The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand shall not exceed the following limits:

Clay, fine silt and fine dust when determined in accordance with IS 2386 (Part 2):

a. In natural sand or crushed gravel sand & crushed stone sand: Not more than 5% by mass

b. Organic impurities when determined in accordance with IS 2386 (Part 2): Color of the liquid shall be lighter than that indicated by standard specified in IS 2386 (Part-2)

Grading of sand for use in Plaster shall conform to IS 1542 (as below)

IS sieve designation	**Percentage passing**
10mm	100
4.75mm	95 to 100
2.36mm	95 to 100
1.18mm	90 to 100
600 micron	80 to 100
300 micron	20 to 65
150 micron	0 to 15

4.3 Water

Water for plastering and pointing shall conform to `Standard Specification for Civil and Structural Works- Materials' (Structural Specification no. 6-68-0002)

4.4 Cement Mortar

Cement mortar shall conform to `Standard Specification for Civil and Structural Works- Brick Masonry' (Structural Specification no. 6-68-0009) unless otherwise mentioned.

4.5 Cement Mortar with Waterproofing Compound

Waterproofing compound shall conform to IS: 2645 of approved make.

4.6 Gypsum Plaster

Gypsum plaster shall conform to IS 2542 (Part I) and IS 2547 (Part II). The plaster shall consist of retarded hemihydrate gypsum plaster and light weight aggregate. Other additions may be incorporated to impart desired properties.

4.7 Ready Mix Plaster

Ready Mix Plaster shall be ready mix cement plaster rendered with polymer additives, well graded sand and fillers. Compressive strength of the material shall be minimum 7.5 Mpa in 28 days as per IS: 2250.

Ready Mix Plaster shall be pre packed material requiring only water addition at site.

Copyright EIL – All rights reserved

5.0 PLAIN CEMENT PLASTER

5.1 The mortars of specified mix as per the specifications of 'Cement Mortar' (Refer clause 4.4) shall be used for plain cement plaster. Proportions of ingredients of cement mortar for various thicknesses of plaster shall be as per following table:

20mm thick plaster	1 cement: 6 sand (by volume), in two layers
18mm thick plaster	1 cement: 6 sand (by volume), in two layers
15mm thick plaster	1 cement: 4 sand (by volume)
12mm thick plaster	1 cement: 4 sand (by volume)
06mm thick plaster	1 cement: 4 sand (by volume)

6.0 CEMENT PLASTER WITH WATERPROOFING COMPOUND

6.1 The mortars of specified mix as per the specifications of 'Cement Mortar' (Refer clause 4.4) shall be used. Proportions of ingredients of cement mortar for various thicknesses of plaster shall be as per clause no 5.1

6.2 Waterproofing compound shall be mixed to cement mortar as recommended by the approved Manufacturer but @ 3% by weight as minimum.

7.0 SAND FACE PLASTER

7.1 Sand face plaster shall be 20mm thick consisting of 13 mm thick under layer and 7 mm thick top layer.

7.2 Under layer shall be 13 mm thick (1 cement: 4 sand, by volume) plain cement plaster.

7.3 Top layer shall be 7 mm thick (1 cement: 2 sand, by volume, granule size 2 to 2.5mm) plain cement plaster.

7.4 The mortars of specified mix as per the specifications of 'Cement Mortar' (Refer clause 4.4) shall be used for plain cement plaster.

7.2 Application of sand face plaster shall be as described in `two-layer plaster work' in clause no. 9.7. The surface of the sand face plaster shall be finished rough with sponge or as directed by the Engineer-in-charge.

8.0 EXPOSED AGGREGATE FINISH

8.1 Exposed aggregate finish plaster shall consist of 12 mm thick under layer and 20 mm thick top layer.

8.2 Under layer shall be 12 mm thick plain cement plaster (1 cement: 4 coarse sand, by volume) finished rough. The mortars of specified mix as per the specifications of 'Cement Mortar' (Refer clause 4.4) shall be used for plain cement plaster. The under layer shall be applied in accordance with `One layer plaster work' described in clause no. 9.6.

8.3 Top layer shall be 20 mm thick admixture of white cement and grey cement (mix. ratio 1:1 by volume) mixed with white/colored marble chips/pebbles (as required for desired shade/ colour

Copyright EIL – All rights reserved

of the finished surface) of 6mm to 12mm nominal size. Mix ratio shall be 1 cement: 1 marble chips/pebbles by volume. Marble dust @ 15% by volume with pigment (conforming to IS:2114, as required for obtaining desired colour/ shade of the finished surface) shall be added to the admixture.

The pebbles to be used shall be well washed and drained. The admixture shall be thrown wet on to the under layer while it is still plastic using strong whipping motion at right angles to the face of the wall.

One coat of neat cement slurry @ 2.75 kg cement per square meter of area shall be applied on to the under layer to receive the top layer.

The whole plastering shall be laid in panels of maximum 1200mm x 1200mm size or as per drawing with 12mm x 20mm grooves in between formed by holding removable wooden batons over the under layer.

Loose mortar etc. on the top surface shall be cleaned/removed by brushing/washing/spraying with water jet after initial setting of mortar.

9.0 APPLICATION OF PLASTER

9.1 Finishing

Plastered surface shall be plumb, without any undulations and defects such as cracks etc. Patterns/ grooves etc. shown in the drawing shall be provided. Any cracks, damages, any part of work which sound hollow when tapped or found damaged or defective otherwise shall be cut out in rectangular shape and redone as directed by Engineer-in-charge

9.2 Preparation of Background Surface

9.2.1 The background surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing.

9.2.2 Smooth surfaces shall be roughened by wire brushing or hacking for non-hard and hard surfaces respectively.

9.2.3 Projections on surfaces shall be trimmed wherever necessary to get even surfaces. In case of brick/stone masonry, raking of joints shall be carried out wherever necessary.

9.2.4 The background surface shall be allowed to dry out for sufficient period before carrying out the plaster work. The background surface shall not be soaked but only damped evenly thereafter before applying the plaster.

9.2.5 In case of concrete work, projecting blurs of mortar formed due to the gaps of joints in shuttering shall be removed. Such surface shall be scrubbed clean with wire brushes. The surface shall be pock marked with a pointed tool at spacing of not more than 50 mm centers, the pocks being made not less than 3 mm deep to ensure a proper key for the plaster. The surface shall be washed off and cleaned of all oil, grease etc. and well wetted before the plaster is applied.

Copyright EIL – All rights reserved

9.3 Sequence of Operations

9.3.1 The surfaces to be plastered, shall first be prepared as described in `Preparation of background surface' in clause no 9.2

9.3.2 For external plaster, the plastering operations shall be started from the top floor and carried downwards.

9.3.3 The first under layer shall then be applied to ceilings. After the ceiling plaster is complete and scaffolding for the same removed, plastering on wall shall be started.

9.3.4 After a suitable time interval, the secondary layers if required shall be applied. After a further suitable time interval, the finishing coat shall be applied first to the ceiling and then to the walls.

9.3.5 Plastering of cornices, decorative features, etc. shall be completed before the finishing coat is applied.

9.4 Scaffolding/Staging

Scaffolding/staging for plastering/pointing shall be as per `Standard Specification for Civil and Structural Works- Brick Masonry' (Structural Specification no. 6-68-0009)

9.5 Chicken Wire Mesh

150mm wide, closely knit, 20-gauge chicken wire mesh stretched tight and fixed with G.I. "U" type nails shall be provided at all the masonry/ block work and RCC joints.

9.6 One Layer Plaster Work

9.6.1 To ensure even, specified thickness, plaster of 150 mm x 150 mm shall be first applied horizontally and vertically at not more than 2-meter interval over the entire surface to serve as gauges.

9.6.2 The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall be brought to true surface by working with a wooden straight edge reaching across the gauges with small upward and sideways movements at a time.

9.6.3 Finally the surface shall be finished off true with a trowel or wooden float to obtain a smooth texture. Excessive trowelling or overworking the float shall be avoided.

9.6.4 All corners, arises. angles and junctions shall be truly vertical/ horizontal and shall be carefully finished. Rounding or chamfering of corners, arises, junctions etc. shall be carried out with proper templates to the size required.

9.6.5 In suspending the work, the plaster shall be left cut clean to line, both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped clean and wetted before plastering the adjoining area.

Copyright EIL – All rights reserved

9.6.6 Plastering work shall be closed on the border of the wall and nearer than 150 mm to any corners or arises and shall not be closed on the body of the features such as plaster bands, cornices nor at the corners or arises.

9.7 Two Layer Plaster Work

9.7.1 The first or under layer of the specified thickness shall be applied as described in clause no. 9.6.

9.7.2 Before the first coat hardens, surface of it shall be beaten up by edges of wooden tapers and close dents shall be made on the surface. The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

9.7.2 The second layer shall be complete to the specified thickness in the same manner as for first layer.

9.8 Curing of plaster

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of 7 days. During this period the plaster shall be suitably protected from all damages at the contractor's expense by such means as approved by the Engineer-in-charge. The date of execution of plastering shall be marked on the plastering to ensure the proper duration of curing.

10.0 GYPSUM PLASTER

10.1 Gypsum plastering shall be done using premixed gypsum plaster and aggregates as mentioned in clause no. 4.6

10.2 Preparation of Gypsum plaster shall be in accordance with approved Manufacturer's standard and recommended practice. The powder (gypsum plaster) shall be mixed with clean water in clean plastic buckets to avoid mixing with impurities, ensuring thorough mixing by help of mixing rod so as to avoid formation of lumps and unmixed residues. The water to plaster ratio should be maintained as per approved manufacturer's specification.

10.3 Application of Gypsum plaster shall be in accordance with clause nos. 9.1 to 9.7

10.4 Curing

There is no requirement of curing. Gypsum plaster dries in 3 days, after which painting can be done directly over the finished surface.

11.0 READY MIX PLASTER

11.1 Ready-mix plastering shall be done using pre packed plaster ingredients as mentioned in clause 4.7

11.2 The powder (ready mix) shall be mixed with clean water, preferably in clean plastic buckets to avoid mixing with impurities, ensuring thorough mixing by help of mixing rod or mechanical

Copyright EIL – All rights reserved

stirring for 2-3 minutes as to avoid formation of lumps and unmixed residues. The water to plaster ratio shall be maintained as per approved manufacturer's specification.

11.3 Application of ready-mix plaster shall be in accordance with clause nos. 9.1 to 9.7. The plaster mix shall be applied within the time (after preparation of the mix) recommended by the approved Manufacturer. Curing shall be done in accordance with clause no 9.8 or as recommended by the approved Manufacturer as approved by the Engineer-In-Charge.

11.4 Curing

Curing shall be done in accordance with clause no 9.8 or as recommended by the approved Manufacturer and as approved by the Engineer-In-Charge.

12.0 POINTING

Pointing shall be of the type specified such as flush, cut or weather struck, raised and cut etc.

12.1 Preparation of Base Surface

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall be less than 20 mm.

12.2 Cement Mortar

Cement Mortar shall be in accordance with the specifications of cement mortar described in clause no. 4.4.

12.3 Application of Mortar and Finishing

The cement mortar (1 cement: 4 sand, by volume) shall be pressed into the raked out joints with a pointing trowel according to the type of pointing specified. The mortar shall be spread over the corner edges or surfaces of the masonry. The pointing shall then be finished with the pointed tool. The superfluous mortar shall be cut off from the edges.

12.4 Flush Pointing

The cement mortar shall be pressed into joints and shall be finished off flush and leveled. The edges shall be neatly trimmed with trowel and straight edges.

12.5 Cut or Weather Struck Pointing

The mortar shall first be pressed into joints. The top of the horizontal joints shall then be neatly pressed back by about 15 mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall also be similarly pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles in case of brick & coursed rubble masonry.

Copyright EIL – All rights reserved

12.6 Raised and Cut Pointing

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm and width 10 mm more as directed. The pointing shall be finished to a smooth but hard surface.

12.7 Curing

Curing shall be as described in clause no. 9.8

13.0 MEASUREMENT

13.1 Plastering shall be measured by the area of actual plastered surface.

13.2 Pointing shall be measured by the actual area of the surface on which pointing is done.

Copyright EIL – All rights reserved

छत उपचार का मानक विनिर्देशन

STANDARD SPECIFICATION FOR ROOF TREATMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
7	10.05.22	REVISED AND ISSUED AS STANDARD SPECIFICATION	SANDEEP SHARMA	ANISH KUNDU	SAMIR DAS	SANJAY MAZUMDAR
6	12.01.18	REVISED AND ISSUED AS STANDARD SPECIFICATION	SG	JS/SD	RS	R NANDA
5	15.05.12	REVISED AND ISSUED AS STANDARD SPECIFICATION	MKV	SM	JKB	VK D MALHOTRA
4	21.03.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V. CHATURVEDI
3	10.03.99	REAFFIRMED AS STANDARD SPECIFICATION	SD	MLB	SCJ	AS

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Standards of Testing of Materials
BS	:	British Standards
EN	:	European Standards
IS	:	Indian Standards
ISO	:	International Organization for Standardization
NBC	:	National building Code
NFPA	:	National Fire Protection Association
NABL	:	National Accreditation Board for Testing and Calibration Laboratories
PUF	:	Polyurethane
CuM	:	Cubic Meter
GSM	:	Grams per square meter
PCC	:	Plain cement concrete
Sq.M	:	Square meter
MPa	:	Mega Pascal

Architecture Standards Committee

Convenor: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumdar (Strl)
Mr. Charanjeet Singh (Proj.)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4

2.0 REFERENCES 4

3.0 ROOF WATERPROOFING SYSTEMS 5

4.0 POLYMER MODIFIED BITUMINOUS ROOF WATER PROOFING 5

5.0 POLYURETHANE (PU) WATERPROOF COATING (SINGLE COMPONENT) 9

6.0 WATERPROOFING CUM INSULATION SYSTEM 14

7.0 DELIVERABLES BY THE CONTRACTOR 17

8.0 WARRANTY 17

9.0 MEASURMENT 17

Copyright EIL – All rights reserved

3.0 ROOF WATER PROOFING SYSTEMS

3.1 General

3.1.1 Roof waterproofing system shall be a complete system including base preparation and top finishing ensuring leak proof, water tight roof/ terrace surface and efficient rain water drainage. Following types of roof waterproofing systems shall be provided as specified in design basis, job specifications, item descriptions, drawings etc.

1. Polymer modified bituminous (APP) roof waterproofing system.
2. Polyurethane (PU) coating (single component) waterproofing system.
3. Waterproofing cum insulation system.

If roof waterproofing system is not mentioned specifically, the roofing treatment system shall be provided as below :

1. Polymer modified bituminous (APP) roof waterproofing system shall be provided in case of buildings which are not centrally air conditioned.
2. For centrally air conditioned buildings, Waterproof cum insulation system shall be provided.

3.1.2 The roof waterproofing system shall be leak-proof, water tight, properly finished and levelled with necessary slope for efficient roof water drainage.

3.1.3 All waterproofing materials of the system shall be from a single approved Manufacturer. Mix of waterproofing materials procured from different Manufacturers shall not be permitted.

3.1.4 The roof waterproofing system shall be laid by agencies approved by Engineer-In-Charge.

4.0 POLYMER MODIFIED BITUMINOUS (APP) ROOF WATER PROOFING SYSTEM

APP (Atactic Polypropylene polymer) roof waterproofing system shall consist of cement concrete screed on prepared base, primer coat, Bituminous (APP) membrane and a top protective finishing layer.

4.1 Materials

4.1.1 Cement concrete screed

Cement concrete screed shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete .Thickness of the screed shall be minimum 50 mm. Thickness at various locations of the roof/ terrace shall be as required for maintaining required slope to ensure proper roof drainage. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

4.1.2 Primer

Bituminous solvent based primer of approved quality conforming to IS: 3384 or ASTM D41.

4.1.3 Bituminous membrane for waterproofing

Bituminous membrane for waterproofing shall be 4 mm thick prefabricated polymer (APP-Atactic Polypropylene) modified and shall be reinforced with nonwoven Polyester and shall have following properties.

Copyright EIL – All rights reserved

1.0 GENERAL

This standard specification lays down requirements of water proofing treatment for RCC roofs and terraces of buildings.

2.0 REFERENCES

2.1 The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Standards	Document title
ASTM C165	Standard Test Method for Measuring Compressive Properties of Thermal Insulations
ASTM C177	Standard Test For Measuring the Thermal Conductivity of a Material by Means of a Guarded-hot-plate Apparatus.
ASTM C423	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
ASTM C518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C836	Standard Specification for High Solids Content, Cold Liquid- Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM C1363	Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
ASTM D5	Standard Test Method for Penetration of Bituminous Materials
ASTM D36	Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
ASTM D41	Standard Specification for Asphalt Primer Used in Roofing, Damp-proofing, and Waterproofing
ASTM D146	Standard Test Methods for Sampling and Testing Bitumen- Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D1623	Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM D1970	Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2842	Standard Test Method for Water Absorption of Rigid Cellular Plastics
ASTM D6226	Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM D7425	Standard Specification for Spray Polyurethane Foam Used for Roofing Applications
IS 3384	Bitumen primer for use in waterproofing and damp-proofing
IS12432 (Part-3)	Indian Standard Application of Spray Applied Insulation - Code of Practice

Copyright EIL – All rights reserved

Property	Value	Testing Method
Thickness	4 mm	ASTM D751
Penetration at 25deg. C, 100g, 5 seconds	25 +/- 5 mm	ASTM D5
Softening point	110 to 155 deg C	ASTM D36
Low Temp. Flexibility	-2 deg C to -10 deg C	ASTM D1970
Tensile strength		
- Longitudinal	> 500 N/ 5cm	ASTM D146
- Transverse	> 450 N/ 5cm	ASTM D146
Elongation		
- Longitudinal	> 40%	ASTM D146
- Transverse	> 40%	ASTM D146
Water absorption	0.12% max.	ASTM D570

4.1.4 Top protective finishing layer

Top protective layer shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade Concrete with 24 SWG chicken wire mesh. Thickness of the layer shall be minimum 50 mm.

4.2 Workmanship

4.2.1 The waterproofing system shall be laid in accordance with approved Manufacturer's standard practice as approved by Engineer-In-Charge and following clauses.

4.2.2 In order to avoid damages in the roofing system, the system shall be laid after the pedestals, structures etc. to be placed on the roof/ terrace are done.

4.2.3 Any pipes or openings / protrusions which are required to be provided on the roof shall be provided prior to taking up the base surface preparation.

4.2.4 The system application shall be done at suitable weather condition as mentioned/ recommended in the product data sheet etc. of the materials / system.

