Annexure

Name of Tender: Supply, Fabrication and Installation Works of Signage and Graphics including all transportation, loading and unloading, etc. for Seven Metro Stations viz.Airport, Ujwal Nagar, Jaiprakash Nagar, Chhatrapati Square, Ajni Square, Rahate Colony and Congress Nagar of Reach-1, Nagpur Metro Rail Project.

Technical Specifications

Nagpur metro - System wide color specifications:

Pantone Codes of 3435c, 3272c, 306c and Burnt Orange.

All the Signage and Graphics for Nagpur Metro shall use the following colors **Vinyl Films**: Vinyl films have been developed with manufacturers for the specific PANTONE shades, with the desired specification for a minimum performance requirement. The Engineer-In-Charge shall use these films for all the signage execution after approval. All material and execution of vinyl films shall confirm to the detailed technical specifications and notes for quality of workmanship given in this document.The Engineer-In-charge shall approve any other color used in vinyl films prior to its use.

Powder Coating: All powder coating shall confirm the to the detailed technical specifications and notes for quality of workmanship given in this document

Painting: All painting shall confirm the to the detailed technical specifications and notes for quality of workmanship given in this document.

Printing: The Engineer-In-charge shall duly approve Printing of graphics for information and safety signs shall be done as per specified printing process and workmanship quality as described in this document and samples of all colors. Every batch of printing shall be approved for color matching.

All Materials and their workmanship specifications:
For all other material required for the works, the approval of the Engineer shall be obtained by the Contractor prior to the use of the material in the works

Contractors are expected to provide the standard warranty and the invoices from the manufacturers covering all the materials used.

1 Acrylic

1.1White Cast acrylic sheets with 40% light transmission shall be used as face of all illuminated signs.
1.2 The acrylic should have excellent weather-ability and UV stability for min 10 years.
1.3 Acrylics made from virgin polymers shall be used for the sign faces
1.4 A8mm thick Acrylic sheet is proposed for illuminated sign faces with a +/- 0.6mm tolerance for the thickness
1.5 Approved make shall be as per the list below or equivalent duly approved based on a sample presented to Engineer-In-charge.

- Perspex® from Lucite®
- SHINKOLITE PX cast acrylic sheet developed by Mitsubishi Rayon Co., Ltd.
- Plexiglas from Evonik industries

2 Polycarbonate

2.1 All polycarbonate sheets should be UV stabilized outdoor grade
2.2 No visual defects are allowed by inspection from a close inspection and the material should offer a min 10years warranty against yellowing and loss of light transmission
2.3 Approved make shall be as per the list below or equivalent duly approved based on a sample presented to Engineer-In-charge.
Lexan by GE

3 Workmanship for both Acrylic and Polycarbonate

3.1 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.

3.2 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.

3.3 Flatness of the sheets is very important for the signs to appear neat.

3.4 The cutting shall be done using powered saw to a tolerance of +/- 1mm. The edges shall be cleaned of any bur and chamfered to make the acrylic comfortably sit inside the frame.

4 Vinyl Films

4.1 Block out vinyl films

4.1.1 Cast films should to provide complete light blocking characteristics with less than 0.001% light transmission.

4.1.2 A luster/matt finish colour matching to Pantone 2768C and 382C on the outside and uniformly white on the adhesive side

4.1.3 A cast vinyl face film of thickness between 100 to 130 micron, with clear acrylic based permanent pressure sensitive adhesive.

4.1.4 The film shall provide strong adhesion to a wide variety of substrates with perfect dimensional stability and perform well as second surface media.

4.1.5 The films should have self extinguishable property.

4.1.6 Should have a performance guarantee against colour fading, peeling, cracking

4.2 Transluscent Vinyl film

4.2.1 Translucent Graphic Film to allow light transmission

4.2.2 Cast vinyl film of thickness (0.05 mm) with clear pressure sensitive adhesive

4.2.3 A cast vinyl film with a clear, permanent, pressure-sensitive adhesive and a translucent synthetic liner that does not split if wet

4.2.4 The films should have self extinguishable property.

4.2.4 Should have a performance guarantee against color fading, peeling, cracking

4.2.5 Should be able to withstand temperatures in the range -45° to +77°C

4.3 Protective over-laminate

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 a maximum life specified within the range manufactured by supplier and all warranties for the above products shall apply.

Pantone Ref	Application Requirements
3435c	Blockout
3272c	Blockout
306c	Blockout/Translucent
Burnt Orange	Blockout/Translucent

4.4 Diffuser films

4.5 Frosted vinyls

4.6 Printable vinyls

4.7 Opaque vinyls

4.8 Printable floor application

4.9 Floor laminate

4.10 Photoluminiscent (Avery Glow in Dark –VF, product code AVFG302N12450)

4.10 Suggested product names for various products from approved manufacturers

1) 3M
2) Avery(Optional with pre approval from NMRCL)

3M Specifications(Primary and Compulsury)

3M Specification	Color/Feature
3630-126 DK EME GREN 48INX50YD	Dark Emerlad Green
3630-236 48IN X 50YD	Turquoise
3630-124 BURNTORANGE 48INX50YD	Burnt Orange
3630-57 48"X50Y O.BLUE	Olympic Blue
3635-100 Light Enhancement	Light Enhancement Film
3635-22B BLACK BLOCKOUT MATTE	Black Block Out Film
3635-20B 48"X50Y WHITE	White Block Out Film
3635-30 48"X50Y Diffuser Film	Diffuser Film
Matte Overlaminate 3660M	Overlaminate for Color Vinyl
3M 180C-10 Printable Film	Printable Film
3M 8520 Matte Overlamination	Overlamination for 180C-10

Avery Dennison Specifications

Alternate Selection(Optional with pre approval from NMRCL)			
Pantone Shade	**Block Out**	**Transluscent Vinyl**	**Warranty**
Pantone 3435 C	5300/ 205A Green	5500 QM/4120A Green	5 Years
Pantone 3272 C	5300/ 204A Green	5500 QM/4121A Green	5 Years
Pantone 306 C	5300/203A Blue	5500 QM/4122A Blue	5 Years

All the vinyl film shall be from the approved vendor/supplier and shall be approved by the Engineer-In-charge before ordering.

