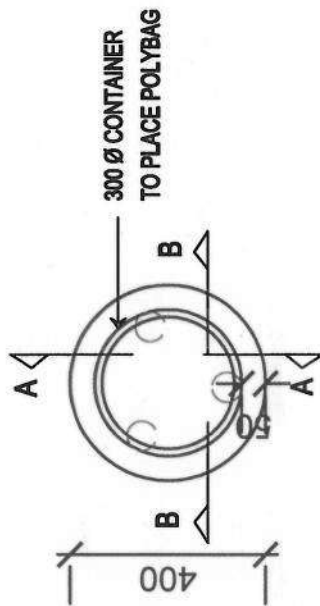
AIRPORTS AUTHORITY OF INDIA
DEPARTMENT OF PLANNING
ARCHITECTURAL CELL

A.M. (06) PG	DGM VINCEN SUZUKI ORE
B.A. (08) PAU	
B.M. (ARCH)	
A.G. (09) B	
E.D. (ARCH)	
S. BOSMA S	

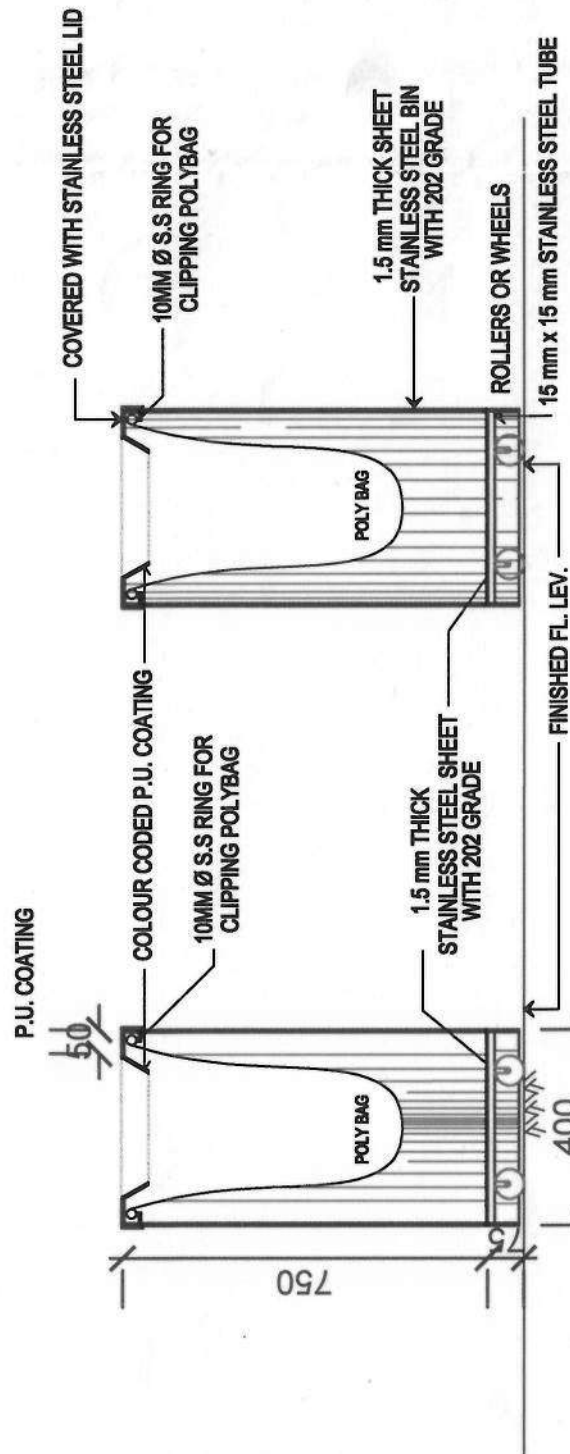
DRG. NO.
JOB NO.