4.2.5 Base surface preparation

a. The entire base surface of the roof/ terrace shall be thoroughly cleaned with wire brush or mechanically and all foreign matter including loose concrete etc. shall be removed.

b. Well defined cracks on the surface shall be cut to "V" section, cleaned and filled up with polymerised mastic or a paste of liquid single component elastomeric waterproofing and fine sand mix or with Polysulphide Sealant.

c. Potholes or depressions shall be filled up after removing weak cement concrete or cement plaster etc. with PCC (1 cement :1.2 coarse sand :3.5 stone aggregate of 6mm & down size by volume,) or M15 grade concrete laid over a coat of neat cement slurry @2.75 Kg of cement per Sq.M of area, to achieve a smooth prepared surface.

d. The finished surface shall be perfectly dry and any dampness should be allowed to evaporate

Copyright EIL – All rights reserved

4.2.6 Screed

a. PCC or M15 grade concrete screed shall be laid over prepared base surface in required slope. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

c. The screed shall be finished and cured to receive the primer coat. The screed layer and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

4.2.7 Primer coat

a. The finished and cured screed shall be cleaned and Bituminous solvent based primer shall be applied over the entire area to be waterproofed including abutting vertical surfaces.

b. If required, the surface of the screed layer shall be prepared in accordance with clause no 4.2.5.

c. Primer coat shall be cold applied. Minimum coverage shall be 0.2 to 0.4 litre per square metre.

d. The primer coat shall be allowed to dry for minimum 24 hours.

4.2.8 Fixing of APP membrane

a. The APP polymer modified bituminous membrane shall be laid over the primer coat by torch welding. The membrane shall be properly pressed during laying to remove any entrapped air.

b. The joints should be sealed properly with necessary side laps of 100 mm and end laps of 150 mm.

c. The membrane shall be continued along the vertical surfaces up to a minimum height of 300mm above the fillet/ coving. The continued membrane shall be terminated in minimum 20 mm x 10 mm chase to be provided in the vertical surface and shall be sealed with approved quality polyurethane sealant. Alternatively, the membrane can be continued over the entire vertical surface and suitably covered by coping at top.

d. After the membrane is laid, water ponding test for leakage shall be done on waterproof treated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 metre x 2 metre and water ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge

4.2.9 Top protective finishing layer

a. The top protective finishing layer of PCC or M15 grade concrete (minimum 50 mm thick) with chicken wire mesh shall be laid over APP membrane without sprinkling of clean sand. The finished surface shall be in desired slope.

Copyright EIL – All rights reserved

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

c. The PCC or M15 grade concrete shall be laid in panels of maximum 1200 x 1200 mm size.

e. The PCC or M15 grade concrete and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

f. The joints between panels shall be raked out neatly (after stipulated curing period) to a minimum 10mm X 10mm V groove and shall be filled up approved quality polyurethane sealant.

e. Khura (minimum size 450 mm x 450 mm) shall be provided at every rain water outlets.

4.2.10 Finishing of waterproofing treatment over parapets/ vertical surfaces

APP membrane continued over parapets/ vertical surfaces shall be finished with minimum 12 mm thick plaster.

4.2.11 Waterproofing treatment in RCC gutters

a. Water proofing treatment over Parapets/ Vertical surfaces of gutter shall comprise of APP membrane continued over parapets/ vertical surfaces finished with minimum 12 mm thick plaster.

b. Waterproofing treatment on horizontal surface of gutter shall comprise of screed of PCC or approved light weight material such as cinder concrete, APP waterproofing membrane and top finishing layer of plaster or PCC or M15 grade concrete as approved.

c. Base horizontal surface shall be prepared in accordance with clause 4.2.5

d. Necessary slope shall be provided by means of PCC or M15 grade concrete or approved light weight material such as cinder concrete.

e. APP membrane over roof surface shall be continued over the sloped surface and continued on vertical parapet of the gutter and inside the rain water pipes similar to roof application of the APP membrane.

f. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

g. After the membrane is laid, water ponding test for leakage in the gutter shall be done as directed by Engineer-In-Charge by making sand/mud bundhs and water ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

Copyright EIL – All rights reserved

h. APP membrane shall be finished with minimum 12 mm thick plaster or PCC as approved. PCC or M15 grade concrete shall be laid in accordance with clause 4.2.9

4.3 Testing

Test for leakage shall be done in two stages.

Stage 1:

After the APP membrane is laid, water ponding test for leakage shall be done on waterproof treated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 meter x 2 meter and water ponding for minimum 72 hours.

Stage 2:

After the top protective finishing layer is cured, water ponding test for leakage shall be done for finished surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels and water ponding for minimum 72 hours. Smooth roof water drainage through roof water outlets shall also be checked during this stage of testing.

Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

5.0 POLYURETHANE (PU) COATING (SINGLE COMPONENT) WATERPROOFING SYSTEM

Single component PU waterproofing system shall consist of cement concrete screed on prepared base, primer coat, PU waterproof coating, Geo-textile membrane and a top protective finishing layer.

5.1 Materials

5.1.1 Cement concrete screed

Cement concrete screed shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete. Thickness of the screed shall be minimum 50 mm. Thickness at various locations of the roof/ terrace shall be as required for maintaining required slope to ensure proper roof drainage. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

5.1.2 Primer

Primer shall be polyurethane primer compatible to single component Polyurethane water proofing coating (which shall be applied over the primer) and shall be as per approved Manufacturer/ system provider's standard specification and as approved by Engineer-In-Charge.

5.1.3 Polyurethane (PU) water proofing coating

Copyright EIL – All rights reserved

Polyurethane water proofing coating/ membrane shall be single component (moisture cured, elastomeric, free from bitumen and tar) viscous liquid containing urethane polymers having following properties:

Property	Value	Testing Method
Solid content	Minimum 85%	ASTM C 836
Elongation	Minimum 400%	ASTM D 412
Tensile Strength	2-3 MPa	ASTM D 412

5.1.4 Top protective finishing layer

Top protective layer shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete with 24 SWG chicken wire mesh. Thickness of the layer shall be minimum 50 mm.

5.1.5 Geo-textile membrane

Geo textile membrane shall be of 150 GSM (grams per square meter) as per approved Manufacture/ system provider's specification and as approved by Engineer-In-Charge.

5.2 Workmanship

5.2.1 The waterproofing system shall be laid in accordance with approved Manufacturer's standard practice as approved by Engineer-In-Charge and following clauses.

5.2.2 In order to avoid damages in the roofing system, the system shall be laid after the pedestals, structures etc. to be placed on the roof/ terrace are done.

5.2.3 Any pipes or openings / protrusions which are required to be provided on the roof shall be provided prior to taking up the base surface preparation.

5.2.4 The system application shall be done at suitable weather condition as mentioned/ recommended in the product data sheet etc. of the materials / system.

5.2.5 Base surface preparation

e. The entire base surface of the roof/ terrace shall be thoroughly cleaned with ire brush or mechanically and all foreign matter including loose concrete etc. shall be removed.

f. Well defined cracks on the surface shall be cut to "V" section, cleaned and filled up with polymerised mastic or a paste of liquid single component elastomeric waterproofing and fine sand mix or with Polysulphide Sealant.

g. Potholes or depressions shall be filled up after removing weak cement concrete or cement plaster etc. with PCC (1 cement :1.2 coarse sand :3.5 stone aggregate of 6mm & down size by volume,) or M15 grade concrete laid over a coat of neat cement slurry @2.75 Kg of cement per Sq.M of area, to achieve a smooth prepared surface.

h. The finished surface shall be perfectly dry and any dampness should be allowed to evaporate

5.2.6 Screed

Copyright EIL – All rights reserved

a. PCC or M15 grade concrete screed shall be laid over prepared base surface in required slope. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

c. The screed shall be finished and cured to receive the primer coat. The screed layer and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

5.2.7 Primer coat

Polyurethane primer shall be brush applied @ 6-8 square meter area/ Litre over the entire prepared roof surface.

5.2.8 Polyurethane (PU) water proofing coating

a. Polyurethane water proofing coating of specified thickness shall be spray or brush applied as directed by Engineer-In-Charge in minimum two layers over primer. If thickness is not mentioned specifically, thickness shall be minimum 1.5 mm DFT (dry film thickness)

b. Scrim cloth reinforcement shall be provided in between the layers. Scrim cloth reinforcement shall also be provided in places where there is a change in surface profile. eg. junction of horizontal and vertical surface of wall, pedestal etc and also near openings for rainwater pipe etc. Scrim cloth to be placed for a distance of 150 mm on either side of junction. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

c. The coating shall be properly cured.

d. After the waterproofing coating is cured, water ponding test for leakage shall be done on waterproof coated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 metre x 2 metre and water ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

5.2.9 Top protective finishing layer

a. Geo textile member shall be provided over the cured PU coating as a separation layer for subsequent screed layer after emptying the water used for ponding test for leakage.

b. The top protective finishing layer of PCC or M15 grade concrete (minimum 50 mm thick) with chicken wire mesh shall be laid over Geo textile member. The finished surface shall be in desired slope.

c. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

Copyright EIL – All rights reserved

d. The PCC or M15 grade concrete shall be laid in panels of maximum 1200 x 1200 mm size.

e. The PCC or M15 grade concrete and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

f. The joints between panels shall be raked out neatly (after stipulated curing period) to a minimum 10mm X 10mm V groove and shall be filled up approved quality polyurethane sealant.

g. Khura (minimum size 450 mm x 450 mm) shall be provided at every rain water outlets.

5.2.10 Waterproofing treatment over parapets/ vertical surfaces on roof

Waterproofing treatment over Parapets/ Vertical surfaces shall comprise of Polyurethane water proofing coating (refer clause 5.1.3) over primer coat (refer clause 5.1.2) finished with cement plaster. Sand shall be sprinkled over the Polyurethane water proofing coating when still in tacky state, to form key for holding cement plaster finishing on polyurethane waterproofing coating.

a. Entire surface shall be prepared in accordance with clause 5.2.5

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces. The angular fillet/ coving shall be cured by means of regular wetting.

c. Polyurethane Primer coat shall be applied over the prepared surface in accordance with clause 5.2.7.

d. The Polyurethane water proofing coating (minimum 1.5mm DFT -Dry Film Thickness) applied on roof shall be continued over parapet/ vertical surface over the primer coat.

e. The Polyurethane water proofing coating shall be continued over vertical surface as per drawing or as directed by Engineer-In-Charge subjected to upto minimum 300 mm height from the finished roof surface.

f. Scrim cloth reinforcement shall be provided in between the layers of the coating and in places where there is a change in surface profile. eg. junction of horizontal to vertical surfaces and also near openings for rainwater pipes/ outlets etc. Scrim cloth shall be placed for a distance of 150 mm on either side of junction.

g. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

h. The coating shall be properly cured.

5.2.11 Finishing of parapet/ vertical surfaces

Copyright EIL – All rights reserved

a. Sand shall be sprinkled over the Polyurethane water proofing coating when still in tacky state, to form key for holding cement plaster finishing on polyurethane waterproofing coating.

b. Minimum 12mm thick cement plaster (1 cement : 4 sand, with polypropylene fibers @ 125 gms per bag of cement or as per recommended dosage by manufacturer to avoid cracking and disintegration) finishing shall be provided over the Polyurethane water proofing coating.

5.2.12 Roofing treatment in concrete gutters

a. Roofing treatment over Parapets/ Vertical surfaces of gutter shall comprise of Polyurethane water proofing coating over primer coat finished with minimum 12mm thick cement plaster similar to clause 5.2.10 & 5.2.11. The treatment shall be done on entire vertical surfaces/Parapet including gutter facia top.

b. Roofing treatment on horizontal surface of gutter shall comprise of screed of PCC or M15 grade concrete approved light weight material such as cinder concrete, Polyurethane water proofing coating over primer coat, Geotextile membrane and top finishing layer of plaster or PCC as approved.

c. Entire surface shall be prepared similar to the base surface preparation of roof surface.

d. Necessary slope shall be provided by means of PCC or M15 grade concrete or approved light weight material such as cinder concrete.

e. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces. The angular fillet/ coving shall be cured by means of regular wetting.

f. Polyurethane Primer coat as per clause 5.1.2 shall be applied over the prepared surface in accordance with clause 5.2.7.

g. The Polyurethane water proofing coating (Minimum 1.5mm DFT -Dry Film Thickness) applied over roof shall be continued over horizontal and parapet/ vertical surface of gutter in accordance with clause 5.2.8 over the primer coat.

h. Scrim cloth reinforcement shall be provided in between the layers and in places where there is a change in surface profile. eg. junction of horizontal to vertical surfaces and also near openings for rainwater pipes/ outlets etc. Scrim cloth shall be placed for a distance of 150 mm on either side of junction.

i. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

j. The coating shall be properly cured.

k. After the waterproofing coating is cured, water ponding test for leakage in the gutter shall be done as directed by Engineer-In-Charge by making sand/mud bundhs and water

Copyright EIL – All rights reserved

ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

l. PU waterproof coating shall be finished with minimum 12 mm thick plaster or Screed as approved. The screed shall be laid in accordance with clause 5.2.9

m. Ponding test for leakage of the finished roof surface shall be done after the top layer has cured in locations as directed by Engineer-In-Charge by making sand / mud bundhs water ponding for 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

5.3 Testing

Test for leakage shall be done in two stages.

Stage 1:

After the waterproofing coating is cured, water ponding test for leakage shall be done on waterproof coated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 meter x 2 meter and water ponding for minimum 72 hours.

Stage 2:

After the top protective finishing layer is cured, water ponding test for leakage shall be done for finished surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels and water ponding for minimum 72 hours. Smooth roof water drainage through roof water outlets shall also be checked during this stage of testing.

Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

6.0 WATERPROOFING CUM INSULATION SYSTEM

Waterproofing cum Insulation system shall consist of cement concrete screed on prepared base, primer coat, Polyurethane foam insulation, PU waterproof coating, Geo-textile membrane and a top protective finishing layer as below :

Layer	Material
1st layer	PCC screed over prepared roof surface
2nd layer	Polyurethane primer coat
3rd layer	40 mm thick machine sprayed Polyurethane Foam insulation
4th layer	Minimum 1.5mm DFT (Dry Film Thickness) single component Polyurethane (PU) water proofing coating
5th layer	Geo-textile membrane
6th layer	PCC top protective finishing layer

6.1 Materials

6.1.1 Cement concrete screed

Copyright EIL – All rights reserved

Cement concrete screed shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete. Thickness of the screed shall be minimum 50 mm . Thickness at various locations of the roof/ terrace shall be as required for maintaining required slope to ensure proper roof drainage. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

6.1.2 Primer

Primer shall be polyurethane primer compatible to sprayed Polyurethane Foam insulation or single component Polyurethane water proofing coating as applicable (which shall be applied over the primer) and shall be as per approved Manufacturer/ system provider's standard specification and as approved by Engineer-In-Charge.

6.1.3 Sprayed Polyurethane Foam insulation

Polyurethane Foam insulation shall be CFC (Chlorofluorocarbons) and HCFC (hydro chlorofluorocarbon) free with closed cell structure having following properties. (Reference: Properties for type-1 foam as mentioned in Table-1 of ASTM D 7425.)

Property	Value	Testing Method
Thermal resistance of 25mm thickness	Minimum 0.98 K-sqM/W at mean temperature 24 degree C	ASTM C177, C1363 or C 518
Compressive strength	Minimum 276 KPa at yield or 10% deformation	ASTM C165 or ASTM D 1621
Density	Minimum 40 Kg/CuM	ASTM D 1622
Water absorption	Maximum volume % 5	ASTM D 2842
Tensile Strength	Minimum 276 KPa	ASTM D 1623
Closed cell content	Minimum 90%	ASTM D 6226

6.1.4 Polyurethane (PU) water proofing coating

Polyurethane water proofing coating/ membrane shall be single component (moisture cured, elastomeric, free from bitumen and tar) viscous liquid containing urethane polymers having following properties:

Property	Value	Testing Method
Solid content	Minimum 85%	ASTM C 836
Elongation	Minimum 400%	ASTM D 412
Tensile Strength	2-3 MPa	ASTM D 412

6.1.5 Top protective finishing layer

Top protective layer shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete with 24 SWG chicken wire mesh. Thickness of the layer shall be minimum 50 mm thick

6.1.6 Geo-textile membrane

Geo textile membrane shall be of 150 GSM (grams per square meter) as per approved Manufacture/ system provider's specification and as approved by Engineer-In-Charge.

Copyright EIL – All rights reserved

6.2 Workmanship

6.2.1 Base Surface Preparation

Surface preparation shall be in accordance with clause 5.2.5

6.2.2 Screed

Screed shall be laid in accordance with clause 5.2.6

6.2.3 Primer coat

Primer coat shall be applied in accordance with clause 5.2.7

6.2.4 Polyurethane Foam insulation

Polyurethane Foam insulation shall be spray applied conforming to IS : 12432, part-3 over the primer coat in layers with compatible spraying machine to form a seamless, crack free and monolithic insulation layer. Public movement shall be restricted over the insulation layer.

6.2.5 Polyurethane (PU) water proofing coating

Polyurethane water proofing coating shall be applied in accordance with clause 5.2.8. Water After the coating is cured, ponding test shall be done in accordance with clause 5.2.8.

6.2.6 Geo-textile membrane

Geo-textile membrane shall be provided over the cured Polyurethane water proofing coating as a separation layer for subsequent PCC layer after emptying the water used for ponding test for leakage.

6.2.7 Top protective finishing layer

Top protective finishing layer of PCC or M15 grade concrete shall be laid in accordance with clause 5.2.9.

6.2.8 Waterproofing treatment over parapets/ vertical surfaces

Waterproofing treatment over parapets/ vertical surfaces on roof shall be done in accordance with clause 5.2.10

6.2.9 Finishing of parapet/ vertical surfaces

Finishing of parapet/ vertical surfaces shall be done in accordance with clause 5.2.11

6.2.10 Roofing treatment in concrete gutter

Roofing treatment in concrete gutter shall be done in accordance with clause 5.2.12

Copyright EIL – All rights reserved

6.3 TESTING

Test for leakage shall be done in two stages.

Stage 1:

After the polyurethane waterproofing coating is cured, water ponding test for leakage shall be done on waterproof coated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 meter x 2 meter and water ponding for minimum 72 hours.

Stage 2:

After the top layer is cured, water ponding test for leakage shall be done for finished surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels and water ponding for minimum 72 hours. Smooth roof water drainage through roof water outlets shall also be checked during this stage of testing.

Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

7.0 DELIVERABLES BY THE CONTRACTOR

The Contractor shall furnish product data sheets and test certificates (by Government or NABL approved Laboratories) in support of properties/ performance of specified materials/ systems. Method of tests shall be as mentioned in related standards.

8.0 WARRANTY

Warranty of minimum 10 years shall be provided by the contractor for leak proof roof or any other damage/ defect of the complete roofing system. Any leakage, damage, defect (excepting any leakage, damage caused by 3rd party and causes not attributable to waterproofing contractor) within the warranty period shall be rectified by the contractor at his own cost to the satisfaction of Engineer In charge.

9.0 MEASUREMENT

Measurement of waterproofing treatment shall be the measurement of actual surface area on which waterproofing has been done.