5 Workmanship for Vinyl pasting (Plotter cut Vinyl sheet graphics/text)

5.1 Vinyl shall be pasted on Acrylic sheets and on ACM after removing the masking film.

5.2 Proper preparation of application surface is essential to obtain high quality and long lasting markings.

5.3 Application:
- 5.3.1 Clean the substrate as per recommendation of vinyl manufacturer.
- 5.3.2 Remove entire liner from adhesive side of film.
- 5.3.3 Align the film and press one edge to surface with finger.
- 5.3.4 With a squeeze, apply remaining film using overlapping strokes. Hold the film away from surface to avoid pre adhesion.

5.4 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.

5.5 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.

5.6 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.

5.7 For all the sign faces - the film should be wrapped around the edge of acrylic with up to a min distance of 25mm on all sides.

5.8 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.

5.9 Self matching and complementing films should be used for all situations involving layers of films laminated in a single sign.

5.10 The graphics for the Blockout 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.

5.11 The final applied graphics shall be free from any kinds of wrinkles, air bubbles and placement/orientation problems.

5.12 Contractors are expected to provide the standard warranty and the invoices from the vinyl manufacturers covering all the vinyl used.

6 Printing

6.1 The graphics and text of the signage system shall be printed with inkjet printers
6.2 Ink type: solvent ink, designed for 2 years outdoor application
6.3 Provide a hard lamination film to resist scuffing, scratching
6.4 Ink color: cyan, magenta, yellow, black
6.5 Same colours of the signages shall be uniform as specified and shall not vary from sign to sign. Printer has to get approval on all printed colours in graphics matching to specified PANTONE colours and submit 3 copies of each swatch 100mm X 100mm
6.6 Facility of printing directly onto a variety of specially treated vinyls and other materials

6.7 Machine to accommodate media widths of up to 62 inches and offers resolution of 300dpi
6.8 Graphics and text shall be without any ink bleeding and smudging
6.9 The printer agrees to produce and maintain high quality standards

7 Aluminium Composite Material (ACM/ACP) :

7.1 Composition:
Low-density polyethylene (LDPE) core sandwiched between two skins of aluminium alloy.
For exterior signs Overall thickness of ACM/ACP: 4 mm

7.2 Surface Finish :

7.2.1 Front side: Factory pre-finished by the manufacturer with a PVDF Kynar 500 (70:30) or LUMIFLON or DURAGLOSS 5000 based coating.

- The finished surface shall be factory protected with a self-adhesive peel-off-foil.
- Peel-off-foil to withstand at least 6 months exposure to local weather condition without losing the original peel off characteristic or causing stains or other damages to the painted panel surface.

7.2.2 Reverse side: Reverse side of the panel surface shall be coated in a factory applied protection lacquer or protective primer, without protective peel-off-foil. Total dry-film thickness of the protection lacquer/ protective primer shall be minimum 4 microns or mill finish if Marine grade Aluminium EN-AW-5005A (AlMg-1)/ EN-AW-3004 (AlMn1Mg1) is used.

7.3 Colour Definitions:
The white colour panel to be used in all signs shall be approved prior to its use by presenting a sample to the Engineer-in-charge.

7.4 Warranty:
ACM/ACP manufacturer shall provide a 10 (TEN) years Warranty against defects such as but not limited to :

- De-lamination.
- Color fading
- Loss of gloss.

For this purpose Original of Manufacturers Warranty certificate in the name of the contractor to be submitted with the bill.

7.5 Mandatory identification marks:

7.5.1 Each ACM/ACP panels shall bear markings as follows:
On Peel-off-foil:

- Manufacturer's name/brand printed clearly for easy identification.
- Direction of grains for metallic colors, by way of an arrow.

The reverse side of the panel to have the following minimum information printed:

- Production batch identification number or Date & Time of production of ACM/ACP panel for establishing linkage with the batches.
- Any other information as per manufacturer's policy such as paint reference number etc.
- Manufacturer's name/brand printed clearly for easy identification.

7.6 General Conditions:

7.6.1 ACM/ACP supplier shall provide technical assistance to the selected converters using their material. The training/ assistance to include advice on the use of appropriate equipment and hardware for ACM/ACP fabrication and installation. The training/ assistance to include training to the selected ACM/ACP converters' personnel in India/ Abroad, for correct methodology to be adopted for ACM/ACP fabrication and installation.

7.6.2. Engineer-in-Charge may ask for training schedule/ report from the converter and/ or manufacturer under (inter-alia) following conditions :

- Inability to produce designs as per specifications despite efforts on the part of the converter.
- If the workmanship of signage elements is found to be unacceptable/ poor.
- No further application of paint by means of any method shall be permitted after first painting of ACM/ACP at the manufacturer's factory. No repair/ touch-up of factory finished paint coated surface shall be permitted at any time. Engineer-in-Charge may reject such sign elements at no cost to NMRL.

7.7 ACM/ACP (Aluminium Composite material) panel should conform to following standards:

Table

S. No.	Description	Standard Test	Acceptable Value/Result
A.	Physical Tests For ACM/ACP		
1.	Overall Thickness of ACMACP	Visual Check/ Measurement as per QAP	4mm (± 0.2mm) Exterior 3mm (± 0.2mm) Interior
2.	Aluminium Skin Thickness (each side)	Visual Check/ Measurement as per QAP	0.5mm(+0.04mm)/(-.025 mm) Exterior 0.25mm(+0.04mm)/(-.025 mm) Interior
3.	Panel weight (ACM/ACP)	Visual Check/ Measurement as per QAP	5.5 Kg/m^2 (± 5%) Exterior 3.8 Kg/m^2 (± 5%) Interior
B.	Mechanical Properties of ACM/ACP		
1.	Peel off strength Drum Peel Test	ASTM D 1781 or ASTM D 903	> 72 mmN/mm or More than 4N/mm
C.	Properties of Aluminium Skin		
1.	Tensile strength (Rm)	ASTM E8	Minimum 110 N/mm^2
2.	Modules of elasticity	ASTM E8	Min 68000 N/mm^2
3.	Elongation	ASTM E8	A_{50} 2%
4.	0.2% proof stress	ASTM E8	Minimum 100 N/mm^2
D.	Properties of Paint Finish (Front Side Only)		
1.	Coating Type	Using FTIR (instrument) or chemical method	DURAGLOSS – Cycloaliphatic Polymer Resin Cross-Linked with a specific melamine blend LUMIFLON – Fluoro Ethylene Alkyl Vinyl Ether PVDF – Polyvinylydenfluorid
2.	D.F.T. (Dry Film Thickness) of paint	ASTM D 1400 or ECCA T1	23.75 Micron to 45 Micron
3.	Specular Gloss	ASTM D 523 or ECCA T2	Solid Colors 25-40% Metallic Colors 20-35%
4.	Abrasion Resistance	ASTM D 968 or ASTM D 4060	>25 liters per unit or < 45mg/ 1000 cycles (weight loss)
5.	Gloss Retention	ASTM 523 or ECCA T2	Min 60% (after 10 years)
6.	Color Retention	ASTM D 2244 or ECCA T3	5 units (Max.) over 4000 hrs.