ELEVATION



PLAN

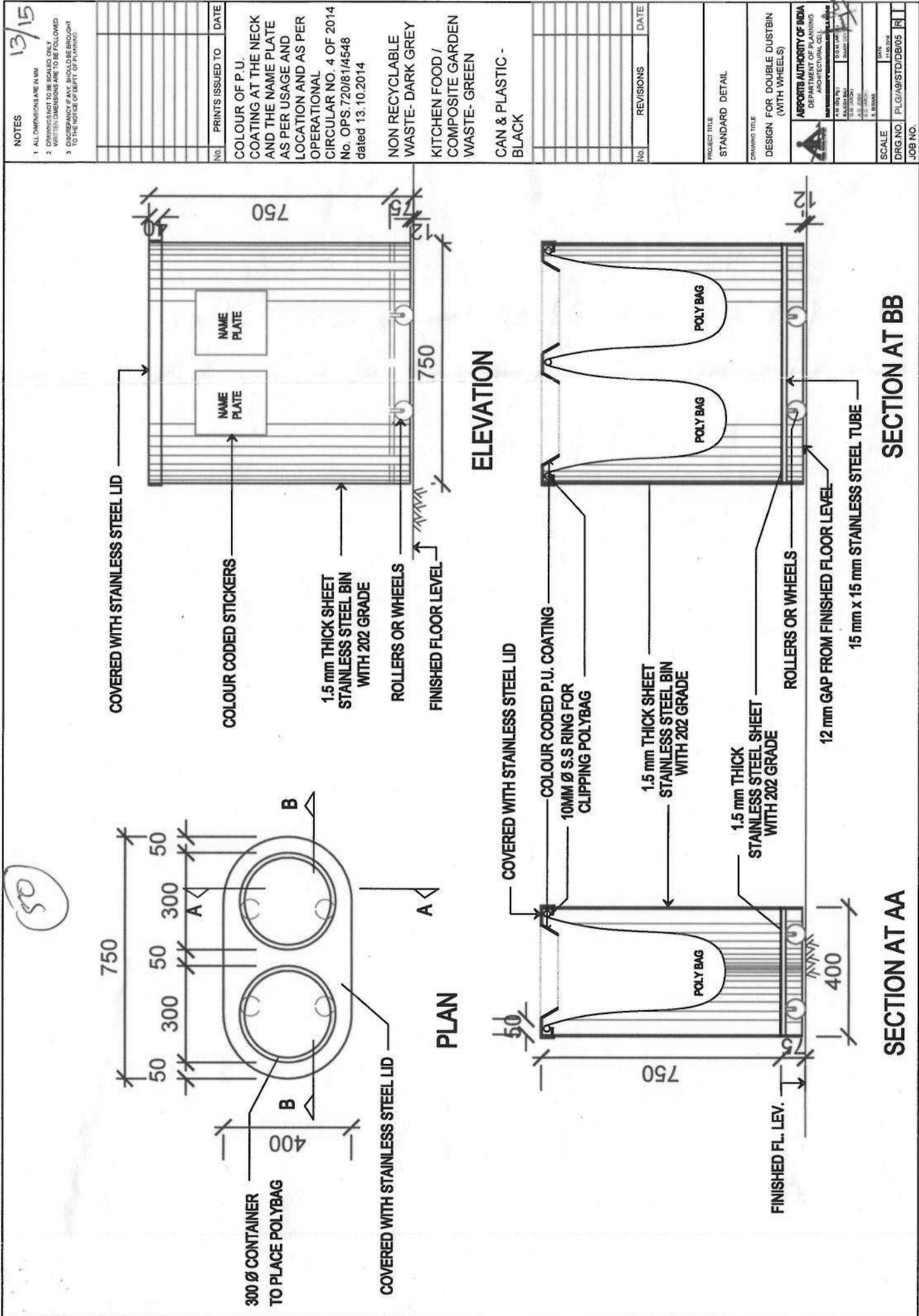


SECTION AT BB

SECTION AT AA

DRG-23

DRG 10



DRG-24



SECTION AT AA



No.	REVISIONS	DATE