Copyright EIL – All rights reserved

पुताई, रंगीन पुताई, डिस्टेम्परिंग, पैन्टिंग और पालिशिंग का मानक विनिर्देश

STANDARD SPECIFICATION FOR WHITE/ COLOUR WASHING, DISTEMPERING, PAINTING AND POLISHING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	11.05.23	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	TUSHAR SRIVASTAVA	ATUL GUPTA	SAMIR DAS	SANJAY MAJUMDAR
6	25.08.17	REVISED & ISSUED AS STANDARD SPECIFICATION	AM	JS/ JKB	RAJAN SRIVASTAVA	R. NANDA
5	09.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	TS	JS	JKB	D MALHOTRA
4	21.03.07	REVISED & ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V. CHATURVEDI

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing and Materials
BS	:	British Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
BIS	:	Bureau of Indian Standards
EN	:	European Standards
RCC	:	Reinforced Cement Concrete
VOC	:	Volatile Organic Compounds
ISO	:	International Organization for Standardization
NFPA	:	National Fire Protection Association
POP	:	Plaster Of Paris

Architecture Standards Committee

Convenor : Mr. Samir Das

Members : Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumdar (Strl)
Mr. Charanjeet Singh (Proj.)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

Contents

1.0 GENERAL 4
2.0 REFERENCES 4
3.0 TYPES OF PAINTS /POLISHING 5
4.0 MATERIALS 5
5.0 WORKMANSHIP 6
6.0 WHITE WASHING 7
7.0 COLOUR WASHING 7
8.0 ACRYLIC DISTEMPER 8
9.0 WATERPROOF CEMENT PAINT 9
10.0 ACRYLIC/ PLASTIC EMULSION PAINTING (For interior surfaces) 10
11.0 ACRYLIC BASED EXTERIOR EMULSION PAINT (For exterior surfaces) 11
12.0 ACRYLIC COPOLYMER AGGREGATE FINISH 12
13.0 SYNTHETIC ENAMEL PAINTING 12
14.0 APPLICATION OF CLEAR FINISHES (Polishing, Varnishing) 13
15.0 MEASUREMENT 15

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 This Specification covers requirements of White/ Colour Washing, Distempering, Painting & Polishing on building works as interior or exterior finishing or decorations etc.

1.2 Unless otherwise specifically mentioned in design basis, job specification, drawings, item descriptions etc. all plastered, wooden and bare metal surfaces shall be painted.

1.3 For energy efficient and green or sustainable buildings job specification, item descriptions specific to these buildings shall be referred.

2.0 REFERENCES

The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document title
IS 2395	Code of practice for painting concrete, masonry and plaster surfaces.
IS 6278	Code of practice for white washing and colour washing.
IS 712	Specification for building limes
IS 55	Specification for Ultramarine blue for paints.
IS 63	Specification for whiting for paint and putty.
IS 427	Distemper (dry), colour as required.
IS 428	Washable Distemper
IS 15489	Paint, Plastic Emulsion- Specification
IS 2338 Part-1	Code of practice for finishing of wood, and wood based materials. Part-1 : Operations & workmanship
IS 2338 Part-2	Code of practice for finishing of wood, and wood based materials. Part-2 : Schedule
IS 5410	Cement paint, colour as required.
IS 2524 Part-1	Code of practice for painting non-ferrous metals in buildings. Part-1 : Pre-treatment
IS 2524 Part-2	Code of practice for painting non-ferrous metals in buildings. Part-2 : Painting
IS 1477 Part-1	Code of practice for painting ferrous metals in buildings. Part-1 : Pre-treatment
IS 1477 Part-2	Code of practice for painting ferrous metals in buildings. Part-1 : Painting
IS 384	Brushes, paints and varnishes, flat.
IS 486	Brushes, sash, tool, for paints and varnishes.
IS 110	Ready mixed paint, brushing, grey filler enamels for use over primers
IS 3585	Ready mixed paint, aluminium brushing priming water resistant for wood work.
IS 110	Ready mixed paint, brushing, grey filler for enamels for use over primers
IS 2395 Part-1	Painting of concrete, masonry & plastered surface, code of practice. Part-1 : Operations and workmanship
IS 2395 Part-2	Painting of concrete, masonry & plastered surface, code of practice

Copyright EIL – All rights reserved

	Part-2 : Schedule
IS 3536	Ready mixed paint, brushing, wood primer - Specification
IS 109	Specification for ready mixed paint, finishing, priming, plaster, to indian standard colour no. 361 light stone and no. 631 light grey, white and off - White
IS 2074	Ready mixed paint air drying red oxide zinc chrome priming specification

3.0 TYPES OF PAINTS /POLISHING

3.1 Type of Painting/ polishing shall be as mentioned in design basis, job specification, drawings, item descriptions etc.

3.2 Unless otherwise specified in design basis, drawings, item descriptions, job specifications etc, Type of Painting/ polishing shall be as per following table.

Surface	Paint/ polishing type
Internal Masonry/ Block work/ RCC wall and ceiling surface	Interior grade Acrylic Emulsion paint
External Masonry/ block work/ RCC/ plastered surface	Exterior grade Acrylic Emulsion paint
Local/ Hard wood, engineered wood and bare metal surface	Synthetic Emulsion paint
Teak or superior wood surface	French polishing

Note :

For energy efficient and green or sustainable buildings job specification, item descriptions specific to these buildings shall be referred.

4.0 MATERIALS

4.1 All materials required for the execution of painting work shall be obtained direct from approved manufacturers and shall be brought to the site in makers drums, bags etc. with seals unbroken.

4.2 In case of ready mixed paints, thinning if necessary, the brand of thinner shall be as per recommendations of the manufacturer.

4.3 Wall putty shall be minimum 2 mm thick and white cement and polymer based wall putty type.

4.4 Primer shall be compatible with the finishing paint.

4.5 The allowable limits of quantity of VOC (Volatile Organic Compounds) in different types of paints and primer shall be as defined in the following parameters:

A. Primer

Type of Primer		**Allowable VOC Content**
Pink & Grey primer on wood	:	< 50 gms/ltr
Ready mix red oxide zinc chromate primer	:	< 250 gms/ltr

Copyright EIL – All rights reserved

Water thinnable cement primer on wall	:	<50 gms/ltr

B. Paints

Type of Paint		Allowable VOC Content
Acrylic Emulsion	:	<50 gms/ltr
Plastic Emulsion	:	<50 gms/ltr
Acrylic Distemper	:	<50 gms/ltr
Synthetic Enamel	:	<150 gms/ltr

5.0 WORKMANSHIP

5.1 Colour/ texture of the wash/ distemper/paint/ polishing shall be as approved by the Engineer-in-charge. Sample painting shall be done as directed by the Engineer-In- charge for approval/ selection of the colour/ texture.

5.2 Washed/ distempered/Painted/ polished surface shall be even and uniform without patches, marks, without any defect and of finish as desired by the Engineer-In-Charge. Any defect or shortcomings in the finishing shall be rectified to the satisfaction of the Engineer –In- Charge.

5.3 Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being white washed.

For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

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

For ceiling, proper stage scaffolding shall be erected.

5.4 Surface preparation shall be done as mentioned for various type of wash/ distemper/paint/ polishing. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

5.5 Preparation and application of wash/ distemper/paint/ polishing shall be done as mentioned for various types. However, in case of excessive un-even surfaces, punning with Plaster of Paris shall be done on the surface if and as directed by the Engineer-In-Charge.

5.6 Paint shall be applied by brushing or spraying or by using rollers as directed by the Engineer-In-Charge. The brushing operations are to be adjusted to the spreading capacity advised by the manufacturer. During painting, every time after the paint has been worked out of the brush bristles, the bristles shall be opened up by striking the brush suitably.

Spray machine used may be of high pressure type or low pressure depending on the nature and location of work. After work, the brushes shall be completely cleaned of paint and shall be hung in a thinner if intended to be used afterwards. The spray guns shall be cleaned thoroughly after every break in work. The paint/ polish containers, when not used shall be kept close and free from air.

5.7 After the finishing of work, the adjacent surfaces not intended to be washed/ distempered/painted/polished shall be thoroughly cleaned of all paint patches and shall be

Copyright EIL – All rights reserved

finished in accordance with surface finishing of such surfaces. Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned.

5.8 Number of coats of paint as mentioned is the minimum number of coats. Additional coats shall be provided as required for obtaining desired colour and finishing.

5.9 The operation for each coat shall consist of stroke of the brush/ roller from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left. Each coat shall be allowed to dry before the next coat is applied.

5.10 The painting on ceiling should be done prior to that on walls.

6.0 WHITE WASHING

White washing in general shall conform to IS 6278.

6.1 Preparation of Surface

The surface shall be thoroughly cleaned of all dirt, dust, mortar dropping and other foreign matter before white wash is to be applied. Surfaces already white/colour washed shall be broomed down to remove all dust, dirt, loose scales of lime wash or other foreign matters.

All damaged portions of the surface plaster shall be removed to full depth of plaster in rectangular patches and plastered again after raking the joints in masonry properly. Such portions shall be wetted and allowed to dry before any operation.

All holes, cracks, patches etc. not exceeding 0.1 sq. m. in area shall be made good with material similar to that of the surface. Surfaces affected by efflorescence, moss, fungi, algae, lichen etc. shall be treated in accordance with IS: 2395.

6.2 Preparation of White Wash

The fat lime conforming to IS: 712 shall be slaked at site and shall be mixed and stirred with about 5 litres of water for 1 kg. of unslaked lime to make thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 4 kg of gum dissolved in hot water shall be added to each cubic metre of lime cream. Approved quality ultramarine blue conforming to IS 55 @ 3 gram per kg. of lime shall also be added to the solution. The whole solution shall be stirred thoroughly before use.

6.3 Application

White wash shall be applied with "MOONJ" brush to the specified number of coats. Minimum number of coats shall be three. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left.

7.0 COLOUR WASHING

7.1 Preparation of Surface shall be similar to clause no 6.1

Copyright EIL – All rights reserved

7.2 Preparation of colour wash

Sufficient quantity of colour wash enough for the complete job shall be prepared in one operation to avoid any difference in colour. The basic white wash solution shall be prepared in accordance with clause no 6.2. Mineral colours of approved shade and quality not affected by lime shall be added to the white wash solution in proportions as directed by Engg.in-charge. Solid lumps etc. in the colour powder shall be ground to fine powder, sieved and mixed evenly and thoroughly to the white wash solution. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface.

7.3 Application

Colour wash shall be applied with "MOONJ" brush to the specified number of coats. Minimum number of coats shall be three. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left.

For new work, a priming coat of white wash with lime or with whiting shall be provided. Three or more coats of colour wash shall then be applied on the entire surface till it represents a smooth and uniform finish.

For old work, after the surface preparation, a coat of colour wash shall be applied over the patches and repairs. Then coats of colour wash shall be applied over the entire surface. The colour washed surface shall present a uniform finish.

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

8.0 ACRYLIC DISTEMPER

8.1 Preparation of Surface

The surface shall be thoroughly cleaned of dust, old finish by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of Plaster of Paris (POP) mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

In case of distempering over existing distempered surface, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster-of-paris mixed with the colour to be used. The surface then shall be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of distemper is allowed.

8.2 Priming Coat

The priming coat shall be with distemper primer or cement primer, as required. If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied. For old work no primer coat is necessary.

Copyright EIL – All rights reserved

A priming coat of whiting conforming to IS 63 shall be applied over the prepared surface. The priming coat shall be prepared by mixing 2.5 kg. of whiting and one litre of glue solution (prepared by mixing 250 gm. glue conforming to IS: 852 with boiling water) together and placing it in a covered vessel with enough water to cover the mixture which shall be left to cool until it becomes a jelly.

Priming coat shall be applied with "MOONJ" brush or roller to the specified number of coats. Minimum number of coats shall be minimum one. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left. Each coat shall be allowed to dry before the next coat is applied.

8.3 Preparation of Distemper

1st quality Acrylic distemper having VOC content less than 50 gms/litre of approved brand and manufacture shall be used for preparation of distemper. The Acrylic distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

8.4 Application of Distemper

For new work, 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 distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes or roller in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

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

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

For old work, the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

The finished surface shall be even and uniform without patches, marks, distemper drops etc.

9.0 WATERPROOF CEMENT PAINT

9.1 Preparation of Surface

Preparation of Surface shall be similar to clause no 6.1. The surface so prepared shall be thoroughly wetted with clean water before the paint is applied.

9.2 Preparation of Paint

Waterproof cement paint conforming to IS 5410 shall be mixed with water and stirred to obtain a thick paste which shall then be diluted to brushable consistency. The proportion of mixture shall be as per manufacturer's recommendation. The paint shall be mixed in such quantity which can be used up within an hour of mixing to avoid setting and thickening of the paint.

Copyright EIL – All rights reserved

9.3 Application of Paint

The surface shall be treated with waterproof cement paint in minimum three coats maintaining the coverage rate (kg/ square metre) as mentioned in approved Manufacturer's standard literature. No less than 24 hours shall be allowed between two coats and subsequent coats shall be applied only after the preceding coat has become hard to resist marking by subsequent brushing.

9.4 Curing

Curing shall be started after the paint has hardened. Curing shall be done as recommended by the approved Manufacturer and by sprinkling with water two or three times a day. This shall be done between coats and for at least two days following the final coat.

10.0 ACRYLIC/ PLASTIC EMULSION PAINTING (For interior surfaces)

10.1 Acrylic/ plastic emulsion paint (for interior surfaces) shall be of interior grade, premium quality conforming to IS: 15489 and having VOC less than 50 gm/ litre.

10.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

First coat of primer shall be applied over the surface and the surface shall be allowed to be dry for 6-8 hours.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

Once the surface is dried, second coat of primer shall be applied after sand papering and cleaning the surface.

After 6-8 hours, when the surface is dry, it shall again be sand papered and cleaned for a clean and smooth service.

In case of already painted surface, old paint and loose particles shall be removed before stating the above mentioned preparation process.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

10.3 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

10.4 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to

Copyright EIL – All rights reserved

the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, velvety smooth finish, even and uniform shade without patches, marks, paint drops etc.

11.0 ACRYLIC BASED EXTERIOR EMULSION PAINT (For exterior surfaces)

11.1 Acrylic/ plastic emulsion paint (for exterior surfaces) shall be of exterior grade, premium quality conforming to IS: 15489 and having VOC less than 50 gm/ litre.

It shall be an acrylic based wall coating for exterior surfaces to form a crack free, flexible, tough, alkali & fungal resistant and UV resistant waterproof coating with silicone additives.

11.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

Any old paint shall be removed with removing agent as per manufacturer's instructions. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

1-2 coats of primer shall be applied over the surface and the surface shall be allowed to be dry for 6-8 hours.

After 6-8 hours, when the surface is dry, it shall again be sand papered and cleaned for a clean and smooth service.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

11.3 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

11.4 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, velvety smooth finish, even and uniform shade without patches, marks, paint drops etc.

Copyright EIL – All rights reserved

12.0 ACRYLIC COPOLYMER AGGREGATE FINISH

12.1 It shall be an acrylic based textured wall coating system consisting of quartz and silica aggregate, inorganic pigments and other additives to form a crack free, flexible, tough, waterproof coating.

12.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

Any old paint shall be removed with removing agent as per manufacturer's instructions. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

12.3 Preparation of coating

Preparation of coating using various components shall be in accordance with procedures recommended by the approved Manufacturer to achieve the desired finish.

12.4 Application

Application of the system shall be in accordance with procedures recommended by the approved Manufacturer to achieve the desired finish. Sealing coat, primer etc. as recommended by the approved Manufacturer shall also be provided.

13.0 SYNTHETIC ENAMEL PAINTING

13.1 Synthetic Enamel paint shall conform to IS 2933

13.2 Preparation of surface

A. Preparation of wood surface

The woodwork to be painted shall be dry and free from moisture and any foreign matter. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by griding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS 345 with same shade as Paint shall be used. The surface treated for knotting shall be dry before paint is applied.

Plywood, Block board, Particle board etc. shall be treated in the same manner as for wood work.

Copyright EIL – All rights reserved

B. Preparation of Iron and steel surface

All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface if any, shall be removed.

13.3 Priming

The primer shall be ready mixed primer and compatible to the paint.

Primer for wood work shall conform to IS 3536. Primer for Iron and steel shall be Red Oxide Zinc Chromate primer conforming to IS 2074, for cement, concrete and plastered surfaces primer shall conform to IS 109.

Dirt or any other extraneous material on the surface shall be removed and the priming shall be applied in minimum two coats.

13.4 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

13.5 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, smooth finish, even and uniform shade without patches, marks, paint drops etc.

14.0 APPLICATION OF CLEAR FINISHES (Polishing, Varnishing)

14.1 For the application of clear finishes, the following procedures shall generally be adopted in accordance with IS: 2338 (Part-I)

A. Filling
B. Staining
C. Sealing
D. Finishing

14.2 Filling

Fillers shall be applied to prevent the excessive penetration of the finish to the surface for obtaining a smooth finish. Fillers shall be conforming to IS: 345.

Fillers shall be heavily applied to the wood surface by hand, using hessian or jute rag across the grain. It shall be rubbed when still wet to get better penetration. After 5-10 minutes it shall be wiped off by hand across the grain followed by a light wipe with the grain. The filled surface shall be dried preferably over night and smoothened with abrasive paper.

Copyright EIL – All rights reserved

14.3 Staining

A. Spirit Stains

Spirit stains are solutions of spirit soluble dyes in Industrial methylated spirit.

B. Oil Stains

Oil stains are solutions of oil soluble dyes in linseed oil, but, usually consist of insoluble, semi-transparent pigments ground in linseed oil and thinned with turpentine or other solvent.

14.4 Surface Preparation

Surface intended for staining shall be kept scrupulously clean and free from greasy finger marks. It shall be prepared by careful smoothing with fine abrasive paper used in the direction of the grain. Small cracks/nail holes shall be stopped with plastic wood/fine plaster of Paris. The stopping shall be rubbed down with fine abrasive paper when hard and touched with a thinned knotting before staining. In case of oil staining stopping shall be done after staining using tinted putty or wood filler.

14.5 Application of Stains

Stains shall be applied by brushing and wiping or by spraying. The stain shall be so thinned that it can be applied fairly, liberally without over staining and over lapping.

14.6 Sealing

A suitable sealer shall be applied on the filled and sanded surface to prevent absorption by the wood of the succeeding coats of finish and to seal stain and filler and thus preclude their bleeding into the finish coat.

Sealer may be sprayed on taking care not to flood the surface and it shall be allowed to dry hard. When fully dry the surface shall be sanded taking care not to cut through at corners and edges. Dust shall be blown off and surface wiped with a clean rag.

14.7 Finishing

The stained surface shall be varnished, wax-polished or French polished as required after it is dried.

A. Varnishing

Varnishing of wood and wood based material shall be in accordance with IS: 2338 (Part-I).

Surfaces to be varnished shall be prepared to produce a smooth, dry and matt surface and all dust and dirt shall be removed from the surface.

The Varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with short light strokes to avoid frothing. It shall be allowed to flow out while the next section is being laid in. Excess Varnish shall be scraped out of the brush and then the first section be crossed, re- crossed and laid off lightly. The Varnish, once it has begun to set, shall not be retouched. In case of any mistake, the Varnish shall be removed and the work shall be started afresh.

Copyright EIL – All rights reserved

Where two coats of varnish are applied, the first coat shall be a hard drying under coating or flatting varnish which shall be allowed to dry hard and then be flatted down before applying the finishing coat. Sufficient time shall be allowed in between two coats.