Table			
S. No.	Description	Standard Test	Acceptable Value/Result
7.	Chalk Resistance	ASTM D4214 or ECCA T14	Max rating 8 units after 4000 hrs.
8.	Adhesion	ASTM D3359 or ECCA T6	No adhesion loss permitted

7.8 Approved Makes :

- Õ Aluco Bond from Alcan Composite, Germany
- Õ Alupolic from Mitsubishi, Japan
- Õ Reynobond from M/s. Alcoa, France

8 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 Fabrication work for CRCA Mild Steel sheets

9.1 The Metal handling and Fabrication work for CRCA Mild Steel sheets shall be got executed from a specialised agency.

9.2 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 CO_2welding and skilled CAD/CAM facilities, engineers and skilled and trained personnel and adequate storage facilities.

9.3 Sheet metal blanking shall be preferably done using laser cutting to save on material, reduce wastage, have less burr on cut blanks, speed of execution and achieve accuracy

9.4 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.

9.5 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.

9.6 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.

9.7 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

9.8 If the work for sheet metal is done with specialized agency the contractor shall be required to submit to the NMRL copies of all the vouchers received from the approved fabricator and cheques/drafts paid by him to the approved fabricator as well as the copies of the documents establishing the excise paid by the fabricator for this work.

9.10 Finish for sheet metal 0.062" (1.6 mm) CRCA

9.11 Surfaces indicated "A" finished to match sample

9.12 Surfaces without identification or indicated "C" to be unfinished.

9.13 Parts to be free of visible defects on "A" and "B" surfaces.

9.14 Flat surfaces to have: Flatness tolerance of 0.05 mm per 25 mm. Not to exceed 0.50 mm over the entire surface.

9.15 Each Part to be approved by Engineer-In-charge prior to production.

9.16 Definitions:

- "A" surface: The top or front, most often viewed surface by consumer.
- "B" surface: Generally the front edge/sides or back/bottom of a part. Not viewed as often as an "A" surface.
- "C" surface: Internal surfaces. Part surfaces not normally seen. Normally "c" surfaces are not inspected for cosmetic attributes.

10 Aluminium Sections:

10.1 Aluminium plates and sections shall conform to Aluminium alloy of grade 63400 WP of IS-733.

10.2 For information signs off-the shelf Aluminium sections shall be procured which snap-close using a spring clip creating a hinged action holding the infill panels in place.

10.3 Vandal proof sections shall be used, which secure type is requiring a special tool to open. Image included below for reference.

10.4 These sections shall be capable to hold a total infill panel upto a maximum thickness of 8mm and shall have the rigidity to make A0 size panel frames.

10.5 All sections shall be perfectly straight free from surface damages, bends and twists.

10.6 Bent profiles shall not be forcefully straightened.

10.7 Straightness tolerance shall not exceed of 1.5mm per 1000 mm.

11 Structural Steel

All structural steel shall be of tested quality and shall conform to one of the following standards

IS:226 Structural steel (Standard Quality)
IS:2062 Structural steel (Fusion welding quality) Grade A (1992)
IS:961 High Tensile Structural Steel (Ordinary)
IS:1161 Steel Tubes for Structural purposes Grade B (1992)
IS:4923 Hollow steel sections for Structural use

The 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 Contractor shall arrange for testing of the steel samples as per IS:1608 - 1599.

12 Welding Electrodes: Welding electrodes used for the works shall conform to IS:814/latest and shall be supplied by manufacturer approved by the Engineer and shall be of the grade approved by the Engineer. All Electrodes shall be kept under dry conditions. Any electrode which has part of its flux coating broken away or is damaged shall be rejected.

13 Bolts and Nuts: Bolts and nuts used for the works shall unless otherwise specified be black bolts and nuts supplied by manufacturer approved by the Engineer and shall confirm to IS:1367 and 1367 (1980)
For the truss hot-dip galvanised (@300 gm/sqm) bolt sleeve of mild steel grade 'B' conforming to IS:2062 and 4 dia 12mm anchor bars welded to same as per detailed drawing and instruction of the engineer shall be provided. The Length and diameter of sleeve shall be 300mm and 60mm respectively. The sleeve shall receive hexagon head bolt IS:1363 (part-I)- ISO 4016-M-20x90-8.8. Hexagon head bolt shall be provided with galvanised spring washer as per the detailed drawing and instruction of the Engineer.

14 Washers: Plain washers shall be made of mild steel conforming to IS:5369 (1975), unless otherwise specified. One washer shall be supplied with each bolt and, in case of special types of bolts, more than one washer as needed for the purpose shall be supplied. An additional double coil helical spring washer, conforming to IS:6755

(1980), shall be provided for bolts carrying dynamic or fluctuating loads and those in direct tension. Tapered washers, conforming to IS:5372 (1975) and IS:5374 (1975), shall be used for channels and beams respectively wherever required.

15 Structural steel works:

15.1 These specifications shall be read in conjunction with the CPWD specifications 1996 and other relevant reference specifications described in the section 1 of these specifications.

The Contractor will provide all materials and equipment required to complete the works in every respect, whether such materials are required as part of the permanent structures or temporary for fabrication or erection or maintenance including specifically structural steel plates, flats, bars, welding rods, rivets, bolts and nuts, paint, welding sets in the shop and at site, all workshop facilities, derricks, cranes, pulley blocks, wire ropes, hemp or manila ropes, winches, erection cleats and temporary braces or supports and all other materials required to deliver the Works complete in every respect.

All labour required for fabrication and erection for any cleaning, making good, rectifying, hauling, painting and for any other ancillary work required to complete fabrication and erection.

The Contractor shall observe all safety requirements for erection of structural steelwork as covered in IS:7205.