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PROJECT TITLE	STANDARD DETAIL

DRAWING TITLE

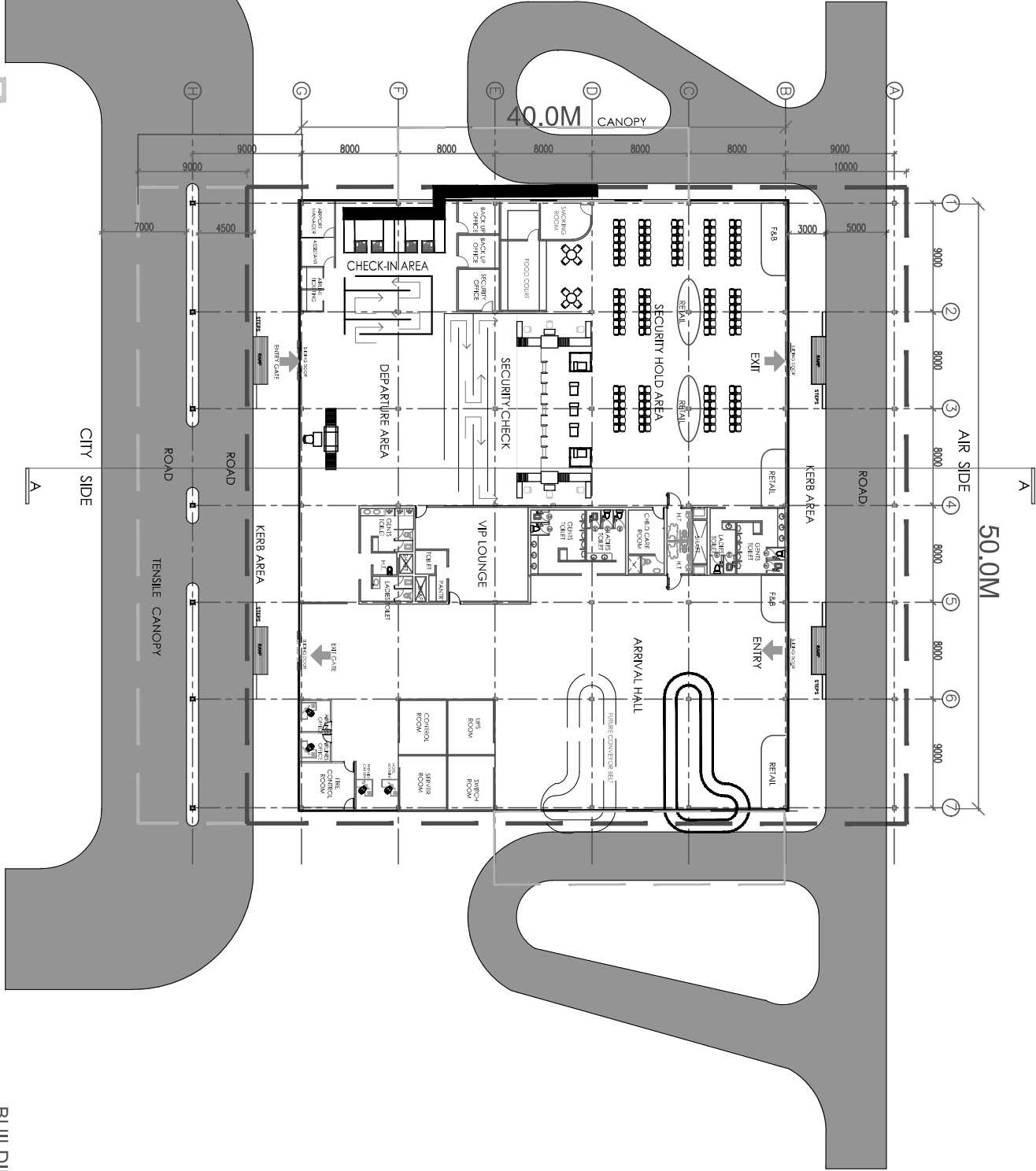
DESIGN FOR TRIPPLE DUSTBIN
(WITH WHEELS)