When flat varnishing is used for finishing, a preparatory coat of hard drying undercoating of flatting varnish shall first be applied and shall be allowed to harden thoroughly. It shall then be lightly rubbed down before the flat varnish is applied. On larger areas, the flat varnish shall be applied rapidly, and the edges of each patch applied shall not be allowed to set, but shall be followed up whilst in free working conditions.

B. French Polish

French polish shall conform to IS :348. Suitable pigments shall be added to get the required colour.

The surface to be French polished shall be rubbed down to smoothness with sand paper and shall be well dusted. Pores in the surface shall be filled up with fillers.

A pad of woollen cloth covered by a fine cloth shall be used to apply the finish. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles applying the polish sparingly but uniformly over the entire area to give an even surface. A trace of linseed oil may be used on the face of the pad for the purpose. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

15.0 MEASUREMENT

Painting/ polishing shall be measured by the area of actual painted/ polished surface.

Copyright EIL – All rights reserved

छत के कार्यों का मानक विनिर्देश

STANDARD SPECIFICATION FOR ROOFING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	04.03.22	REVISED & ISSUED AS STANDARD SPECIFICATION	ANISH MAHALA	ANISH KUNDU	SAMIR DAS	SANJAY MAZUMDAR
6	08.12.15	REVISED & ISSUED AS STANDARD SPECIFICATION	ANISH MAHALA	JKB	R. SRIVASTAVA	S. CHANDA
5	06.07.10	REVISED & ISSUED AS STANDARD SPECIFICATION	GB	JS	JKB	N. DUARI
4	21.03.07	REVISED & ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V. CHATURVEDI
3	09.03.99	REAFFIRMED AS STANDARD SPECIFICATION	SD	MLB	SCJ	AS

Copyright EIL – All rights reserved

Abbreviations:

AS	: Australian Standards
ASTM	: American Society for Testing and Materials
BS	: British Standards
BS-EN	: British Standards European Norm
CGI	: Corrugated Galvanized Iron
EN	: European Standards
EPDM	: Ethylene Propylene Diene Monomer
GI	: Galvanized Iron
IS	: Indian Standards
ISO	: International Organization for Standardization
MS	: Mild Steel
NBC	: National building Code
SWG	: Standard Wire Gauge

Architecture Standards Committee
Convenor: Mr. Samir Das

Members: Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumder (Strl)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0	GENERAL.....	04
2.0	REFERENCES.....	04
3.0	CORRUGATED GALVANISED STEEL SHEET ROOFING.....	04
4.0	ALUMINIUM ALLOY SHEET ROOFING/ CLADDING.....	07
5.0	PRECOATED GALVANIZED STEEL SHEET ROOFING / CLADDING.....	09
6.0	PRECOATED ZINC ALUMINIUM STEEL SHEET ROOFING / CLADDING.....	11
7.0	FIBRE CEMENT CORRUGATED SHEET ROOFING/ CLADDING.....	13
8.0	MEASUREMENTS.....	16

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 This Specification covers requirements of sheet roofing/ cladding and associated accessories for buildings and sheds. The specifications of metal sheets (with regards to material) are also applicable for barricades required during construction.

1.2 The roofing and cladding system shall ensure leak-proof enclosure by means lapping of sheets, closure of joints, junctions and gaps etc., efficient roof water drainage system etc. using necessary flashings, accessories and fittings.

1.3 The roofing and cladding system shall also have provisions for natural lighting and ventilation.

2.0 REFERENCES

2.1 The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Standards	Document title
IS: 277	Galvanized steel strips and sheets (Plain and corrugated)
IS: 513	Cold reduced carbon steel sheet and strip
IS: 737	Wrought aluminium and aluminium alloy sheet and strip for general engineering purposes
IS: 1254	Corrugated aluminium sheet
IS: 2676	Dimensions for wrought aluminium and aluminium alloys, sheet and strip
IS: 13592	Unplasticized Polyvinyl Chloride (PVC-U) Pipes for Soil and Waste Discharge System Inside and Outside Buiildings Including Ventilation and Rainwater System
IS: 14871	Products in fibre reinforced cement - Long corrugated or asymmetrical section sheets and fittings for roofing and cladding - Specification
IS: 15961	Hot dip aluminium - Zinc alloy metallic coated steel strip and sheet (Plain)

3.0 CORRUGATED GALVANISED STEEL SHEET (C.G.S) ROOFING

3.1 Material

3.1.1 C.G.S. Sheets

C.G.S sheet shall conform to IS: 277.

Copyright EIL – All rights reserved

Unless otherwise specified in drawings, item descriptions, job specifications etc. the sheets shall be 1.00 mm thick and with zinc coating (total on both sides) not less than 275 gm/ sqm.

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanising shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

3.1.2 Ridges, hips, valley, flashing and gutter of plain galvanised steel sheets

Leakproof roofing system with efficient rain water drainage of the roofing system shall be ensured by providing ridges, hips, valley, flashing and gutter etc. (all bent and fabricated to required shape) made of plain galvanized steel sheets.

Unless otherwise specified in drawings, item descriptions, job specifications etc. thickness and width etc. of these shall be as below:

Item	Thickness (mm)	Minimum overall width (mm)
Ridge	0.8	600
Hip	0.8	600
Valley	1.60	900
Flashing	1.00	400
Gutter	1.00 (minimum)	Profile, dimensions shall be as required for roof drainage

3.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

3.2 Laying and Fixing

3.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

3.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

3.2.3 The sheets shall be laid with a minimum lap of 150 mm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 150 mm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 200 mm. The minimum lap of sheets with ridge, hip and valley shall be 200 mm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

Copyright EIL – All rights reserved

3.2.4 Lapping in C.G.S. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.S. sheet, before the sheets are fixed in place.

3.2.5 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with anticorrosive polymer coated J or L hook bolts and nuts, 8 mm diameter, with polymer cap, seal and thrust washer. J hooks shall be used for fixing sheets on angle iron purlins, and L hooks shall be used for fixing the sheet to R.S. joists, timber or precast concrete purlins. The length of the hook bolt shall be varied to suit the particular requirements.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 300 mm. Coach Screws shall not be used for fixing sheets to purlins.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

3.2.6 Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by bolts and nuts 25 × 6 mm size. As the overlap at the sides extends to two corrugations, these bolts shall be placed zig-zag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 600 mm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

3.2.7 Ridges and hips of C.G.S. sheet roofing shall be covered with ridge and hip sections of plain G.S. sheet (properly bent in shape for fitting over roofing sheet) with a minimum lap of 200 mm on either side over the C.G.S. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 200 mm. They shall be fixed to the perlins with 8mm dia hooks, bolts, nuts and washers (similar to those used in laying the roofing sheets)

3.2.8 Valley shall lap with the C.G.S. sheets not less than 250 mm width on other side. The end laps of valley shall also be not less than 250 mm.

3.2.9 Flashings shall lap not less than 150 mm over the roofing sheets. The end laps between flashing pieces shall not be less than 250 mm.

3.2.10 Valley and flashings shall be fixed to roof structural members with 8mm dia hooks, bolts, nuts and washers (similar to those used in laying the roofing sheets)

3.2.11 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Hooks/ bolts/ nuts (minimum 6 mm dia) and washers for fixing shall be similar to those used in laying the roofing sheets. Connecting bolts shall be above water line of the gutter.

Copyright EIL – All rights reserved

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of G.S. sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

3.2.12 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

3.2.13 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins.

3.2.14 The roof when completed shall be true to lines and slopes and shall be leak proof.

4.0 ALUMINIUM ALLOY SHEET ROOFING/ CLADDING

4.1 Material

4.1.1 Corrugated Aluminium alloy sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of corrugated Aluminium alloy sheet for roofing and cladding shall conform to following specification.

Alloy Grade	31500 B, H4 as specified in IS: 737: 2008
Profile	Profiled/corrugated sheet shall be Industrial troughed sheet Conforming to IS: 1254 -2007
Thickness	20 SWG (0.91mm) for roofing 22 SWG (0.71mm) for wall cladding (Thickness, tolerances shall be as per IS: 2676-1981)
Pitch	125 mm
Crest Height	38 mm

Finishing of the sheets shall be plain mill or stucco embossed finish. Unless otherwise specified in drawings, item descriptions, job specifications etc, the finishing shall be stucco embossed finish in approved colour.

4.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain Aluminium alloy sheet of grade 31500 B / H2 conforming to IS: 737.

Unless otherwise specified in drawings, item descriptions, job specifications etc the dimensions and other specifications shall be as mentioned in the following table.

Accessory	Dimension
Ridge piece	0.91 mm thick, minimum 600 mm wide
Apron piece	0.71 mm thick, minimum 150 mm x 150 mm

Copyright EIL – All rights reserved

Eaves piece	0.71 mm thick, minimum150 mm x 150 mm
Corner piece	0.71 mm thick, minimum 150 mm x 150 mm
Gutter	2 mm thick, width as required.

Finishing of accessories shall be similar to that of the roofing/ cladding sheet.

4.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

4.2 Laying and fixing

4.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

4.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

4.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm on roofs and one corrugated for sides lap. If the roof slope is less than 15 degrees, end lap shall be increased to 230 mm. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

4.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with stainless steel (SS 304 grade) or carbon steel or aluminium alloy hex head self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

If not mentioned specifically, carbon steel screws shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

4.2.5 Carbon steel screws shall be hex head, self drilling type with multi-layered high density anti-corrosive coating of Aluminium & Zinc (AZ), fitted with AZ150 GSM 0.8mm thick Alu-Zinc coated EPDM bonded washer.

4.2.6 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leakproof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

Copyright EIL – All rights reserved

4.2.7 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

4.2.8 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

4.2.9 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

4.2.10 The roof when completed shall be true to lines and slopes and shall be leak proof.

5.0 PRECOATED GALVANIZED STEEL SHEET ROOFING / CLADDING

5.1 Material

5.1.1 Pre-coated galvanized steel sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of pre-coated galvanized steel sheet for roofing and cladding shall conform to following specification and performance properties.

Base metal	Cold rolled steel sheet conforming to IS : 513, galvanized (275 g/SqM total on both side) by hot dip process as per IS : 277.
Profile	Profiled/corrugated sheet
Pitch	195 to 255 mm (with intermediate ribs)
Crest Height	Not less than 28 mm
Base metal thickness	0.60 mm (+/- 0.03)
Overall coated thickness	0.65 mm
Weight	Minimum 5.80 Kg/ SqM
Finishing – top surface	Regular modified polyester of minimum 20 (+/- 2) microns over primer coat of 5 microns.
Finishing – bottom surface	Polyester coat of minimum 5 microns over primer coat of 5 microns
Yield strength	Minimum 550 MPa
Pencil hardness	H-2H
Bending test	2-4 T

Copyright EIL – All rights reserved

Salt spray test	750 hours (exposed top side)
QUV – Wealterometer test	1000 hours
Humidity test	Minimum 750 hours

The sheets shall be of approved colour.

5.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain pre-coated galvanized steel sheet similar (except corrugation) to the sheet specified for roofing/ cladding.

5.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

5.2 Laying and fixing

5.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

5.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

5.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm to 250 mm for a slope more than 15 degree (1 in 4) and 200 mm to 300 mm for slope less than 15 degree. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

5.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

If not mentioned specifically, Zinc coated or Zinc- Tin alloy coated, hex head screws as per AS 3566 class -3 fasteners with EPDM washers shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

Copyright EIL – All rights reserved

5.2.5 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leakproof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

5.2.6 Gutters shall be made leak proof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

5.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes

5.2.8 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

5.2.9 The roof when completed shall be true to lines and slopes and shall be leak proof.

6.0 PRECOATED ZINC ALUMINIUM STEEL SHEET ROOFING / CLADDING

6.1 Material

6.1.1 Pre-coated Zinc- Aluminium steel sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of pre-coated galvanized steel sheet for roofing and cladding shall conform to following specification and performance properties.

Base metal	The base metal of the roofing shall be cold rolled steel sheet conforming to AS: 1397 or IS : 513. It shall be coated with Al-Zn alloy (55.00% Aluminium, 43.40% Zinc, 1.60% Si) / Zincalume by Hot-dip process as per IS :15961 or AS:1397 or ASTM : A792M. (class AZ 150, having minimum 150 g/SqM AZ coating mass total on both sides).
Profile	Profiled/corrugated sheet
Pitch	195 to 255 mm (with intermediate ribs)
Crest Height	Not less than 28 mm
Base metal thickness	0.45 mm (+/- 0.03)

Copyright EIL – All rights reserved

Overall coated thickness	0.52 mm
Weight	Minimum 4.50 Kg/ SqM
Finishing – top surface	Super durable polyester of minimum 20 (+/- 2) microns over polyester primer coat of 5 microns.
Finishing – bottom surface	Polyester coat of minimum 5 microns over primer coat of 5 microns.
Yield strength	Minimum 550 MPa
Pencil hardness	H-2H
T-Bending test	Maximum 5T
Salt spray test	1000 hours (exposed top side)
QUV – Wealterometer test	1000 hours
Humidity test	Minimum 1000 hours

6.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain Pre-coated Zinc- Aluminium steel sheet sheet similar (except corrugation) to the sheet specified for roofing/ cladding.

6.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

6.2 Laying and fixing

6.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

6.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

6.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm to 250 mm for a slope more than 15 degree (1 in 4) and 200 mm to 300 mm for slope less than 15 degree. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

6.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

Copyright EIL – All rights reserved

If not mentioned specifically, Zinc coated or Zinc- Tin alloy coated, hex head screws as per AS 3566 class -3 fasteners with EPDM washers shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

6.2.5 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leak proof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

6.2.6 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

6.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes

6.2.8 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

6.2.9 The roof when completed shall be true to lines and slopes and shall be leak proof.

7.0 FIBRE CEMENT CORRUGATED SHEET ROOFING/ CLADDING

7.1 Material

7.1.1 Fibre cement corrugated sheet

Fibre cement corrugated sheets shall conform to IS :14871 and following specification.

Composition	The sheets shall be asbestos free and reinforced by organic and /or inorganic synthetic fibres. The product shall be composed essentially of an inorganic hydraulic binder (in case of Portland pozzolana cement Portland slag cement, addition of pozzolanic materials and slag shall not be permitted) or a calcium silicate binder formed by the chemical reaction of a silicate binder formed by the chemical reaction of a.

Copyright EIL – All rights reserved

	siliceous (includes ground silica, pulverized fuel ash and amorphous silica) and calcareous material reinforced by organic and /or inorganic synthetic fibres. Pozzolanic materials process aids, fillers and pigments which are compatible with the fibre reinforced cement may be added. The inorganic hydraulic binder shall be either ; 33 grade ordinary Portland cement conforming to IS : 269 or 43 grade ordinary Portland cement conforming to IS :8112 or 53 grade ordinary Portland cement conforming to IS :12269 or Portland pozzolona (fly ash based) cement conforming to IS :1489 - part 1 or Portland pozzolona (calcined clay based) cement conforming to IS :1489 - part 2 or Rapid hardening cement conforming to IS :8041 or Portland slag cement conforming to IS :455 Fly ash used shall conform to IS 3812.
Thickness	Unless otherwise specifically mentioned, the thickness shall be 6 mm (tolerance : +/- 10%)
Pitch	146 mm (tolerance : + 6 mm, - 2 mm)
Depth	48 mm (tolerance : + 4 mm, - 5 mm)
Finishing	The sheets shall be free from cracks, chipped edges or corners and other damages. Top exposed surface shall have pre-painted finish with minimum 30 micron thick exterior grade premium quality acrylic emulsion paint. Bottom surface shall have factory finish.

7.1.2 Accessories

Accessories such as adjustable ridges, hips, finishing pieces, eaves filler pieces, north light and ventilator curves, barge boards, expansion joint sheets, "S" type louvers, gutters etc. shall be of the same Manufacturer (unless approved otherwise by Engineer- In- Charge) as the sheet used for roofing/ cladding and as per Manufacturer's standard specification.

7.1.3 In case, sizes of readymade non-metallic gutters by the same Manufacturer of the sheet are not adequate/ suitable for roof drainage, gutters of required size fabricated out of minimum 1 mm thick G.S. sheet (painted in same colour as that of roofing sheet or as approved) shall be provided.

7.1.4 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

7.2 Laying and fixing

Copyright EIL – All rights reserved

7.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

7.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

7.2.3 The sheets shall be laid with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm in cases of roof with a pitch flatter than 1 vertical to 2.5 horizontal. In the cases of very exposed situations, minimum end lap shall be 200 mm. Side lap shall be minimum half a corrugation.

7.2.4 Sheets shall be fixed to the purlins or other roof members by means of 8 mm diameter polymer coated GI J or L hook bolts, nuts and EPDM washers or with self drilling fasteners and EPDM washers. For inserting the bolts/fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown of the sheets. Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

7.2.5 The free overhang of the sheets at the eaves shall not exceed 300mm.

7.2.6 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leak proof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing/cladding sheets)

7.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

7.2.8 Metal sheet gutters shall be made leak proof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

7.2.9 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

Copyright EIL – All rights reserved

7.2.10 The roof when completed shall be true to lines and slopes and shall be leak proof.

8.0 MEASUREMENT

8.1 Measurement of sheets in roofing and cladding shall be the measurement of superficial area of the sheets on the flat without allowance for laps and corrugations. No deductions shall be made for openings upto 0.4 SqM. For opening areas exceeding 0.4 SqM, such areas shall be deducted.

8.2 If not mentioned otherwise, measurement of metal flashings, ridge/hip pieces, corner pieces, gutters (including all fittings and fixtures) etc. shall be the measurement of surface areas of these.

8.3 If not mentioned otherwise, measurement of readymade accessories and fittings (having standard size/profile) of fibre cement sheet shall be the measurement of their lengths.

8.4 If not mentioned otherwise, measurement of rain water pipes (including all fittings and fixtures) shall be the measurement of their actual lengths

Copyright EIL – All rights reserved

सेनिटेरी फिटिंगों और फिक्सचर का मानक विनिर्देश

STANDARD SPECIFICATION FOR SANITARY FITTINGS & FIXTURES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
7	13.10.23	REVISED & ISSUED AS STANDARD SPECIFICATION	AKHILESH MAURYA	ATUL GUPTA	SAMIR DAS	SANJAY MAZUMDAR
6	03.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	RH	RG	JKB	D MALHOTRA
5	03.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	RH	RG	JKB	D MALHOTRA

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing & Materials
BS	:	British Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
BIS	:	Bureau of Indian Standards
EN	:	European Standards
ISO	:	International Organization for Standardization
ABS	:	Acrylonitrile Butadiene Styrene
HDPE	:	High density polyethylene

Architecture Standards Committee

Convenor: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumder (Strl)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0	GENERAL.....	04
2.0	REFERENCES	04
3.0	WATER CLOSET SYSTEM	05
4.0	URINAL SYSTEM.....	08
5.0	WASH BASIN/SINK.....	08
6.0	FITTINGS & FIXTURES.....	10
7.0	INSTALLATION.....	10

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 This Specification covers requirements of sanitary fixtures and fittings such as Water Closets, Wash Basins, Urinals, Water Taps etc.