15.2 Drawings:

15.2.1 The Engineer will supply to the Contractor profile drawings showing sizes of all structural members and typical connection details.

15.2.2 Should there be any discrepancy in the drawings the Contractor is to refer the matter to the Engineer. The Contractor shall further provide a 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.

15.2.3 The Contractor is to prepare all the necessary fabrication shop drawings and these shall be submitted to the Engineer in duplicate and be approved by him before fabrication is commenced. All such drawings shall show the dimensions of all parts, method of construction, welding and bolting. A further set of all approved fabrication drawings shall be supplied by the Contractor for use of the Engineer as required.

15.2.4 Approval by the Engineer of drawings or any other particulars submitted by the Contractor shall not relieve the Contractor of full responsibility for any discrepancies, errors or omissions therein. The Contractor shall at his own expense supply such additional copies of his working drawings as arerequired for the use of the interested parties.

15.3 Workmanship and Fabrication:

15.3.1 For all the works, workmanship shall be of first class quality, throughout, In conformity with IS:800 (latest), and true to line, level and dimension as shown in the drawings or instructed by the Engineer.

15.3.2 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 not 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.

15.3.3 Cutting shall be done automatically. Hand flame cutting will not be permitted.

15.3.4 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.

15.3.5 Holes for bolts shall be drilled to conform to clause 10 of IS:7215 (1974). Punching of holes will not be permitted. All drilling shall be free from burrs. No holes shall be made by gas cutting process.

15.3.6 All welding for the works shall be carried out by first class welders and shall be in accordance with IS:816, IS:819, IS:1024, IS:1261, IS:1323 and IS:9595.The Engineer 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 Contractor at his cost.
Safety requirements should conform to IS:7205, IS : 7273 and IS : 7269 as applicable and should conform to safety, economy and rapidity.

15.3.7 As much work as possible shall be welded in shops. 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 tack welding must be strong enough to hold the parts together but small enough to be covered by the general welding. The welding procedure shall be so arranged that the distortion and shrinkage stresses are reduce to a minimum.

15.3.8 All joints required in structure to facilitate transport or erection shall be shown on the drawings or as specified by the Engineer. Should the 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. The lengths of structural shall be the maximum normally available in the market jointing of shorter length in order to make up lengths required shall not be permitted.

15.3.9 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.

15.3.10 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 Contractor to the approval of the Engineer.

15.3.11 All members of trusses and lattice girders shall be straight throughout their length, unless shown otherwise on the drawings, and shall be accurately set to the lines shown on the drawings. Sheared edges of gussets or other members to be straightened and dressed where necessary.

15.3.12 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.

15.3.13 Apart from the requirements of welding specified under the above sub clauses, sections above, the 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.

15.3.14 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 centre of the joint outwards.

15.4 Testing of Welds :

15.4.1 Butt welds - Radiographic testing of 5% of welds as per IS 1182.
15.4.2 Fillet Welds- Ultrasonic testing of 5% of welds.
15.4.3 All welded connections shall be inspected as per IS:822.
15.4.4 All welds shall be tested by “dye penetration test” as per current practices.
15.4.5 Agency for testing of weld shall be approved by the Engineer prior to testing.
15.4.6 Defected welds shall be repaired or replaced as decided by the engineer. The repaired or replaced welds shall be tested using the same methods as above. Additionally, when defective welds are found, the cause of the defective welding shall be determined and the contractor shall institute immediate corrective action.
15.4.7 No extra payable shall be made for the tests indicated above.

15.5 Protection of Steel Works (IS:8629) :

15.5.1 Sand blasting where specified shall be carried out in accordance with IS:1477.

15.5.2 Painting work shall be carried out in accordance with IS:8629 (Parts I to III).
Painting shall be applied under the temperature requirement specified by the manufacturer.

15.5.3 The steel work, prior to delivery, shall be cleaned form scale, rust, dirt and grease etc., but 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.

Paint brushes round/oval and flat shall be conforming to IS:487 and IS:384 codes respectively, if painting with brushing is approved by Engineer.

The spraying equipment shall be compatible with the paint material, fitted with necessary gauges and controls and approved by the Engineer.

15.5.4 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.

15.5.5 All paints and primers shall be of best quality and in original sealed containers as packed by the paint manufacturer conforming to the relevant Indian Standards and shall be procured directly from the manufacturers. All paint to be used shall be stored under cover in such conditions as will preserve it from extreme of temperature and the paint shall be used and applied strictly in accordance with the manufacturer's instructions.

15.5.6 In addition, the following specification shall apply to the shop painting of contact and inaccessible surfaces:

- Õ 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.
- Õ 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.
- Õ Contract surfaces in connection using High Strength Friction Grip bolts shall not be painted or oiled and shall be free from dirt, loosed scale, burrs, pits and any other defects which would prevent the solid seating of the parts and would interfere with the development of friction between them.
- Õ 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.

15.5.7 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 conforming to IS:958 (1975), or solvent deposited compound conforming to IS:1153 (1975) or IS:1674 (1960), or treated as specified in the drawings.

15.5.8 Surfaces to be in contact with concrete shall not be painted.

15.5.9 The 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.

15.5.10 Surfaces not in contact but inaccessible after shop assembly shall receive the specified protective treatments before assembly.

15.5.11 Exposed machined surfaces shall be adequately protected.

15.5.12 A uniform film thickness of paint is to be ensured throughout the work.

15.5.13 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.

15.6 Erection & Site Work:

15.6.1 The 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.
The structure should be divided into erectable modules as per the total 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.

Immediately prior to erection any rust in the paint area shall be removed by power wire brushing to a standard equivalent to SA3.

15.6.2 During erection the rough handling of fabricated materials such as bending, straining or pounding with sledges shall be avoided. Any damage to thestructure during transportation or erection shall be immediately rectified by the Contractor at his own cost. The straightening of bend edges of plates, angles and other sections shall be done by methods which will not cause fracture.
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.

15.6.3 The Contractor shall be responsible for accurately positioning, leveling and plumbing of all steelwork and placing of every part of the structure in accordance with the approved drawings and to the satisfaction of the Engineer. All stanchion base, beam and girder bearings etc. shall be securely supported on suitable steel packs. All reference and datum points shall be fixed near the work site for facilitating the erection work.