AIRPORTS AUTHORITY OF INDIA
DEPARTMENT OF PLANNING
ARCHITECTURAL CELL

AM (mg/kg)	0.04 MGC
NAME (ML)	SUDY DIV
GM (ARCH)	
A.G. JUNE	
ED (ARCH)	
S. NEWAS	

SCALE	DATE 11/05/2016
DRG.NO.	PLG/A9/STD/DB/06 R
JOB NO.	

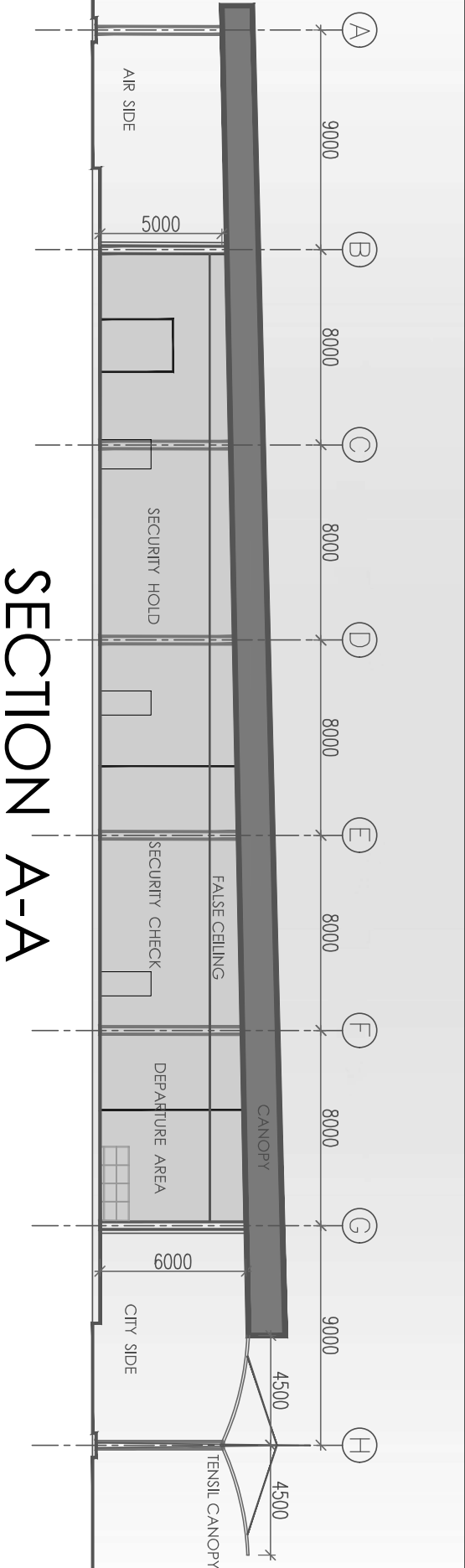


BUILDING AREA = 2000 Sq.M

GROUND FLOOR PLAN

PREPARED BY	AMIT KUMAR	SCALE
DESIGNED BY	H.S. RAJESH	
CHECKED BY	ED (P.G.)	DATE: JUNE 2020





SECTION A-A



AIRPORTS AUTHORITY OF INDIA
DEPARTMENT OF PLANNING,
AAI, RAJIV GANDHI BHAWAN,
SAFDAJUNG AIRPORT, N DELHI-110003

SECTION			
PREPARED BY	AMIT KUMAR	SCALE	
DESIGNED BY	DR. (ARCH)		
CHECKED BY	H. RAJHAR	DATE	JUNE 2020
DATE	JUNE 2020		