1.2 In case of Green rated buildings water efficient fixtures shall be used as required to reduce water consumption and for obtaining the green rating. All fixtures installed within the project shall have flow rates at 45 psi or 3.10 bar pressure.

1.3 Other than faucets, which are installed in spaces with water head heights less than 5m/17ft, in a gravity-fed system, flow rates for the fixtures shall not exceed as mentioned in the following table.

Plumbing Fixture	Flow rate
Water Closet (Solid Flush)	6 liter per flush
Water Closet (Liquid Flush)	3 liter per flush
Urinal	3.8 liter per flush
Shower head	10 liter per minute
Lavatory Faucet	8 liter per minute
Kitchen Faucet	8 liter per minute

1.4 The water closets/ cisterns/wash basins/ Urinals shall be of approved colour.

1.5 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

1.6 Associated plumbing works shall be concealed type.

1.7 Sanitary fittings and fixtures shall be procured from Manufacturer approved by the Engineer-In-Charge

2.0 REFERENCES

The codes and standards listed below contain provisions, which through reference in this specification constitute provisions of this standard specification, if not explicitly mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document Title
IS : 2556 Part 1-17	Specification for Vitreous Sanitary appliances (Vitreous China, Part 1-17)
IS : 2267	Specification for Polystyrene Moulding and Extrusion Materials
IS : 407	Specification for Brass Tubes for General Purposes.
1S :774	Specification for Flushing cisterns for water closets and urinals (other than plastic cisterns)

Copyright EIL – All rights reserved

IS: 775	Specification for cast iron brackets and supports for wash basins and sinks
IS :781	Specification for Cast copper alloy screw down bib taps and stop valves for water services
IS : 1300	Specification for Phenolic moulding materials.
IS :2064	Code of Practice for Selection, Installation and Maintenance of Sanitary appliances
IS :2548 Part-1	Specification for Plastic Seats and Covers for water closets Part-1: Thermoset seats and covers
IS :2548 Part-2	Specification for Plastic Seats and Covers for water closets Part-2: Thermoplastic seats and covers
IS :2326	Specification for automatic flushing cistern for urinals (other than plastic cisterns)
IS : 3389	Specification for Urea-formaldehyde Moulding Materials.
IS :7231	Specification for plastic flushing cisterns for water closets and urinals.
IS : 7328	Specification for High Density Polyethylene Materials for Moulding and Extrusion.
IS : 9758	Specification for flush valves and fittings for water closets and urinals.
IS : 13983	Specification for stainless steel sinks for domestic purposes.

3.0 WATER CLOSET SYSTEMS

3.1 General

3.1.1 Water closet Systems shall be a water tight and leakage free system consisting of squatting pans/commodes complete with water supply, flushing and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

3.1.2 Flushing and disposal of the waste shall be by means of water either from direct water supply line or from flushing cisterns/ tanks through flush valves as mentioned.

3.1.3 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

3.2 Flushing Cisterns/ Tanks

3.2.1 Flushing cisterns shall either be integral with the squatting pan/ commode and shall be open or concealed tank type as mentioned. Connection between cistern and closet shall be made by means of flush pipe/ bend. Flush pipe/ bend shall be firmly fixed with clamps etc. and shall be concealed both in wall and floor.

Copyright EIL – All rights reserved

3.2.2 The cisterns shall be complete with all necessary fittings/ fixtures etc. as required and mentioned in the table below.

Component	Material
Cisterns/ Tanks	Minimum 3 mm thick High density polyethylene (HDPE) conforming to IS 7328 or polystyrene, high impact or polypropylene conforming to IS 2267. (In case of cisterns integral with wash down type closets, the material shall be vitreous china)
Flush pipe/ bend	40mm dia High density polyethylene pipe conforming to IS 407 or unplasticised PVC plumbing pipe conforming to IS 2501
Siphon/ valve	High density polyethylene (HDPE) Conforming to IS 7328 or polystyrene, high impact or polypropylene conforming to IS 2267.
Operating mechanism/ lever	Non- ferrous, corrosion resistant material
Float valve	Polyethylene conforming to IS 7328
Coupling nut and lock-nut	Non- ferrous material
Capacity	Minimum 5 litre
Connection pipes/ tubes	Reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.2.3 Flushing cisterns shall be dual valve type with dual pushing button plates. In case of open type of cisterns, the valve shall be integral with the cistern. In case of concealed cistern/ tank, the valve plate (made of non ferrous metal or ABS (Acrylonitrile Butadiene Styrene) and having same finishing of the Faucets, taps etc.) shall be provided on the concealed surface at suitable location. Stop cocks/ valves shall be provided in the system for installation/ maintenance.

3.3 INDIAN WATER CLOSET (IWC)

3.3.1 Squatting Pan shall be of vitreous china and Orissa Pan type conforming to IS: 2556. The closet shall be fixed in the floor with 150 mm thick sand cushion and shall be connected with CI `S' or `P' trap with approximately 50 mm water seal.

3.3.2 Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes. The flushing rim and inlets hall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing.

3.3.3 Water tap or health faucet with stop cock, valve shall be provided near the closet at suitable location. Connection pipes/ tubes of health faucets shall be flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.4 WASH DOWN TYPE EUROPEAN WATER CLOSETS (EWC)

3.4.1 The commode shall be of vitreous china conforming to IS: 2556.

Copyright EIL – All rights reserved

3.4.2 The closets shall be of one piece construction and shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flushing pipe. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either 'S' or 'P' outlet with at least 50 mm water seal. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush.

3.4.3 The closets shall be floor or wall mounted with flushing cisterns either integral with the commode or separately mounted on wall or concealed cisterns/tanks connected with flush pipe as mentioned.

3.4.4 The commodes shall be provided with a hinged seat and cover/ lid. The seat and cover made of thermosetting or thermoplastic conforming to IS 2548. Thermosetting plastic used shall conform to grade 2 or 3 of IS 1300 when it is phenolic plastic or IS 3389 when it is of urea formaldehyde. The seat and cover shall be fitted with plastic buffers. The cover shall be hydraulically operated type.

3.4.5 Water tap or health faucet with stop cock, valve shall be provided near the closet at suitable location. Connection pipes/ tubes of health faucets shall be flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.4.6 Superior quality EWCs shall be of approved design and shall have following features with respect to clause nos 3.4.1 to 3.4.5 :

Installation type	Wall hung
Commode/ Pan	Rimless with quite close seat cover having anti-bacterial coating.
Cistern	Concealed type, made of high density polyethylene, joint less construction. Water consumption – maximum 2 and 4 litre for partial and full flush respectively. Capacity – upto 10 litre. Valve/ Actuation plate – Separate pressing button for dual flushing, made of ABS (chromium plated)
Health faucet	Chromium plated ABS body with reinforced plastic/ PVC pipe in SS-304 grade jacket.

3.4.7 Premium quality EWCs shall be of approved design and shall have following features with respect to clause nos 3.4.1 to 3.4.5 :

Installation type	Wall hung
Commode/ Pan	Fully skirted (Traps not visible), Rimless with quite close seat cover having anti-bacterial coating.
Cistern	Concealed type, made of high density polyethylene, jointless construction. Water consumption – maximum 2 and 4 litre for partial and

Copyright EIL – All rights reserved

	full flush respectively. Capacity – upto 10 litre. Valve/ Actuation plate – Separate pressing button for dual flushing, made of ABS (chromium plated)
Health faucet	Chromium plated ABS body with reinforced plastic/ PVC pipe in SS-304 grade jacket.

4.0 URINAL SYSTEM

4.1 General

4.1.1 Urinals shall be a water tight and leakage free system consisting of urinals complete with water supply, flushing and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

4.1.2 Flushing and disposal of the waste shall be by means of water from direct water supply line if not mentioned otherwise.

4.1.3 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

4.1.4 The urinals shall be made of vitreous China and half stall type conforming to IS 2556.

4.1.5 The urinals shall be of one piece construction, full stall type with integral flushing rim and of approved colour.

4.1.6 All pipe, fittings, plumbing of water supply connection to the urinals, drainage/ disposal pipes shall be concealed. Stop cock shall be provided just above the urinal for flushing.

4.1.7 Bottle trap and union fittings shall be provided for waste disposal from the urinals.

4.1.8 Urinal partitions shall be provided in between the urinals. If not mentioned specifically elsewhere, partitions made of polished granite stone shall be provided.

4.2 Sensor operated Urinals

4.2.1 With reference to clause no 4.1, in case of sensor operated urinals, the flushing system shall be by means of concealed type electronic type sensors. The power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In-Charge.

4.2.2 Sensor operated urinals shall have pre-flush facility also.

4.3 Waterless Urinals

4.3.1 Waterless urinals shall be made of vitreous china having antibacterial /germs free ceramic surface, fixed with cartridge having debris catcher and hygiene seal.

5.0 WASH BASINS / SINKS

5.1 General

5.1.1 Wash basins and sinks shall be water tight and leakage free system complete with water supply and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

Copyright EIL – All rights reserved

5.1.2 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

5.1.3 The wash basins shall be made of vitreous China conforming to IS 2556.

5.1.4 The wash basins/sinks shall be of one piece construction and of approved colour with nickel chromium plated brass waste fitting for connecting with waste pipe.

5.1.5 All pipe, fittings, plumbing of water supply connection to the basins/ sinks, drainage/ disposal pipes shall be concealed.

5.1.6 Wash basins/ sinks shall be wall mounted or mounted over/ under counters as mentioned in the tender document or construction drawings. In case of wall mounted fitting, the basin/ sink shall be fixed to wall with metal (painted) brackets.

5.1.7 Shape, design and size of the wash basins/ sinks shall be as approved by the Engineer-In-Charge.

5.1.8 Wash basins shall be provided with taps/ pillar cocks/ faucets of approved design. Mixer type tap/ pillar cock shall be provided in case of hot and cold water supply.

5.1.9 Bottle trap and union fittings shall be provided for waste disposal from the wash basins.

5.1.10 In case of Sinks, taps with long and swinging neck shall be provided so that water reaches in all the areas of the Sink.

5.1.11 Connection pipes/ tubes shall be of flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

5.2 Superior quality Wash Basins and faucets

5.2.1 Superior quality Wash Basins shall be round or oval shaped under counter top type with either electronic sensor operated or pressmatic type faucets as mentioned.

5.2.2 In case of sensor operated basins, power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In- Charge.

5.2.3 Faucets shall be of brass body, chromium plated of approved design and shall be mounted over the counter or mounted on the basin itself as decided by Engineer-In-Charge.

5.3 Premium quality Wash Basins and faucets

5.3.1 Premium quality Wash Basins shall be over the counter top and thin rim type, of approved shape with electronic sensor electronic sensor operated.

5.3.2 Power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In- Charge.

5.3.3 Faucets shall be of brass body, chromium plated of approved design and shall be wall mounted or mounted over the counter as decided by Engineer-In-Charge.

5.4 Kitchen/ Pantry/ Laboratory sinks

Kitchen/ Pantry/ Laboratory sinks shall be of stainless steel (304 -18/8) conforming to IS 13983. Nominal thickness of SS sheet shall not be less than 1 mm before forming. Thickness

Copyright EIL – All rights reserved

at any point of the sink, after forming shall not be less than 0.75mm. Depth of the bowl shall not be less than 150 mm. Minimum internal dimensions, when measured on the bowl centre lines across the top of the bowl shall be 380mm x 340 mm for rectangular bowls and 360 mm for round bowls.

6.0 FITTINGS & FIXTURES

6.1 General

6.1.1 Fittings/ fixtures such as Taps/ Valves/ Faucets/Shower roses/ bib, stop, pillar cocks etc shall be of approved design and finish and shall be procured from approved Manufacturer.

6.1.2 Fittings/ fixtures shall be provided as per table below :

WC cubicles	Bib cock or health faucet, Coat/ Robe hook, Toilet paper holder
Shower cubicles	Towel rail, Coat/Robe hook, Soap tray, Shower rose
Wash Basins	Mirror and Faucets for each wash basin, Touch less type Soap dispenser (Tissue paper dispenser in locations decided by the Engineer-In-Charge) and Hand drier near wash basin.

6.1.3 Removable floor trap covers made of stainless steel shall be provided over all floor traps.

6.1.4 Fittings/ fixtures shall be made of non-ferrous anti corrosive metallic materials with chromium plated finish if not mentioned otherwise.

6.2 Specifications of sanitary fittings/ fixtures

6.2.1 Sanitary fittings/ fixtures shall meet the following specifications if not mentioned otherwise specifically in the tender/ bid documents and construction drawings.

Fittings/ fixtures	Specification
Bib Cocks, Stop Cocks, Pillar cocks, Taps, valves, Faucets, mixers etc.	15mm dia, chromium plated Brass body conforming to IS : 781 Faucets for superior and premium quality wash basins shall be as mentioned.
Health Faucets	Chromium plated Brass body with bracket
Shower rose	Chromium plated Brass body conforming to IS : 2064 with adjustable rose and supporting arm.
Toilet paper holder	Chromium plated Brass body or stainless steel (grade – 304)
Liquid soap dispenser	Plastic body
Towel ring/ rail/ rack	Stainless steel (grade – 304)
Mirror	Made of minimum 5mm thick glass with beveled/ rounded edge.
Coat/Robe hook	Stainless steel (grade – 304)

7.0 INSTALLATION

7.1 Sanitary fittings/ fixtures shall be installed by licensed plumber.

7.2 The fixtures/ fittings shall be installed in accordance with the Manufacturer's recommendation and as approved by the Engineer-In-Charge.

7.3 All fittings/ fixtures shall be installed ensuring water tightness using sealers/ gaskets etc. as required.

Copyright EIL – All rights reserved

7.4 All holes/ punctures in walls due to installation shall be concealed by stainless steel round covers matching with the fixture/ fittings.

7.5 Pedestals of WCs/ wash basins etc. in contact with the floor finish shall be suitably sealed.

7.6 All screws for fixing/ fitting etc. shall be of stainless steel fixed with anchor fasteners.

Copyright EIL – All rights reserved

बनावटी छत, बनावटी तल, अंडरडेक इन्सुलेशन और पार्टीशनिंग का मानक विनिर्देश

STANDARD SPECIFICATION FOR FALSE CEILING, FALSE FLOORING, UNDERDECK INSULATION & PARTITIONING

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convener	Approved by: Standards Bureau Chairman
8	18.09.25	REVISED & ISSUED AS STANDARD SPECIFICATION	PIYALEE DAS	ATUL GUPTA	ANISH KUNDU	MAINAK NANDI
7	08.03.22	REVISED & ISSUED AS STANDARD SPECIFICATION	PIYALEE DAS	ATUL GUPTA	SAMIR DAS	SANJAY MAJUMDAR
6	22.03.17	REVISED & ISSUED AS STANDARD SPECIFICATION	AM	JS/JKB	R. SRIVASTAVA	R. NANDA
5	23.11.11	REVISED & ISSUED AS STANDARD SPECIFICATION	GB	JS/SD	JKB	D. MALHOTRA

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society of Testing of Materials
BS	:	British Standards
CISCA	:	Ceilings & Interior Systems Construction Association
CRCA	:	Cold Rolled Close Annealed
EN	:	European Standards
GI	:	Galvanized Iron
IS	:	Indian Standards
ISO	:	International Organization for Standardization
MS	:	Mild Steel
NABL	:	National Accreditation Board for Testing and Calibration Laboratories
NRC	:	Noise Reduction Coefficients
NBC	:	National Building Code
NFPA	:	National Fire Protection Association
PVC	:	Polyvinyl Chloride
RCC	:	Reinforced Cement Concrete
SS	:	Stainless Steel

Architecture Standards Committee

Convenor: Mr Anish Kundu

Members:
Mr. Sandeep Sharma
Ms Maitrayee Majumdar (Strl)
Mr Charanjit Singh (Projects)
Mr Indrajit Neog (Construction)
Ms Gursharan Jeet Kaur
Mr Atul Gupta
Mr Anish Mahala

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4
2.0 REFERENCES 4
3.0 FALSE CEILING SYSTEMS 4
3.1 GENERAL 4
3.2 MINERAL FIBRE BOARD FALSE CEILING SYSTEM 5
3.3 GYPSUM BOARD SEAMLESS FALSE CEILING SYSTEM 6
3.4 CALCIUM SILICATE BOARD FALSE CEILING SYSTEM 8
3.5 CALCIUM SILICATE TILE FALSE CEILING SYSTEM 9
3.6 ALUMINIUM FALSE CEILING SYSTEM (SQUARE GRID TYPE) 10
3.7 ALUMINIUM FALSE CEILING SYSTEM (LINEAR PLANK TYPE) 11
4.0 UNDERDECK INSULATION SYSTEM 12
4.1 POLY- ISOCYANURATE (PIR) FOAM INSULATION SYSTEM 12
4.2 GLASS WOOL INSULATION SYSTEM 12
5.0 FALSE (RAISED ACCESS) FLOORING SYSTEM 13
6.0 PARTITIONING 16
6.1 GYPSUM BOARD PARTITIONING 16
7.0 MEASUREMENT 17

Copyright EIL – All rights reserved

1.0 GENERAL

This standard specification lays down requirements of false ceiling, false flooring, under deck insulation, and partitioning system.

2.0 REFERENCES

2.1 The codes and standards listed below contains provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Sr. No.	Standards	Document Title
1	ASTM C423	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
2	ASTM C635	Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
3	ASTM C636	Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
4	ASTM E1414	Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
5	ASTM E1477	Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
6	BS 476 part 6/7	Fire Test
7	CISCA	The Ceilings & Interior Systems Construction Association Acoustical ceilings: Use and Practice
8	IS 277	Galvanized Steel Sheets (Plain and Corrugated)
9	IS 2095	Gypsum plaster boards
10	IS 2676	Dimension for wrought aluminium and aluminium alloy sheet and strip
11	IS 12436	Specification for. Preformed rigid polyurethane (pur). And polyisocyanurate (pir) foams
12	IS 8183	Bonded mineral wool - specification.

3.0 FALSE CEILING SYSTEMS

3.1 GENERAL

3.1.1 False or suspended ceiling systems shall be complete with supporting frame work / suspension system and ceiling boards/ panels/ tiles. Following types of false ceiling systems (either with only one type or in combination of various types) shall be provided as specified in design basis, job specifications, item descriptions, drawings etc.

1. Mineral Fibre board false ceiling system.
2. Gypsum board seamless false ceiling system.

Copyright EIL – All rights reserved

3. Calcium Silicate board false ceiling system.
4. Calcium Silicate tile false ceiling system.
5. Aluminium false ceiling system. (square grid type)
6. Aluminium false ceiling system. (linear plank type)

If false ceiling type is not mentioned specifically, Mineral Fibre board false ceiling system shall be provided.

3.1.2 False or suspended ceiling systems shall be installed at desired heights and levels in designs, patterns and shapes in accordance with approved fabrication drawings. Fabrication drawings shall be prepared and submitted by the Contractor and approved by Engineer-In-Charge.