15.6.4 All equipment used by the Contractor shall be sufficient for the purpose and for the erection of the steel work, in the time specified in the 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. The approval of the Engineer shall not relieve the Contractor of the responsibilities for the loads to which the erection equipment shall be called upon to carry. Adequate arrangement shall be made to resist wind loads and lateral forces arising at the time of erection.

15.6.5 The 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 Contractor shall supply and fix, without extra charge, any temporary bracing which may be necessary.

15.6.6 All steelwork shall be erected in the exact position as shown on the drawings. All vertical members shall be truly vertical throughout and all horizontal members truly horizontal, fabrication being such that all parts can be accurately assembled and erected. No permanent bolting, welding or grouting shall be done until proper alignment has been obtained and checked by the Engineer.

15.6.7 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.

15.6.7 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 paintshall 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.

15.7 Inspection:

15.7.1 The contractor shall inform the Engineer of the progress in fabrication and as to when individual pieces are ready for inspection. All gauge templates necessary to satisfy the Engineer shall be supplied by the contractor. The Engineer may at his discretion check the results obtained at the 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 contractor. During Inspection, the component/member shall not have any load or external restraint.

15.7.2 Structural steel and componentsviz. bolts, nuts, washers, welding consumables, etc. should be tested for mechanical and chemical properties as per the requirement of the relevant IS or any other specified codes/standard.

15.8 Holding down and Anchor bolts :

15.8.1 The holding down and anchor bolts should conform to the requirements laid down in IS:624 or as directed by the Engineer.

15.8.2 Installation: Individual bolts in groups of holding down bolts shall be positioned accurately within a tolerance of +6mm. The bolts shall be set vertically to a tolerance of not more than 1 in 250.

15.8.3 During the casting of concrete the contractor shall ensure that space between the bolt and sleeves is kept clean after removal of shuttering. The contractor shall provide and fix timber plugs to maintain this space in a clean condition. The projecting threads of bolts shall be protected by approved wrapping materials.

15.8.4 Grouting of bolt tubes shall be carried out after the steelwork or equipment have been aligned, plumbed and leveled.

15.9 Tolerances :

15.9.1 All tolerances shall be in accordance with IS:7215 unless otherwise specified.

15.9.2 The maximum deviation for line and level shall be + 3.0mm for any part of the structure including for location of column centers.

15.9.3 The maximum deviation from plumb for columns shall be +3.0mm in 10.0m height subject to a maximum of +6.0mm in a total height of 30.0m.

15.9.4 The deviation at the centre of the upper chord member from vertical plane running through the centre of the bottom chord shall not be more than 1/1500 of span but in no case more than 10.0mm. The lateral displacement of top chord at centre of span form vertical plane running

through centre of supports shall not be more than 1/250 of the depth of truss but in no case more than 20.0mm.

15.9.5 Tolerances for anchor fasteners shall be as specified by respective manufacturers in their Technical and Specifications publication booklets.

16 LED Specification:

16.1 Make : LT Technologies,Bangalore
Series : Maze XL Series
Color : Cool White
Color Temp (K) : 8000
Luminous (Fluxc(Im/PCS) : 144
Luminous per Watts : 100
Power (w/module) : 1.44
Input Voltage (PCS) : 12V with CCR and with Over Load Technology,

Following is the typical arrangement of the LED for one signage box of size 1200mm x 300mm x 130mm. Contractor should produce one sample according to this and analyse LED requirement, and if any change should inform NMRCL same to get approval and proceed manufacturing.

TYPICAL USE OF LED MODULES PER SIGNAGE BOX					
BOX SIZE	LED USED	TOTAL MODULES	TOTAL WATTS	TOTAL AREA	60Watts ps
1200x300x130	LTMAZEXL655V00	18	26	3.5sq.ft	1

16.2 LED FLOOD LIGHT for outdoor Purpose.

Make : PASOLITE
Code : FL 2038
Wattage : 15W
Output : 100 Lumens per Watt
Life Span : 50000 Burning Hours
IP Rating : IP 65
LED color : White/Warm White
Material : Die cast Aluminium

16.3Contractors are expected to provide the standard warranty and the invoices from the manufacturers covering all the lights used.

17 Specifications for electrical works:

17.1 Wiring for Indoor Signs:

Illuminated direction and emergency signs

17.1.1 All lights mounted in an individual internally lit sign shall be switched ON & OFF in group, through a switch and controlled through a M.C.B. (The switches controlling circuits and M.C.Bs. are not in the scope of this tender.) The contractor shall provide a Bakelite connector on each sign for connection to feeding wire outside, which shall be extendable in flexible conduit upto a distance of 2.0 M. from the sign. This extendable wiring shall either be laid within the provision made in the supporting structure or in flexible conduit.
For all the suspended and projected signs this provision shall be made through one of the suspender or the connection member to the sign respectively.

17.1.2 The 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.

17.1.3 All connectors and joints shall be mounted or fixed to the internal structures of signs with insulating fixtures

17.1.4 The interconnecting wiring between light fixtures within the sign shall not be less than 1.5 Sq.mm and shall be FRLS, PVC insulated 1.1 KV grade, with multi-stranded copper conductor.

17.1.5 If specified - An earth terminal shall be provided on each of the lit sign which shall be connected with the earthing conductor laid alongwith incoming circuit wiring.

17.1.6 All wiring within the sign enclosure shall be covered with flexible 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.

17.2 Wiring for Outdoor Signs:

Totem sign

17.2.1 The pole box proposed within the stone pedestal of **Totem sign at entrances** shall have provision of one SPN M.C.B. of 6A (10 KA breaking capacity) for control / Isolation of incoming and outgoing cables / wires. The wiring within the sign from pole box shall be provided by the contractor which shall be of 2.5 sq.mm. FRLS, PVC insulated 1.1 KV grade, with multi-stranded copper conductor for phase and neutral and 1.5 sq.mm. with solid copper conductor wire for earth. The incoming cable upto pole box shall not be in the scope of this tender, but its terminations shall be the responsibility of the contractor. An earth terminal for connecting the earth wire shall be provided in the pole box.
Pole box (junction box) shall be made out of polycarbonate/compressed moldedfiberglass polyester and designed to insulate and protect the controller and component in outdoor/indoor application making it water proof. It shall be Lockable with a universal lock/ quarter turn lock and UV stabilized for outdoor usage. This Junction box shall have a front openable hinged door provided with appropriate gasket And all metal components/fittings should be non corrosive made of brass to withstand moist condition.