3.1.3 Fabrication drawings shall be prepared based on drawings issued by Engineer-In-Charge and in co-ordination with other system providers such as lighting, HVAC, Fire-fighting system components, fittings and fixtures of which are accommodated on the ceiling or above and below.

3.1.4 The ceiling system shall be sturdy, finished, levelled and aligned as per approved drawings without any undulations, sagging or other defects. Zig-zag alignment of visible supporting system or ceiling panels/ tiles shall not be permitted.

3.1.5 All components of the ceiling system shall be from the approved Manufacturers of the whole and full system only. Materials / components procured from other Manufacturers shall not be permitted.

3.1.6 The ceiling systems shall be installed by agencies approved by Engineer-In-Charge.

3.2 MINERAL FIBRE BOARD FALSE CEILING SYSTEM

The Mineral Fibre board ceiling system shall be in square grid (exposed) type with tiles having bevelled tegular edges.

3.2.1 Ceiling boards/ panels/ tiles

Ceiling boards/ panels/ tiles shall be standard product of the approved Manufacturer and as per following specification.

Sr. No.	Item/ Property	Specification
1	Base Material	Mineral Fiber
2	Panel Dimensions	600 mm x 600 mm
3	Panel Thickness	16 mm
4	Dimension tolerances	+- 0.5 mm
5	Noise Reduction co-efficient	0.55
6	Fire Properties	Class 0/1 as per BS 476 part 6/7
7	Light Reflectance	85%
8	Humidity Resistance	RH 99%

3.2.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of interlocked main, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling panels and shall be standard product of the Manufacturer and as per following specification.

Copyright EIL – All rights reserved

Members of the grid work shall be of galvanised steel (120 gsm on both sides as per IS: 277) mild steel, power pressed to required profile.

The exposed visible surfaces of the suspension system shall be finished with minimum 25 micron pre-painted polyester baked paint.

Mineral Fiber Tile Grid Ceilings Framework Details:

Sl. No.	Ceiling Drop (mm)	Hanger Size (mm)	Distance of hangers in both directions (mm)
1	0 to 1500	Minimum 4mm dia wire rod with level adjuster as per site requirement	1200
2	1500 to 3000	Minimum 6mm Dia Threaded Rod with level adjuster as per site requirement	1200

Note : For ceiling drop exceeding 3000mm, MS section supports shall be provided at appropriate levels, creating a grid with dimensions of 1200x1200mm to support the false ceiling suspension framework. The MS framework must be capable of bearing a load of 40 kg/sqm.

3.2.3 Installation

3.2.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.2.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of threaded hanger rod and level adjuster) at 1200 mm maximum. For ceiling drops greater than 3000mm main members shall be placed at a spacing of 1200x1200 mm (both directions) fixed to the structural suspension arrangement.

3.2.3.3 Cross members shall be interlocked between main runners at 600mm to form 1200 mm x 600mm module.

3.2.3.4 Short cross members shall be fixed between main runners at 600mm to form in the 1200 mm x 600 mm modules to form 600 mm x 600 mm modules.

3.2.3.5 Perimeter sections shall be secured to perimeter walls/ partitions.

3.2.3.6 Ceiling panels/ tiles shall be provided in the suspended grid work.

3.3 GYPSUM BOARD SEAMLESS FALSE CEILING SYSTEM

The gypsum board false ceiling system shall be of seamless finish.

3.3.1 Gypsum boards

Gypsum boards shall conform to IS : 2095 and shall have following properties.

Copyright EIL – All rights reserved

Sr. No.	Item/ Property	Specification
1	Board Thickness	12.5 mm
2	Dimension tolerances	+- 0.5 mm
3	Fire Properties	Non combustible as per BS 476 part 4
4	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.3.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components shall be made of galvanized steel (120 gsm on both sides as per IS: 277) power pressed to required profile.

Gypsum Ceilings Framework Details:

Table -1

Sl. No.	Ceiling Drop (mm)	Bracing	Hanger Size (mm)	Distance of hangers in both directions (mm)	Distance of Interme diate (mm)
1	0 to1500	Not Required	25x10x0.5	1200	1200
2	1500 to 3000	Bracing with L Angle at every 1500mm in Horizontal direction	25x10x0.5	900	900

Note : For heights exceeding 3000mm, MS section supports shall be provided at appropriate levels, creating a grid with dimensions of 1200x1200mm to support the false ceiling suspension. The MS framework must be capable of bearing a load of 40 kg/sqm.

3.3.3 Installation

3.3.3.1 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of cleats and suspension angle member) at 1200 mm maximum.

3.3.3.2 Cross members shall be fixed main runners at the spacing of 450 mm. Additional bracing to be provided as per the ceiling drop from true ceiling as mentioned in the Table No 1.

3.3.3.3 Perimeter sections shall be secured to perimeter walls/ partitions.

3.3.3.4 Ceiling boards shall be fixed to the grid frame work by means of drywall screws. edges of the ceiling boards shall be jointed and finished flush with jointing tapes and compounds as recommended by the approved Manufacturer. The finished surface shall be seamless.

Copyright EIL – All rights reserved

3.3.3.5 The ceiling board surfaces shall be finished with paint etc. as specified.

3.4 CALCIUM SILICATE BOARD FALSE CEILING SYSTEM

The Calcium Silicate board false ceiling system shall be of seamless finish by fixing the ceiling boards on the suspension system.

3.4.1 Calcium Silicate ceiling boards

The calcium Silicate ceiling boards shall be with durable tapper edge type board having following specification.

Sr. No.	Item/ Property	Specification
1	Board Thickness	8 mm
2	Dimension tolerances	+- 0.8 mm
3	Fire Properties	Class 0/1, Class A as per BS 476 part 6/7
4	Humidity Resistance	RH 99%
5	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.4.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components shall be made of galvanized (120 gsm on both sides as per IS: 277) mild steel, power pressed to required profile.

3.4.3 Installation

3.4.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.4.3.2 Main members of grid framework shall be suspended from the soffit @ 1200 mm maximum by means of angle hangers with nuts and bolts, angle hangers being fixed to angle cleats fixed on the soffit by means of dash fasteners.

3.4.3.3 Intermediate members of grid framework shall be fixed to main members @ 450 mm maximum in a direction perpendicular to the main members with connecting clips.

3.4.3.4 Perimeter members shall be fixed on perimeter surfaces.

3.4.3.5 Ceiling boards shall be fixed to the grid frame work by means of drywall screws. Tapered and square edges of the ceiling boards shall be jointed and finished flush with jointing tapes and compounds as recommended by the approved Manufacturer. The finished surface shall be seamless.

3.4.3.6 The ceiling board surfaces shall be finished with paint etc. as specified.

Copyright EIL – All rights reserved

3.5 CALCIUM SILICATE TILE FALSE CEILING SYSTEM

The Calcium Silicate tile false ceiling system shall be of square grid type laid on the suspension system.

3.5.1 Calcium Silicate ceiling tiles

The calcium Silicate ceiling tiles shall be of approved texture having following specification.

Sr.No.	Item/ Property	Specification
1	Tile thickness	8 mm
2	Tile size	595 mm x 595 mm or 610 mm x 610 mm
3	Humidity Resistance	RH 99%
4	Fire Properties	Non combustible as per BS 476, part -4 Class 1 as per BS 476 part 7
5	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.5.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling tiles and shall be standard product of the Manufacturer.

The components shall be made of galvanized (120 gsm on both sides as per IS: 277) mild steel.

Visible areas of the frame work shall be pre-painted with polyester paint.

3.5.3 Installation

3.5.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.5.3.2 Main and cross members of grid framework shall be interlocked (as required to form the square grid suitable for the tile size) and suspended from the soffit by means of slotted galvanized steel cleats, adjustable rods fixed to soffit with anchor fasteners in accordance with approved Manufacturer's standard practice.

3.5.3.3 Perimeter members shall be fixed on perimeter surfaces.

3.5.3.4 Ceiling tiles shall be laid in the grid frame work.

3.5.3.5 The ceiling board surfaces shall be finished with paint etc. as specified.

Copyright EIL – All rights reserved

3.6 ALUMINIUM FALSE CEILING SYSTEM (SQUARE GRID TYPE)

Aluminium false ceiling system (square grid type) shall be standard product of the approved Manufacturer, clip-in type in square grid consisting of Alumium alloy ceiling panels and suspension system.

3.6.1 Ceiling Panels

Ceiling panels shall be made of aluminium alloy AA 3003- H14 (tempered) grade as per IS 2676 having following specification.

Sr.No.	Item/ Property	Specification
1	Panel type	Bevel edged, Perforated type with non-woven acoustical fleece
2	Panel dimension	600 mm x 600 mm
3	Panel thickness	0.7 mm
4	Dimension tolerances	+- 2 mm
5	Fire Properties	Class 0/1 as per BS 476 part 6/7 or class A2-s1, d0 according to EN 13501-1
6	Light Reflectance	63% as per ASTM 1477
7	Perforations	Hole diameter- 1.5 mm, open area- 18%, linear pitch 4.3 mm, diagonal pitch – 3 mm, border area – 9.5 mm
8	Finishing	Polyester powder coating (minimum 60 micron)
9	Salt spray test	750 hours as per ASTM B 117

3.6.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components of the system shall be made of galvanized (90 gsm as per IS 277) steel and finishing shall be baked polyester paint.

3.6.3 Installation

3.6.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.6.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of hanger wire/ threaded rod and level adjuster).

3.6.3.3 Cross members shall be interlocked between main runners to form 600 mm x 600 mm grid.

3.6.3.4 Perimeter sections shall be secured to perimeter walls/ partitions.

3.6.3.5 Ceiling panels/ tiles shall be laid in the suspended grid work.

Copyright EIL – All rights reserved

3.7 ALUMINIUM FALSE CEILING SYSTEM (LINEAR PLANK TYPE)

Aluminium false ceiling system (linear plank type) shall be standard product of the approved Manufacturer, single grid type in concealed system consisting of Aluminium alloy ceiling panels and suspension system.

3.7.1 Ceiling Panels

Ceiling panels shall be made of aluminium alloy AA 3105- H14 (tempered) grade as per IS 2676 having following specification.

Sr.No.	Item/ Property	Specification
1	Panel type	Perforated type with non-woven acoustical fleece with bevel edge and upturn
2	Panel dimension	150 mm (width)
3	Panel thickness	0.7 mm
4	Dimension tolerances	+- 2 mm
5	Fire Properties	Class 0/1 as per BS 476 part 6/7 or class A2-s1, d0 according to EN 13501-1
6	Light Reflectance	63% as per ASTM 1477
7	Perforations	Hole diameter- 1.5 mm, open area- 18%, linear pitch 4.3 mm, diagonal pitch – 3 mm, border area – 9.5 mm
8	Finishing	Polyester powder coating (minimum 60 micron) If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.
9	Salt spray test	750 hours as per ASTM B 117

3.7.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components of the system shall be made of galvanized (120 gsm as per IS 277) steel and finishing shall be baked polyester paint.

3.7.3 Installation

3.7.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.7.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of hanger wire/ threaded rod).

3.7.3.3 Perimeter sections shall be secured to perimeter walls/ partitions.

3.7.3.4 Ceiling panels shall be clipped on to the main members of the suspended grid work.

Copyright EIL – All rights reserved

4.0 UNDERDECK INSULATION SYSTEM

Insulating material of underdeck insulation system shall be of glass wool boards or Polyisocyanurate (PIR) foam boards/slabs as specified in the design basis, item description, job specification drawings etc.

If nothing is mentioned specifically, glass wool boards shall be used.

4.1 POLY- ISOCYANURATE (PIR) FOAM INSULATION SYSTEM

4.1.1 Poly- Isocyanurate (PIR) foam

Poly-Isocyanurate (PIR) foam insulation shall be in the slab form with lining of glass fibre tissue or aluminium foil lining (having 50 mm overlap) on one side.

Poly-Isocyanurate (PIR) foam shall conform to IS: 12436 and shall have following specification.

Sr.No.	Item/ Property	Specification
1	Slab thickness	Minimum 30 mm
2	Density	Not less than 32 kg/ CuM
3	Thermal conductivity (K value)	Not more than 0.023 w/mk at 10 degree C
4	Fire Properties	Class 0/1 as per BS 476 part 6/7

4.1.2 Installation

4.1.2.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's and following specification.

4.1.2.2 Hot blown bitumen (grade 85/25) over a bituminous priming or approved cold adhesive shall be applied over the soffit and PIR board surface after cleaning the surfaces.

4.1.2.3 PIR slabs shall be pressed in position over the bitumen coat when it is still tacky or over the cold adhesive and shall be fixed to the soffit by means of approved fasteners (at four corners and at the centre of the slabs) without damaging the slabs.

4.1.2.4 Overlaps shall be covered with approved sealing compound.

4.1.2.5 The PIR shall be further secured by chicken wire mesh (24 gauge) fixed to the fasteners and tightened with lacing wire.

4.2 GLASS WOOL INSULATION SYSTEM

4.2.1 Glass wool insulation

Glass wool insulation shall be in rolls or boards and shall be pre-laminated on one side with aluminum foil.

Glass wool insulation shall conform to IS: 8183 and shall have following specification.

Sr. No.	Item/ Property	Specification
1	Thickness	Minimum 75 mm
2	Density	Not less than 24 kg/ CuM
3	Thermal conductivity (K value)	Not more than 0.034 w/mk at 25 degree C mean
4	Fire Properties	Class 0/1 as per BS 476 part 6/7

Copyright EIL – All rights reserved

4.2.2 Installation

4.2.2.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's and following specification.

4.2.2.2 The insulation boards/roll shall fixed underside soffit with the help of polyamide based long insulation fasteners @ 450 mm c/c.

4.2.2.3 The joints shall be sealed with self-adhesive aluminum foil tape

5.0 FALSE (RAISED ACCESS) FLOORING SYSTEM

False flooring system shall be modular and removable type and shall consist of floor panels and supporting/ understructure system.

The system shall be factory made and the full system including all components shall be sourced from approved single Manufacturer.

The system shall be strong and durable for movement and other operations.

This specification is applicable for false floorings upto 1000 mm high.

The flooring system shall be capable of supporting following loading conditions when tested as per CISCA test procedure.

i. Concentrated load of 675 Kg. with maximum allowable deflection of 2.5mm and a factor of safety of 2.5.
ii. Uniform load of 2025 Kg/ Square meter.

For details reference shall be made to standard no 7-75-0049.

5.1 Floor panels

Sr. No.	Item/ Property	Specification
1	Material	CRCA steel with cementitious core with hemispherical and reverse cones and 1 mm thick epoxy painted CRCA steel sheet on top. The inner empty core shall be injected with light weight fire retardant non combustible cementitious compound.
2	Size	600 mm x 600 mm x 35 mm thick. (Dimensional tolerance : +- 0.8 mm).
3	Finishing	Top sheet shall be finished with 2 mm thick high pressure laminate or 2 mm thick conductive PVC or stone or other type of tiles as specified. If nothing is mentioned specifically, high pressure laminate shall be provided.
4	Edging	All edges of the panels shall have conductive PVC trims
5	Fire resistance/ property	Class 0 & class 1 conforming to BS 476-part-6 (Fire propagation) and BS 476-part-7 (Surface spread of flame).

Copyright EIL – All rights reserved

5.2 Understructure/ supporting system

False floor understructure shall be installed to support the panels and shall be suitable to achieve required cavity height from the existing floor level. The system shall ensure speedy assembly and removal for relocation and maintenance. The system shall also ensure easy adjustment of levelling (±25mm) and accurate alignment of panels in the vertical direction.
False floor understructure shall consist of Base plate, pedestals, pedestal head assembly, stringers and necessary fittings, fixtures and accessories as specified below.

Sr. No.	Item/ Property	Specification
1	Pedestal Base Assembly .	Powder coated. hot dip galvanized (60-80 micron) mild steel base plate with not less than 150mm x 150mm x 4 mm of bearing area, mechanically riveted to a 32mm dia. of 2 mm thick CRCA steel pedestal designed to engage the head assembly
2	Pedestal Head Assembly	Zinc electroplated CRCA steel pedestal head assembly shall be 90mm x 90mm x 4 mm thick profiled head, mechanically riveted to a 19 mm dia. threaded bright rod, fixed to pedestal by specially designed zinc electroplated steel forged adjusting nut for leveling, locking and changing the height setting.
3	Stringers	Stringers shall be of hot dip galvanized (60-80 microns) steel, minimum 20mm x 32mm x 1.20mm thick CRCA steel.

5.3 Installation

5.3.1 False flooring systems shall be installed by agencies approved by Engineer-In-Charge.

5.3.2 False flooring systems shall be installed at desired heights and levels in designs, patterns and shapes in accordance with approved fabrication drawings. Fabrication drawings shall be prepared and submitted by the Contractor and approved by Engineer-In-Charge.

5.3.3 Fabrication drawings shall be prepared based on drawings issued by Engineer-In-Charge and in co-ordination with other system providers such as which are accommodated in the cavity of the false flooring.

5.3.4 Installation shall be done in accordance with approved system Manufaturer's standard practice, as directed by the Engineer-In-Charge and as mentioned below:

5.3.5 Installation of under structure

a) The base floor and cavity between false flooring and base floor shall be properly cleaned and made dust free and dry. The base cement concrete floor shall be treated with one component polyurethane based coating.

b) Pedestal base assembly shall be fixed to the base floor by fixing base plates to the base floor by minimum 50mm x 8mm anchor fasteners (4 nos. for each plate).

c) The pedestal stud locations shall ensure the grid work as per flooring pattern which in general shall be of 600 mm x 600 mm dimension. The length of the pedestal studs shall be such that clear cavity between false flooring and base flooring is of desired depth. Additional pedestals as needed to support panels where floor is disrupted by columns, walls and cutouts shall be provided. Perimeter pedestal studs shall be provided along the periphery. Pedestal assemblies including pedestal heads shall be weld-free construction, corrosive resistant and shall provide an adjustment range of ±25mm from the specified finished floor heights.

Copyright EIL – All rights reserved

d) The threaded bright rod with the top head attachments shall be inserted into the studs and shall be adjusted to obtain proper level of the finished floor panels by means of the adjustment nut. The nut shall provide location lugs to engage the pedestal base assembly, such that deliberate action is required to change the height setting. Threaded rod shall provide a specially designed anti-rotation device, such that when the head assembly is engaged in the base assembly, the head cannot freely rotate.

e) The pedestal head shall have an anti vibration PVC cap for panel and stringer location. Stringers shall support each edge of panel. The stringers shall have counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. Stringers shall be individually and rigidly fastened to the pedestal with one machine screw for each end of stringer. Bolts shall provide positive electrical contact between the stringers and pedestals. Stringer grid shall ensure maximum lateral stability in all directions. All the field cut panels shall be installed with an appropriate PVC end cap specially designed to accommodate the stinger and arrest Panel beam movement and will ensure the integrity and stability of the system.

5.3.6 Installation of floor panels

a) Floor panels shall be placed over the stringer channels and bolted to pedestal head. All four edges of panels shall be finished with black conductive 5mm wide PVC edge beadings. These edge beadings are glued and sealed in place to avoid detachment.

Floor panels which are field cut (at ends, Console/ Rack location etc.) shall be marked with positional numbering on the underneath and the adjoining wall. The finished floor panels shall be perfectly levelled and aligned without any gaps in between the panels.

b) All accessories such as outlet boxes and grommets as required, Panel lifters (at least one for each building, one number for every 500 Square meter of access floor area) etc. shall be provided in accordance with approved Manufacturer's recommendations.

c) Each individual panel shall be removable for the purpose of maintenance of the cavity. Panel shall be easily removed by one person with a lifting device and shall be fully transferable and totally inter changeable and replaceable in any of the 4 directions at 90 degrees increments, except where cut for special conditions.

d) Necessary cut-outs shall be made in the panels for cable routing, control panel fixation etc. as per drawing.

e) Necessary ramps, slopes, steps etc. shall be also provided for as per drawing with raised access floor components as per approved manufacturer recommendations.

f) Around a control panel/rack, the residual space left out shall be filled up with cut panels of uniform size as required to fully close the gap between the adjacent full panel and the control panel base channel. In this case the part floor panel shall extend upto the full width of the base channel and the cut size shall be determined accordingly. An additional structural steel framework shall be provided along the cut out on which the edge of the floor panel shall rest and over which the base channel of control panel shall be placed.

g) Earth bonding of the system shall be in accordance with approved Manufacturer's standard practice as approved by the Engineer-In- Charge. After completion of the floor and association services, tests shall be arranged to demonstrate that the floor is electrically continuous and fully earth bonded. Points chosen for testing shall include randomly selected pedestals, stringers tops and bottoms of panels, etc.

Copyright EIL – All rights reserved

6.0 PARTITIONING

Partitioning shall rigid, stable, true to the plumb and in accordance with design and approved drawings for all heights.

6.1 GYPSUM BOARD PARTITIONING

Partitioning shall be of gypsum partition boards fixed on galvanized steel frame work. The partitions shall be rigid and stable.

6.1.1 Gypsum partition boards

Gypsum partition boards shall conform to IS : 2095 and shall have following properties. Overall thickness of the finished partition shall be minimum 75 mm.

Sr. No.	Item/ Property	Specification
1	Board Thickness	12.5 mm
2	Dimension tolerances	+- 0.5 mm
3	Fire Properties	Non combustible as per BS 476 part 4

6.1.2 Partition frame

Partition framework shall be in accordance with standard system of the approved Manufacturer and shall consist of profiled floor & ceiling sections and vertical sections of power pressed/ roll formed galvanized steel (minimum 120 gsm, both side inclusive as per IS:277). Minimum thickness of the sections shall be 0.5 mm.

6.1.3 Installation

6.1.3.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's, approved fabrication drawings (prepared by the Contractor) and following specification.

6.1.3.2 Thickness, size, spacing of the frame sections shall be as required for desired height in accordance with recommendations/ standard practice of the approved Manufacturer.

6.1.3.3 Floor and ceiling sections shall be fixed with fasteners of 12.5 mm diameter, 50 mm length @ 600 mm c/c. Vertical sections shall be fixed in the floor and ceiling sections @ 610 mm c/c.

6.1.3.4 Gypsum partition boards shall be fixed on both sides of the framework by drywall screws @ 300 mm c/c.

6.1.3.5 All vertical and horizontal joints of the boards shall be staggered to avoid cracks with provisions of galvanized steel sections fixed to the vertical sections at the horizontal joints of the boards.

6.1.3.6 The jointing and finishing of the boards shall be finished using approved jointing compound, paper tape, metal corner tapes etc. and two coats of primer suitable for the boards.

6.1.3.7 Arrangements of wires/ conduits running through the cavity of the system shall be made. Cut/outs, openings for doors, windows, switches etc. shall be made with necessary framing/ stiffening of the openings.

Copyright EIL – All rights reserved

6.1.3.8 Gypsum plaster boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified. If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour

7.0 MEASUREMENT

7.1 Measurement of false/ suspended ceiling system shall be measurement of actual surface area covered by the ceiling boards/ panels/ tiles.

7.2 Measurement of underdeck insulation system shall be measurement of actual surface area covered by insulation slab/ roll/ board.

7.3 Measurement of false/ raised floor system shall be measurement of actual surface area covered by floor panels.

7.4 Measurement of partitioning system shall be measurement of actual surface area covered by partition boards of one side.

7.5 Area of cut our/ openings for door/ window, various fittings etc. shall be deducted.

Copyright EIL – All rights reserved

अग्निरोधक दरवाजों, खिड़कियों व पार्टीशन के लिए मानक विनिर्देशन

STANDARD SPECIFICATIONS FOR FIRE CHECK/ FIRE RESISTANT DOORS, WINDOWS & PARTITIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	08.02.22	REVISED & ISSUED AS STANDARD SPECIFICATION	SANDEEP SHARMA	ANISH KUNDU	SAMIR DAS	SANJAY MAZUMDAR
1	14.06.14	REVISED & ISSUED AS STANDARD SPECIFICATION	AM/RH	SD	JKB	DM
0	01.02.12	ISSUED AS STANDARD SPECIFICATION	AM	SM	JKB	DM

Copyright EIL – All rights reserved

Abbreviations:

ASTM	: American Society for Testing and Materials
BS	: British Standards
CBRI	: Central Building Research Institute
EN	: European Standards
IS	: Indian Standard
ISO	: International Organization for Standardization
GI	: Galvanized Iron
NABL	: National Accreditation Board for Testing and Calibration Laboratories
NBC	: National building Code
NFPA	: National Fire Protection Association
PVC	: Polyvinyl Chloride
PUF	: Polyurethane foam
SS	: Stainless Steel
UL	: Underwriters Laboratories
CuM	: Cubic Meter

Architecture Standards Committee
Convenor: Mr. Samir Das

Members: Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumder (Strl)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4
2.0 REFERENCES 4
3.0 FIRE CHECK/ RESISTANT/ RATED DOORS, WINDOWS & PARTITIONS 5
4.0 TESTING AND CERTIFICATION 5
5.0 MATERIAL 6
6.0 WOODEN FIRE DOORS 7
7.0 STEEL FIRE DOORS 8
8.0 VISION PANEL 10
9.0 LOUVERS 10
10.0 GLAZED FIRE DOORS 10
11.0 GLAZED FIRE WINDOW 11
12.0 GLAZED FIRE PARTITION 12
13.0 HARDWARE 13
14.0 SOLID TYPE FIRE PARTITION (Calcium Silicate) 14
15.0 SOLID TYPE FIRE PARTITION (Gypsum Plaster Board) 15
16.0 INSTALLATION 16
17.0 DELIVERABLES BY THE CONTRACTOR 17
18.0 GUARANTEE 17
19.0 MEASUREMENT 17

Copyright EIL – All rights reserved

1.0 GENERAL

This standard specification lays down requirements of fire rated/ check/ resistant door, window and partition assemblies intended to provide safety and safe exit from buildings in case of fire.

2.0 REFERENCES

2.1 The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Standards	Document title
IS 2095, Part-I	Gypsum plaster boards – plain gypsum plaster boards
IS 3614	Fire Doors and Doorsets - Specification
IS 16945	Fire resistance test for glass walls
IS 16947	Fire resistance tests for doors with glass panes, openable glass, glass windows and sliding glass doors
IS 277	Galvanized steel sheets (plain and corrugated)-Specification
IS 287	Permissible moisture content for timber used for different purposes-Recommendations
IS 513	Cold reduced low carbon Steel sheet and strip
IS 8183	Bonded Mineral Wool - Specification
IS 14862	Fibre Cement Flat Sheets — Specification
BS 476, Part- 4	Fire tests on building materials and structures. Non-combustibility test for Materials.
BS 476, Part- 7	Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products.
BS 476, Part- 20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction. (general principles).
BS 476, Part- 22	Fire tests on building materials and structures. Method for determination of the fire resistance of non-load bearing elements of construction.
BS 6206	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.
SP-7 (Part-40)	National Building Code of India – part-4 – Fire & life safety
EN-1363-1	Fire resistance tests. General requirements
EN-1364-1	Fire resistance tests for non-load bearing elements. Walls
EN 1634-1	Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware. Fire resistance test for door and shutter assemblies and openable windows
EN 10346	Continuously Hot Dip Coated Steel Strip And Sheet Products.
EN 12600	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.
ISO 834-1	Fire resistance tests: Elements of Building construction- General requirement.
ISO 3008	Fire resistance tests: Door and shutter assemblies, Part 1: General requirements.
ISO 3009-1	Fire-resistance tests: Elements of building construction: Glazed elements.

Copyright EIL – All rights reserved

3.0 FIRE CHECK/ RESISTANT/ RATED DOORS, WINDOWS & PARTITIONS

3.1 Fire check/ resistant/ rated door, window & partition assemblies (termed as "Fire doors, windows, partitions" hereafter) shall be of fire resistance/ rating and type (wooden/ metallic/ glazed etc.) mentioned in the drawings, job specification, item descriptions etc. and shall be complete assembly with frame, shutter/ leaves, glazing, partition panel, hardware etc.

3.2 If type and fire resistance/ fire rating is not specifically mentioned in the drawings, job specification, item descriptions etc., following types of fire doors/ windows/ partitions shall be provided.

Doors:

Steel fire doors having fire resistance/ fire rating of two hours (120 minutes) for Integrity and 30 minutes for insulation.

Windows:

Fully glazed fire windows having fire resistance/ fire rating of two hours (120 minutes) for Integrity and 20 minutes for insulation.

Partitions:

Solid type fire partitions made of calcium silicate board having fire resistance/ fire rating of two hours (120 minutes) for Integrity and insulation.

3.3 The fire doors, windows and partitions shall be in accordance with test certificate or test validity or evaluation report or assessment report (termed as "test report" hereafter) with regards to fire resistance/ rating, material, design, construction, dimension, sizes etc. and shall be complete assembly with frame, shutter/ leaf, glazing, partition panels and hardware.

3.4 Each Fire door, window & partition shall be provided with appropriate label mentioning name of the Manufacturer, fire rating, and year of Manufacturing/ installation.

4.0 TESTING AND CERTIFICATION

4.0 Prototype/ type test repot shall be submitted for each type (such as wooden, steel, glazed etc.), size range and fire resistance / rating of fire doors, windows and partitions.

4.1 Testing for fire resistance / rating of steel and wooden doors shall be done by subjecting a full size construction to test in accordance with the procedures laid down in ISO 3008 or BS 476: part 22.

4.2 Testing for fire resistance/rating of glazed doors, windows and partitions shall be done by subjecting a full size construction to test in accordance with the procedures laid down in following codes as applicable:

1. EN 1634-1
2. EN-1364-1
3. ISO 3009
4. BS 476 : part 20, part 22
5. IS 16945
6. IS 16947

Copyright EIL – All rights reserved

4.4 Testing for fire resistance / rating of solid type partition shall be done by subjecting a full size construction to test in accordance with the procedures laid down in BS 476 : part 20 and part 22.

4.5 Hardware if not tested with the door/ window/ partition, shall be type tested or shall be certified for use on specified fire rated door/ window/ partitions.

4.6 These prototype/ type test reports shall be issued by CBRI or NABL accredited laboratories or renowned National/ International Laboratories/ Test houses. Certifications of hardware shall be by renowned national/ international certification agencies.

4.7 The prototype/ type test certificate/ certifications etc. shall be valid at the time of submission and shall not be older than five years and shall be submitted by the supplier or manufacturer.

4.8 In case of change in design, material, construction, increase in dimensions (width, breadth, height, overall perimeter) or area of the complete assembly (including frame, shutter/leaves, glazing, partition panels and other individual components) as mentioned in the submitted prototype/ type test report, test reports appropriate to the changes shall be submitted.

4.9 However, refer to specific clauses of this specification pertaining to various type of doors, windows and partitions for allowable changes with respect to clause no 4.8

5.0 MATERIAL

5.1 Timber

Timber and timber boards/ composite material used in the construction of the fire doors shall be of thoroughly seasoned hardwood. The moisture content of any material used in the construction including frame and shutter shall not be more than 15 percent, in accordance with IS 287.

5.2 Calcium Silicate board

Calcium Silicate board shall conform to IS 14862 and shall have following properties:

Density	Not more than 900 kg/ cuM
Material class	Non-combustible, in accordance with BS 476: Part 4
Surface spread of flame	Class 1 in accordance with BS 476: Part 7
Thermal conductivity	K factor - 0.15W/mK
Nominal Mixture content (air-dried)	<15%

5.3 Fire Resistant Gypsum plaster board

Fire Resistant Gypsum Plaster boards shall conform to IS 2095 Part 1 and BS- 1230 (Part-1). Density shall be minimum 960 Kg/cuM (+/- 50).

5.4 Galvanized steel sheet

Galvanized steel sheet shall be zinc coated, alloyed type and shall conform to IS 277. The coating weight shall meet or exceed the minimum requirements for coatings of 120 gram/ square meter, total of both sides.

5.5 Cold rolled low carbon steel sheet

Cold rolled low carbon steel sheets shall conform to IS 513 or EN 10346. Drawing quality shall be DX52D and shall have following properties:

Copyright EIL – All rights reserved

Property	Value
Yield strength	Minimum 255 MPa
Tensile strength	Minimum 350 Mpa
Elongation	Minimum 38.5 %

5.6 Glass

The glass panels shall be clear, non-wired, interlayered and toughened type suitable for required fire rating/ resistance of the door/ window / partition assembly.

Each Glass panel shall carry a non-removable marking with the name of the product & the manufacturer inscribed on it.

Thickness of glass lesser than the thickness mentioned in the test report shall not be permitted.

Increase in width, height and overall area of the glass, when compared to dimensions mentioned in the test report shall also be not permitted.

Make, size and thickness of the glass panels shall be as mentioned in the test report for required assembly (door/ window/ partition) of required fire rating and shall have following properties.

Property	Value
Impact resistance	Minimum 2B2 category (When tested in accordance with EN 12600)
Light transmission ratio	Minimum 85% (When tested in accordance with EN 410)

5.7 Insulation

Insulation or infill material shall be resin bonded like resin bonded honeycomb paper core, mineral wool or ceramic wool as mentioned in the test report. Proprietary material may be used, provided they satisfy the requirement of fire resistance/ rating and is mentioned in the test certificate.

Polyurethane foam (PUF) shall not be permitted as infill or insulation material.

Mineral wool and Rock Wool used for insulation shall conform to IS 8183 and density shall be minimum 48Kg/ CuM. Higher density of insulation is permitted.

5.8 Fire & smoke seal

Fire & smoke seals shall be of the same dimensions and configuration as mentioned in the test report.

6.0 WOODEN FIRE DOORS

6.1 Wooden fire doors shall conform to IS: 3614 and this specification. In case of contradiction, this specification or decision by Engineer- In-Charge shall govern.

6.2 Door assembly

6.2.1 The door assembly including door frame, shutter/ leaf, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/

Copyright EIL – All rights reserved

rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

6.2.2 Door frame

Door frames shall be of first grade teakwood and shall be fixed in position by means of anchor fasteners on jambs and head member. Sizes and profiles of the members of the frames shall be as mentioned in the test report. Intumescent fire and smoke seal shall be fitted in the frame in accordance with test certificate.

6.2.3 Door shutter/ leaves

Door shutters/ leaves shall be non-metallic and asbestos free type. They shall be composed of Calcium Silicate boards on both sides and insulation core. Overall thickness of the shutter, thickness of insulation and thickness of calcium silicate boards shall be as mentioned in the test report.

The shutter composition shall have painted/ polished teak wood lipping around the periphery fitted with intumescent fire & smoke seal in accordance with test certificate. The intumescent fire seal may not be required at the bottom of the door leaf.

If not mentioned otherwise, vision panels shall be provided in the door shutters.

6.3 Finishing

The door frames and teak wood lipping around the periphery of the shutters shall be finished with approved quality fire resistant paint conforming to IS 12777 including primer in desired colour.

Both sides of the door shutters/ leaves shall be faced with 3mm thick commercial ply finished with either 1mm thick laminate of approved color, texture and design, or teak ply (finished with fire retardant transparent paint conforming to IS 12777) as mentioned in the drawings, job specification, item descriptions etc.

If finishing of door shutter/ leaf is not specifically mentioned in the drawings, job specification, item descriptions etc., laminate finishing shall be provided.

6.4 Hardware

Reference shall be made to clause no 13.0

6.5 Fire resistance/ rating

If not mentioned otherwise, wooden fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 30 minutes for insulation.

7.0 STEEL FIRE DOORS

7.1 Steel fire doors shall conform to IS: 3614 and this specification. In case of contradiction, this specification or decision by Engineer- In-Charge shall govern.

7.2 Door assembly

7.2.1 The door assembly including door frame, shutter/ leaf, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/

Copyright EIL – All rights reserved

rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

7.2.2 Door frame

Door frames shall be of galvanized steel sheet press formed to required profile. The minimum sheet thickness for frames shall be 1.2 mm (18 gauge) for frame depth upto 150mm. for depth of frame higher than 150 mm, minimum sheet thickness shall be 1.6 mm (16 gauge).

Dimensions and profile of the door frames shall be as mentioned in the test report. However, increase in sheet thickness and frame profile size (compared to the test certificate) is permitted

Door frame shall be provided with stiffeners for hardware/ lock mounting and for fixing of fasteners. Necessary provisions for fixing fire/ smoke seal shall also be kept in the frame.

Hollow door frames shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Door frames shall be fixed in position by means of anchor fasteners on jambs and head member.

7.2.3 Door Shutter/ leaf

Door shutters shall be minimum 45 mm thick with outer skins made of minimum 1.2 mm (18 gauge) thick galvanized steel sheet with infill/ insulation. Internal construction of the shutter shall be provided with rigid reinforcement in addition to the core/ infill. Rigid reinforcement pads shall be provided for receiving hardware like hinges, locks, door closers etc.

Higher thickness of the outer screens (compared to the test certificate) is permitted.

Double leaf shutters shall be provided with astragals.

Intumescent seals shall be provided on all three sides of the leaves and on the meeting stiles of the double leaf door or as per test certificate. Alternatively, the same can provided on the frame and meeting stile of the double leaf door.

If not mentioned otherwise, vision panels shall be provided in the shutters/ leaves.

Louvers shall be provided in the shutters/ leaves if mentioned specifically and test report of the doors with louver is available.

7.3 Finishing

The frame and the shutters shall be finished with minimum 50 microns powder coating in desired colour.

7.4 Fire resistance/ rating

If not mentioned otherwise, steel fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 30 minutes for insulation.

7.5 Hardware

Reference shall be made to clause no 13.0.

Copyright EIL – All rights reserved

8.0 VISION PANEL

Glass for vision panels shall be in accordance with test certificate Maximum area of vision panel shall be 0.06 square meter. Maximum width shall be 200 mm, maximum height shall be 400mm.

In case of change in glass with respect to test report, the changed glass shall be appropriate to the specified fire resistance/ rating and supporting test report of the changed glass shall be submitted.

9.0 LOUVERS

Louvers shall be in accordance with test certificate when tested as a complete assembly on the fire door. Maximum area of the louvers shall not exceed 0.135 square metre. Maximum width and height shall be 300 mm and 450 mm respectively.