Station name

17.2.2 The Junction Control Box proposed for **Station name sign on exterior** sign shall have provision of mounting 2 Nos. S.P. M.C.Bs. of 6A (10 KA breaking capacity) for control / Isolation of incoming and outgoing cables / wires along with separate neutral link and earth link. This junction box shall be of size 150x225x100 mm. Fabricated out of 16 S.W.G M.S. sheet duly painted of same shade and as per specifications specified for painting of structure . This shall have a front openablehinged door, provided with Neoprene gasket and double screwed knobs for closing. The complete junction control box shall be weatherproof and shall have Index of Protection of I.P. – 53.

Two separate out-going circuits shall emanate from the Control Junction Box. Each of them shall control 3 Nos. alternative luminaires by looping the main circuit wiring. All the interconnecting wiring from junction control box to luminaires shall be laid in Heavy Duty M.S. conduits. The phase and neutral wires of each circuit shall be of size 2.5 sq.mm. FRLS, PVC insulated 1.1 KV grade, with multi-stranded copper conductor and earth wire shall be of 1.5 sq.mm. with solid copper conductor laid along with circuit. The size of wire for looping at each luminaire shall not be less than 1.5 sq.mm. FRLS, PVC insulated 1.1 KV grade, with multi-stranded copper conductor for phase & neutral and 1.0 sq.mm. with solid copper conductor wire for earth.

The M.S. conduits for wiring shall be properly fixed with clamps, saddles, nut-bolts etc. The complete conduiting shall be duly painted as per specified shade of the supporting structure. The jointing in the M.S. conduit with T -Junction boxes, sockets, bends, etc. shall be done by threading. All the threaded joints, outlets of wires etc. shall be sealed so as to resist entrance of Moisture, Dust and Vermin's etc.

17.3 Index of Protection:

Since most of the lights/ luminaries are to be installed within the signs the following Index of Protection are proposed for different locations to ward off ingress of dust, vermins and moisture :

1. Indoor signs - I.P. – 54
2. Lights fixtures for Outdoor signs - I.P. – 65
3. Pole Box - I.P. – 65

17.4 List of Items and Approved Makes (Electrical)

Table

Item	**Make as indicated below or equivalent**
Wires and Cables	Finolex/ Havells/ Anchor/ Lapp Kabel
Luminares	Philips / G.E/C.G
Lighting Electronics/Ballasts	Philips/ GE/ C.G
Lamp Holder & Support Bracket	Vossloh Schwabe / Philips Wipro
M.C.B.	L&T/ Siemens/ Schneider/ Legrand/ ABB

17.5 Typical Items use in signing

Table			
Item	**Color temperature**	**Code/ Specific No.**	**Corresponding Make**
20A LED		240 W	Philips, Osram, Bajaj, Wipro
5A LED		60 W	Philips, Osram, Bajaj, Wipro
Electronic Ballast		Appropriate for the above	Philips, Osram, GE, Wipro
connectors 5/20 Amp.			ISI mark and approved by Engineer-in-charge
Junction box		Polycarbonate/ compressed molded fiberglass polyester	Sintex, Allied Moulded Products

- ISI marked connectors shall be used
- Switch boxes etc. shall be got fabricated at approved workshops only
- The tenderer shall quote a specific make from approved make above, in absence of this Information, the tenderer will be asked to supply first approved material.
- For items not covered in the above list, the sample shall be got approved by The Engineer-In-Charge. Makes offered should comply with technical specification of tender.

- **Glass**
  Glass used for signages shall be laminated safety glass as per the specifications for fire exit signsApproved make shall be as per the list below or equivalent duly approved based on a sample presented to Engineer-In-charge.

    - SAINT-GOBAIN Laminated Glass
    - ASAHI Glass
    - Viracon Laminated Glass
    - SunGuard® Laminated Glass

18 CONCRETE WORKS

18.1 General

These specifications shall be read in conjunction with the CPWD specifications 1996 and other relevant specifications described in the Section 1 of these Specifications. Relevant IS and BIS codes will have to be referred to for detailed specification of concrete work.

18.2 Blending of aggregates

In order to obtain optimum workability, individual aggregates of nominal size 20mm, 10mm, 4.75mm and 2.36mm will be blended in such a way that the grading curve for all in aggregates will be a smooth curve from size 0.15mm to 25mm falling within the established envelop grading curve. Contractor shall establish envelop grading curve for each grade of concrete for given maximum size of aggregates and get it approved by Engineer before finalising the mix design.

18.3 Grade of Concrete

The concrete is designated as follows :
Concrete M 25
The letter M refers to the mix
The number 25 represents the characteristic compressive strength of 15cm cubes at 28 days in MPa (Mega Pascals : 1 MPa : 10 kg/cm2 approximately). M25 concrete thus has a characteristic strength of 250 kg/cm2. Other design mixes will also be denoted in same way.

18.4 Mix Design

It is the complete responsibility of the Contractor to design the concrete mixes by approved standard methods and to produce the required concrete conforming to the specifications and the strength, workability requirements approved by the Engineer.

The approved mix design will contain strength requirements, grade of concrete, type of cement,maximum size of aggregates, workability, quality of water and admixture, if allowed.

Mix Design once approved must not be altered without prior approval of Engineer. However, should the contractor anticipate any change in quality of future supply of materials than that used for preliminary mix design, he should inform the Engineer quite in advance and bring fresh samples sufficiently in advance, to carry out fresh trial mixes. Design mix will indicate by means of graphs and curves etc., the extent of variation in the grading of aggregates which can be allowed.

Limits of Water and Cement Contents
Maximum water/cement ratio
For RCC members - 0.45

Cement Content

Cement content in concrete shall not be less than 380 kg/ cum for RCC under normal exposure. Ordinary Portland cement (OPC) of 43 and 53 grade conforming to IS: 8112 and IS: 12269 respectively shall be used. However for nominal mixes, CPWD specification and DSR will be followed. The requirement of the relevant codes, standards and directions of the Engineer shall be followed.

18.5 Finishes :

Unless otherwise instructed the face of exposed concrete placed against formwork shall be rubbed down immediately on removal of the formwork to remove irregularities. The face of concrete for which formwork is not provided other than slabs shall be smoothed with a float to give a finish equal to that of the rubbed down face, where formwork is provided. The top face of a slab which is not intended to be covered with other materials shall be leveled and floated to a smooth finish at the levels or falls shown on the drawings or as directed. The floating shall be done so as not to bring an excess of mortar to the surface of the concrete. The top face of a slab intended to be surfaced with other material shall be left with a spaded finish. Faces of concrete intended to be plastered shall be roughened by approved means to form of a key.

18.6 Grouting of base plates & bolt holes:

Mixing:

Dry grout should be mixed in a mechanical mixer: the conventional 200/400-litre capacity concrete mixer can be used to mix four bags of dry grout; alternatively, paddle type mortar mixers can be used. The quantity of grout to be mixed at one time should not exceed that amount which can be placed in approximately 10 to 15 minutes.

Cleaning and preparation of the surface:
The base concrete should be clean and strong, and its surface should be properly hacked; all dust should be removed suction or compressed air. The surface should be thoroughly wetted with water for several hours. Before the grout is poured, all free water should be removed and the flat surfaces coated with thin cement slurry.

Curing:
The grout should not dry out where external restraint is provided in the form of form-work, the top opening and all stray openings should be covered with wet sack for at least 7 days.

18.7 Reinforced Concrete

18.7.1 Materials:
Formwork shall be of timber, plywood (including marine plywood), steel or any other suitable material capable of resisting damage to the contact faces under normal conditions of erecting forms, fixing steel and placing concrete. The selection of materials suitable for formwork shall be made by the Contractor based on the quality consistent with the specified finishes and safety. For designated areas prominently in public view such as piers, caps, portals, viaduct, parapets etc., preferably steel shuttering will be used.The material shall be approved by the Engineer before erected at site. However, the choice of material shall be decided by the Engineer. The entire responsibility of planning, designing, erection, dismantling,shifting and safety of false work lies with the contractor.
All formwork supports (centring, props, scaffolds etc.) shall only be in structural steel and preferably of pipes conforming to IS:806, IS:1161, IS:1239, IS:2750. Wooden ballies shall not be permitted as props/formwork supports. All props shall be properly braced using x & k bracings.

18.7.2 Timber:
Timber used for formwork shall be easily workable with nails without splitting. It shall be stable and not liable to warp when exposed to sun and rain or wetted during concreting.

18.7.3 Plywood:
Plywood used for formwork shall be minimum 12 mm thick. Shuttering quality plywood complying with IS:4990 and of make approved by the Engineer. Suitable stiffeners and walkers shall be provided depending on the shuttering design.

18.7.4 Steel:
Steel formwork shall be made of minimum 4 mm thick black sheets stiffened with angle iron frame made out of M.S. angles 40 mm x 6 mm supported at suitable spacing.

19 Powder Coating

19.1 Powdercoating on Aluminium Plates

19.1.1 Wherever specified the aluminium plates shall be coated in approved colour and shade with pure polyester powder of Berger / Interpon / Asian Paints / Nerocoat to a minimum thickness of 75 microns.

19.1.2 The pure polyester powder coating shall be got executed from specialised 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 : 200^0 C for 10 mins. (metal temp.)
- Test Certificates from approved laboratory for the representative samples shall be submitted by the Contractor. Testing will be done in presence of Employer's representatives at the cost of contractor.

19.1.3 The curing schedule shall be as specified by the manufacturer of pure polyester powder.

19.1.4 The properties of cured powder films shall be:-

- Scratch hardness: Equal to or more than 4 Kg.
- Impact resistance: Min 150 Kg cm
- Pencil hardness: 3H to 4H
- Salt spray resistance: 500 Hrs.
- Water soak at room temperature: No change after 500 Hrs.
- Detergent resistance: No attack after 500 Hrs.
- Cross Hatch adhesion : GT= O (ASTM D-3359)
- Cured Film thickness: Min 75 microns.

19.1.5 Tests for properties of cured film as given above shall be carried out at frequency specified in relevant IS/BS/ASTM codes or as specified by theEngineer – in-charge.

19.1.6 The surface of aluminium shall be prepared and pretreated as follows before powder coating:-

- Removal of all foreign matter.
- Chromatisation of aluminium 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. The chromate coating and alkali degrease shall be as per requirement of the pure polyester powder manufacturer.
- Proper curing at required temperature shall be done for specified time period so as to achieve the desired properties.

19.1.7 The pure polyester coated surface shall be of uniform texture, colour and gloss and shall be free from cracks, warps and other imperfections.

19.1.8 The pure polyester powder is to be used within its shelf life from the date of manufacturing as specified by the manufacturer.

19.2 Powder coating on M.S-CRCA MILD Steel, Aluminium.

19.2.1 Wherever specified the M.S mild Steel plates and sections shall be coated in approved colour and shade with pure polyester powder of Berger/Interpon/Asian Paints/Nerocoat to a minimum thickness of 75 microns.

19.2.2 The pure polyester powder coating shall be got executed from specialised agency as given in 19.1.2 to 5, 19.1.7 and 8. edit as per number in Aluminium above

19.2.3 The surface of steelshall be prepared and pretreated 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. The Zinc Phosphate conversion treatment and alkali degrease shall be as per requirement of the pure polyester powder manufacturer. 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.

19.2.4The pure polyester coated surface shall be of uniform texture, colour and gloss and shall be free from cracks, warps and other imperfections.

20 Galvanising

Galvanising, wherever specified, shall be minimum 80 microns thick and shall conform to IS-4759.

21 Polyurethane Painting

21.1 The Polyurethane painting, wherever specified, shall conform to CPWD Specifications 1996, volume I – VI), relevant IS codes and standard specifications.

21.2 PU paints matched to shades as per colour specifications shall be of Asian paints/Berger/Kansai Nerolac/

21.3 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 over night 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.

- **Contractors are expected to provide the standard warranty and the invoices from the manufacturers.**

22 Sadarhalli Grey Granite Stone

22.1 Stone is used as pedestals for all the exterior post mounted signs. The stone shall be locally procured dressed at factory and brought to site.

22.2 Proper cares shall be take while transportation to avoid chipping, cracking.

22.3 A sample of stone shall be shown and approved by the Engineer-in-charge.

22.4 All stone used shall be free from cracks, quarrying holes and a damaged piece shall be entirely replaced and not joined at the site.

22.5 Substitute to this, Pre-Cast Concrete Blocks can be used, with pre-approval from GC/NMRCL.

23 EPDM Gasket

Description: Ethylene Propylene Diene Monomer in the form of a strip with required thickness. This This could be glued to one surface .The gasket would get compressed in between two surfaces and gives the right sealing.

EPDM gaskets manufactured by Hanu Industries/Anand Lescuyer/Tremco or equivalent shall be used.

24 Mechanical Fasteners

Dash Fasteners of required diameter and length manufactured by HILTI/FISCHER or equivalent shall be provided..

The Contractor shall make arrangements with the Dash Fastener suppliers – HILTI/FISCHER or other approved suppliers to carry out random pull out tests at site of work to the satisfaction and directions of Engineer-in-charge.

Entire work has to be carried out as per laid down specifications of 'HILTI India Private Limited'. Specification Book published by HILTI will have to be referred to in this respect.

25 Scroller signs

25.1 This is a backlit sign that displays many images or frames in a single sign. The images are printed on a polyester scroll and then attached to a scrolling spool system that displays each image for a customer-determined amount of time that is easily set using the scrolling system controller. Images can be advanced consecutively in both scroll directions, or they can be displayed consecutively and rewound to the beginning and displayed again and again, either in landscape or portrait mode

25.2 These displays are equipped with an internal controller that allows the display time for the frames to be adjusted. There are also manual controls that allow the frames to be displayed in a static position if desired. An optional remote control is available for even more flexibility.

25.3 They can be wall mounted or attached to a floor stand.

25.4 They come in different standard sizes on to which the required graphic could be incorporated.

25.5 DIAZIT, Screen Motion display are few of the brands

26 1. Photoluminiscent signs

All Photoluminiscent signs shall be procured from specialised agency providing signs with following secifications but not limited to:

26.1 Water proof Non corrosive (Tested as per IMO Specifications)
26.2 Withstand temperatures from 30^0 C up to 65^0 C.
26.3 Non corrosive (Tested as per IMO Specifications).
26.4 Tested to ASTM G53-88 Standard (Accelerated UV weathering test)
26.5 Non reactive to Dilute Alkalis and Acids.
26.6 Glow time inexcess of 2 mcd/m^2 after 60 minutes
26.7 UV-stable and weather-resistant for outdoor applications.
26.8 Ability to absorb energy from almost any light source (sunlight, fluorescent, incandescent) and then to emit light when ambient darkness occurs.
26.9 The light produced is yellow-green in color and is highly visible, lasting up to 10 hours.

2. **Suggested product names for various products from approved manufacturers**

The product code -	**AVFG302N12450**
Product name is -	**Avery Glow in Dark – VF(Glow upto 4 Hrs in Dark)**

27 Signage Fixings

27.1 Suspended Signs.

27.1.1 Suspender have been designed for 2 levels for all signs mounted with bottom at 2.4 m above floor

- Smaller lighter suspenders for all signs with fixings to a maximum of 1.8m, and
- Heavier suspenders fixing to the lighter suspenders to reach beyond 1.8 up to 3.5m.

27.1.2 This suspender arrangements cover almost all the situations inside stations up to a clear height of 6m for suspending the sign. A sign with suspendersbeyond 3.5m will not be installed as suspended signs and will be changed toa projected or post-mounted sign. Any situations observed by the contractor shall be brought to the notice of Engineer-In-charge and prior approval shallbe taken before any variation in fixing is done.

27.1.3 The quoted rates of contractor for the suspended signages shall be for suspending the specified suspenders from any medium, RCC Beams/Slabs, and Structural Steel Sections of any shape and size etc.. Nothing extra whatsoever shall be admissible on this account.

27.1.4 In BOQ 2 suspenders of length 1m suspenders have been calculated for each sign. Payment for this item will be done after deducting or adding to this quantity based on calculating the suspender lengths of installed signs. The contractor has to quote for per running meter of both the heavy and light suspenders.

27.1.5 Nothing extra whatsoever shall be admissible for any variations in the lengths and all necessary erection arrangements from site to site for installation of signs.

27.2 Post mounted signs

27.2.1 These signs will have a dedicated special structure and will be calculated per unit for fixing at the location. Height variations will not happen beyond the drawings shown.

27.2.2 The quoted rates of contractor for the Post mounted signs shall be for erection of the post mounted signs on base/floor of any medium, RCC or CC floor etc. with or without floor finishes of any type. Nothing extra whatsoever shall be admissible on this account for arrangements for fixing signs form site to site.

27.3 Face fixed Signs

27.3.1 The quoted rates of contractor for the Face fixed. signages shall be for face mounting the signs at all heights and to any medium, RCC Beams/Slabs or Brick Wall etc. with or without cladding. Nothing extra whatsoever shall be admissible on this account.

27.3.2 Nothing extra whatsoever shall be admissible for any variations of the required face fixing arrangements from site to site of work.

27.3.3 Variation will be admissible only in case of being asked to fabricate and fix a new fixing bracket in place of the bracket fabricated as per the Good for Construction drawings included in Tender Documents. Variation of amount in this case will be mutually decided and approval of the Employer will be obtained before fabricating such brackets.

27.4 Projection signs

27.4.1 The projected signs are fixed using projected bracket fixed to the wall or column with a length proportional to the sign length. The contractor has to quote for each bracket separately as described in the BOQ.

27.4.2 The quoted rates of contractor for the projected signs shall be for each length of bracket separately at all heights and to any medium RCC Beams/Slabs orBrick Wall etc. with or without cladding. Nothing extra whatsoever shall be admissible on this account.

27.5 Special mounting for signs

27.5.1 There will be few situations where the details are not provided for fixing or a special customised detail has to be made for the sign to fix to specific beams, columns etc. in such cases, the contractor will check the site condition, work out a detail for the fixing in consultation with SGDC and get is approved withthe Engineer-in-charge. The contractor has to quote a

rate per Kg of MS usedincluding providing, fabricating, finishing complete with all accessories likenuts, bolts, washers and props etc used at site for installation of the bracket fixing the sign.

27.5.2 The BOQ provides an Item to quote a Unit Rate for fabricating customised fixings for signs. such a rate will be considered for Variation will be admissible only in case of being asked to fabricate and fix a new fixing bracket in place of the bracket fabricated as per provided a customised Good for Constructiondrawings provided by the Engineeri-in-charge. Variation of amount in thiscase will be mutually decided and approval of the Employer will be obtainedbefore fabricating such brackets.