10.0 GLAZED FIRE DOORS

10.1 Door assembly

10.1.1 The door assembly including door frame, shutter/ leaf, stiles, rails, glazing, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

10.1.2 The glazed fire doors shall be fully glazed type with required frame, shutter/ leaf, stiles, top and bottom rails, insulation, fire & smoke seal, hardware etc. Intermediate middle/ lock rails shall not be provided.

10.1.3 Door Frame

Door frame shall be either of galvanized steel sheet or cold rolled low carbon steel sheet press formed to requisite profile.

Minimum thickness of galvanized steel sheet for frames shall be 1.2 mm (18 gauge) for frame depth upto 150mm. for depth of frame higher than 150 mm, minimum sheet thickness shall be 1.6 mm (16 gauge).

Minimum thickness of cold rolled low carbon steel sheet for frames shall be 1.5 mm.

However, increase in steel sheet thickness (compared to the test certificate) is permitted.

Dimensions and profile of the door frames and frame members shall be as mentioned in the test report. Increase or reduction in dimensions and change in profile when compared to the test report shall not be permitted.

Hollow door frames shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Door frame shall be provided with stiffeners for hardware/ lock mounting and for fixing of fasteners. Necessary provisions for fixing fire & smoke seal shall also be kept in the frame.

Door frames shall be fixed in position by means of anchor fasteners on jambs and head member.

10.1.4 Door Shutter/ leaf

Copyright EIL – All rights reserved

The shutter/ leaf frame (stiles and rails) shall be shall be either of galvanized steel sheet or cold rolled low carbon steel sheet press formed to requisite profile. Thickness of steel sheet shall be minimum 1.2 mm.

Dimensions and profile of the stiles and rails shall be as mentioned in the test report. Increase in dimensions and change in profile when compared to the test report shall not be permitted.

However, increase in steel sheet thickness (compared to the test certificate) is permitted.

Width of the stile and rail shall not exceed 100mm. In case of bottom rail width/ height may be upto 125mm.

Intermediate middle/ lock rails shall not be provided.

Hollow sections of stiles and rails shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Glass shall be single piece and increase in glass panel size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips/ screw etc. in accordance with test reports.

10.2 Finishing

The frame and the shutters/ leaves shall be finished with minimum 50 microns powder coating in desired colour.

10.3 Hardware

Reference shall be made to clause no 13.0.

10.4 Fire resistance/ rating

If not mentioned otherwise, glazed fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

11.0 GLAZED FIRE WINDOW

11.1 Window assembly

11.1.1 The window assembly including frame, glazing, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

11.1.2 Specification of window frame shall be similar to the specification of door frame as mentioned in clause 10.0

11.1.3 The glazed fire windows shall be fully glazed type (fixed glazing) with required frame, hardware etc. Glass shall be single piece and increase in glass panel size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips etc. in accordance with test reports.

Copyright EIL – All rights reserved

11.2 Finishing

The frame shall be finished with minimum 50 microns powder coating in desired colour.

11.3 Fire resistance/ rating

If not mentioned otherwise, glazed fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

12.0 GLAZED FIRE PARTITION

12.1 Partition assembly

12.1.1 The partition assembly shall consist of metal framework and glass panels in accordance with approved design and pattern.

12.1.2 The partition assembly including frame, glazing, insulation etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

12.1.3 Glazed fire partitions shall be fully glazed unless otherwise mentioned specifically. Specification of partition frame shall be similar to the specifications of door frame mentioned in clause no 10.0. Specification of glass shall be as mentioned in clause 5.5.

12.1.4 Glass shall be single piece in a panel and increase in glass size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips/ screws etc. in accordance with test reports.

12.1.5 Size of individual glass panels and overall size of the partition shall not exceed the sizes mentioned in the test report.

12.1.6 The partition shall cover the full height and length mentioned in the drawing etc and shall be fixed on top and bottom also. In case, the height and length mentioned in the drawing etc are more when compared to the test report, solid type partition or other construction having fire rating (120 minutes for both integrity and insulation) shall be provided as/ approved design so that dimensions of both glazed and solid partition/ other construction do not exceed the dimensions mentioned in the test report.

12.1.7 Doors provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

12.1.8 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

12.2 Finishing

The partition frame shall be finished with minimum 50 microns powder coating in desired colour.

12.3 Fire resistance/ rating

If not mentioned otherwise, glazed fire partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

Copyright EIL – All rights reserved

13.0 HARDWARE

13.1 Fire Doors, windows and partitions shall be provided with all required hardware for stability, proper operability and safety ensuring the fire resistance / rating.

13.2 All hardware used on Fire doors, windows and partitions shall be fire rated and certified except for hinges, if it is of minimum 100 mm x 75 mm x 3 mm size and in stainless steel of grade 304 and above. Similarly, pull handles may not require specific fire rating if it is in stainless steel of grade SS 304 and above.

13.3 All other hardware like locks, panic devices, lever handles, door closers etc. if not tested with the fire door, window or partition shall be type tested and certified for use on those specific fire rated doors, windows and partitions.

13.4 Tower/ flush bolts, Aldrops, side bolts and chain with padlocks shall not be provided in Fire doors. However, in case of double shutter/ leaf doors without panic bar, tower/ flush bolts shall be provided on inactive leaf.

13.6 Fire doors in exits (component of means of egress which is between the exit access and the exit discharge), doors opening into exits, staircase enclosure, exit access and exit discharge shall be provided with following hardware.

Sr. No	Hardware	Specific requirement
1	Hinges	Hinges shall be as per test report, If not mentioned in the test report, hinges shall be as per Manufacturer's standard practice. No. of hinges : 1. For doors upto 2400 mm height – 04 Nos per leaf 2. For doors above 2400 mm height – as per Manufacturer's practice.
2	Panic Bar	1. For single leaf door : - Single point panic bar "push to open" push bar, single leaf type – 01 No. 2. For active leaf of double leaf door : - Single point panic bar "push to open" push bar type – 01 No. 3. For inactive leaf of double leaf door Openable locks, trims with handle for panic bars to operate the bar from outside shall also be provided.
3	Door closer	Heavy duty type - 01 No. per leaf
4	Door Stopper	Floor mounted, 45 mm dia, half dome in SS 304 grade - 01 No. per leaf
5	Flush/ Tower bolt	Not required for Doors with Panic Bar, in case of double shutter/ leaf doors without panic bar, SS 304 grade, minimum 300mm long concealed tower/ flush bolts shall be provided on inactive leaf at top and bottom.

13.7 Internal fire doors which are not in the exits and do not open into the exits shall be provided with following hardware.

Sr. No	Hardware	Specific requirement
1	Hinges	Hinges shall be as per test report, If not mentioned in the test report, hinges shall be as per Manufacturer's standard practice. No. of hinges : 1. For doors upto 2400 mm height – 04 Nos per leaf 2. For doors above 2400 mm height – as per Manufacturer's

Copyright EIL – All rights reserved

		practice.
2	Mortice lock	Heavy duty mortice dead lock and D type (SS 304 grade, minimum length 300mm and 22mm dia) handle on both faces (Offset type handle – For all Glazed fire doors) Note: Instead of door handle with mortice dead lock, SS 304 grade lever handle with mortice sash lock on both faces (Offset type handle – For all Glazed fire doors) may be used.
3	Door closer	Heavy duty type - 01 No. per leaf
4	Door Stopper	Floor mounted, 45 mm dia, half dome in SS 304 grade - 01 No. per leaf
5	Flush/ Tower bolt	SS 304 grade minimum 300mm long concealed flush bolt (in inactive shutter of double shutter Doors) at top and bottom.

14.0 SOLID TYPE FIRE PARTITION (Calcium Silicate)

14.1 Partition assembly

14.1.1 The partition assembly shall be made of frame work of galvanized steel or cold rolled low carbon steel sheet profiled horizontal and vertical members, layers of calcium silicate partition boards on both sides and insulation in-fill all as mentioned in the test report in accordance with approved design and pattern. However, increase (when compared to test certificate) in sheet thickness or profile size of steel sections, thickness of insulation, thickness and number of layers of partition) is permitted.

14.1.2 The partition assembly including frame, partition boards, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

14.1.3 Overall size of the partition shall not exceed the sizes mentioned in the test report.

14.1.4 Doors and windows provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

14.1.5 The partition framework shall comprise of vertical studs, intermediate horizontal members, floor and ceiling channels as mentioned in test certificates with regards to material, sizes, thickness, spacing etc.

14.1.6 Minimum thickness of the calcium silicate boards shall be 12mm.

14.1.7 The board's joints shall be staggered, horizontally as well as vertically, to avoid through passage.

14.1.8 Minimum thickness of insulation shall be 50 mm. Insulation material, density etc. shall be as mentioned in test certificates.

14.1.9 Over all thickness of the partition shall not be less than 93 mm and shall be as mentioned in the as mentioned in test certificates. Increase in the thickness is permitted.

14.1.10 If mentioned specifically, this partition system may be used in combination of fire rated glazed partition system with suitable detailing for combining these two partition systems.

14.1.11 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

Copyright EIL – All rights reserved

14.2 Finishing

14.2.1 Calcium Silicate partition boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified.

14.2.2 If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour.

14.2.3 The calcium silicate boards shall be jointed and finished with jointing compound, fibre tape etc. so as to have a flush and even look after finishing.

14.2.4 Any cut-out (such as for switchbox, AC duct etc.), gap in the periphery on the partition and joints between structural member and partition shall be properly sealed with fire sealant as mentioned in the test certificates or in accordance with Partition manufacturer's standard practice.

14.3 Fire resistance/ rating

If not mentioned otherwise, solid type partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and insulation.

15.0 SOLID TYPE FIRE PARTITION (Gypsum Plaster Board)

15.1 Partition assembly

15.1.1 The partition assembly shall be made of frame work of galvanized steel or cold rolled low carbon steel sheet profiled horizontal and vertical members, layers of fire resistant Gypsum plaster boards on both sides and insulation in-fill all as mentioned in the test report in accordance with approved design and pattern. However, increase (when compared to test certificate) in sheet thickness or profile size of steel sections, thickness of insulation, thickness and number of layers of partition) is permitted.

15.1.2 The partition assembly including frame, partition boards, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

15.1.3 Overall size of the partition shall not exceed the sizes mentioned in the test report.

15.1.4 Doors and windows provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

15.1.5 The partition framework shall comprise of vertical studs, intermediate horizontal members, floor and ceiling channels as mentioned in test certificates with regards to material, sizes, thickness, spacing etc.

15.1.6 Minimum thickness of the fire resistant Gypsum plaster boards shall be 12.5 mm.

15.1.7 The board's joints shall be staggered, horizontally as well as vertically, to avoid through passage.

15.1.8 Minimum thickness of insulation shall be 50 mm. Insulation material, density etc. shall be as mentioned in test certificates.

15.1.9 Even if insulation in-fill is not mentioned in the test certificate, minimum 50 mm thick insulation of density 48kg/cuM shall be provided in the cavity of the framework.

Copyright EIL – All rights reserved

15.1.10 Over all thickness of the partition shall not be less than 102 mm and shall be as mentioned in the as mentioned in test certificates. Increase in the thickness is permitted.

15.1.11 If mentioned specifically, this partition system may be used in combination of fire rated glazed partition system with suitable detailing for combining these two partition systems.

15.1.12 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

15.2 Finishing

15.2.1 Gypsum plaster boards on both sides shall be sealed with paper tape, corner edges with metal corner tape and with three-layers of all purpose jointing compound to reinforce the board joints so as to have a flush and even look.

15.2.2 Gypsum plaster boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified.

15.2.2 If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour.

15.2.4 Any cut-out (such as for switchbox, AC duct etc.), gap in the periphery on the partition and joints between structural member and partition shall be properly sealed with fire sealant as mentioned in the test certificates or in accordance with Partition manufacturer's standard practice.

15.3 Fire resistance/ rating

If not mentioned otherwise, solid type partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and insulation.

16.0 INSTALLATION

16.1 Shop drawings of the Fire doors, windows and partitions in accordance to the prototype/ type test report and design drawings shall be prepared and submitted for approval by the Engineer-In-Charge. The shop drawings shall include all details of construction, anchoring, connections, fastenings etc. The fire doors, windows, partitions shall be fabricated in accordance with the approved shop drawings.

16.2 Fire doors, windows, partitions shall be installed by the Manufacturer or agency recommended by the Manufacturer and approved by the Engineer- In-Charge.

16.3 Frames shall be installed plumb, level, rigid and in true alignment and shall be fixed to the adjacent construction so as to retain their position and stability. Fixing of the frames with masonry/ concrete may be done with suitable fasteners. The complete assemblies shall also be installed plumb, level, rigid and in true alignment.

16.4 The maximum allowable gap between the frame and masonry/ concrete work shall not be more than 5-8 mm and shall be sealed with sealant as mentioned in the test certificates/codes & standards or in accordance with the manufacturer's standard practice if not mentioned in the certificates and codes/ standards.

16.5 The door shutters/ leaves, window and partition panels shall be installed and fastened to maintain alignment with frames to achieve maximum operational effectiveness and appearance.

Copyright EIL – All rights reserved

16.6 Installation of hardware shall be in accordance with hardware Manufacturer's recommendations.

16.7 When the smoke/ fire/ intumescent seals are fitted on site, they shall be fitted strictly in accordance with the Manufacturer's recommendations.

17.0 DELIVERABLES BY THE CONTRACTOR

Following documentation/ drawings shall be furnished by the Manufacturer:

1. Prototype/ type Test Certificate of the door, window and partition assembly from test laboratory/ house.
2. Shop drawings.
3. Specification/ Manufacturer's literature, Test certificates and other documentation for materials and items used in the system.
4. Certificate indicating that design and installation of Doors and hardware as per the test reports submitted.
5. Manufacturer's inspection report
6. Manufacturer's Guarantee.

18.0 GUARANTEE

The door/ window/ partition assembly including all hardware shall be guaranteed for a period of 12 months from the date of installation against any manufacturing defect.

In case of any such defect within the guarantee period, the defected part shall be replaced or repaired as required by the Contractor at his own cost.

19.0 MEASUREMENT

Unless otherwise mentioned, measurement of fire doors, windows and partition shall be as below:

19.1 Fire rated doors shall be measured by area of the doors (inclusive of the frame, fixing arrangement, glazing and all fittings).

19.2 Fire rated windows shall be measured by area of the windows (inclusive of the frame, fixing arrangement, glazing and all fittings).

19.3 Fire rated partition shall be measured by area of the partitions (only one side, inclusive of the frames, partition panels, fixing arrangement, glazing and all fittings. Area of doors, windows and other openings shall be deducted).

19.4 Hardware such as door closer, door stopper, locks and trims, panic bar etc., shall be measured in numbers.

Copyright EIL – All rights reserved

स्टोर / गोदाम के लिये भंडारण रैक प्रणाली का मानक विनिर्देश

SPECIFICATION FOR STORAGE RACKING SYSTEM FOR STORE/ WAREHOUSE

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
0	21.12.20	ISSUED AS STANDARD SPECIFICATION	ATUL GUPTA	SAMIR DAS	ANURAG SINHA	S MAZUMDAR

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing and Materials
BS	:	British Standards
EN	:	European Standards
FEM	:	European Material Handling Federation
IS	:	Indian Standards
SEMA	:	Storage Equipment Manufacturers Association
UDL	:	Uniformly Distributed Load

Structural Standards Committee

Convenor : Mr. Anurag Sinha

Members : Mr. C Damodaran
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjit Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4

2.0 DESIGN & ENGINEERING 4

3.0 SPECIFICATION OF MATERIALS AND SYSTEM COMPONENTS 5

4.0 INSTALLATION 10

5.0 SUBMITTALS BY THE CONTRACTOR 10

6.0 WARRANTY 10

Copyright EIL – All rights reserved

1.0 GENERAL

This specification pertains to design, engineering and installation of storage racking system for store/ warehouses.

1.1 Design, Engineering and Installation

Design, detail engineering and installation of storage racking system shall be done by approved agency.

2.0 DESIGN & ENGINEERING

2.1 Storage racking system shall be designed to meet the storage requirement i.e. storage materials, storage quantity, load condition etc. of the stores/ warehouses of the project.

2.2 Storage racking system shall be self supported and structurally stable system consisting of steel frame work (Assembly of upright, bracing, base plates, beam, decking panels, etc.) Structural members shall be of steel slotted sections.

2.3 Lay-out of Racks

Lay-out of racks including number of tiers of racks, spacings, passageways, clearances, loading/unloading, staircases, ladders etc. shall be finalized on the basis of storage requirement, available space, operational and safety requirements.

Minimum spacing between racks shall be 1800mm.

Detailed lay-out of storage Racks shall be prepared by approved agency.

2.4 Design Codes and Standards

Racking system shall be designed in compliance with following codes/ standards/ references.

A. Racking codes/ standards/ References

1. Publications of "European Materials Handling Federation (FEM)" or
2. Publications of "Storage Equipment Manufacturers Association (SEMA)"

B. Structural Design Codes

1. BS 5950 - Part V Structural use of steelwork in building - Part 5 - Code of Practice for design of cold-formed thin gauge sections (British) or equivalent Indian code.

2. IS 1893 - Criteria for Earthquake resistant design of structures.

2.5 General Construction of Racks

2.5.1 Heavy-Duty Shelving System

The racks shall be made of steel slotted profiled sections. The vertical members/uprights will be in single piece of 6500mm (±50 mm) with no joint. Rack ends shall be suitably braced. End faces of each row of racks shall have steel side sheets. The horizontal rack surface shall be made of sectional panels of steel bent/stiffened sections. Requisite side angles and corner plates shall be provided.

Copyright EIL – All rights reserved

Back clad shall be provided in between the back to back racks to prevent the fall of small materials. Same shall also be provided for single racks. Material of back clad as per approved manufactures specifications.

The rack units shall be tiered as required and shall be designed considering maximum load per level as per project requirement.

If not mentioned otherwise, 3 tiers and minimum uniformly distrusted load (UDL) of 900 kg / sq. m per level shall be considered.

Accessibility (by equipment and manual) shall be provided to various levels of storage shelves in the racks.

2.5.2 **Boltless Mobile Shelving System** (with rails)

Boltless Mobile Shelving System shall be made of boltless super-structure installed over rails. Boltless mobile shelving shall have flexibility to adjust levels without any additional tools.

2.6 Structural Design

Structural design shall be done by approved agency complying with codes and standards mentioned in clause 2.4 considering loading and other conditions.

3.0 SPECIFICATION OF MATERIALS AND SYSTEM COMPONENTS

3.1 Material - Load Bearing Members

3.1.1 Heavy-Duty Shelving System

Load bearing members of the system shall be made out of high strength hot rolled steel.

The different types of material used for load bearing members such as uprights and beams shall have following properties:

Steel Type	Minimum Yield Strength	Applicable IS Standard	Equivalent International Standard
Fe 510 or E 350	355 MPa	IS: 5986 or IS:2062	JIS 3101: SS 490 EN 10025 : S 355 JR DIN 17100 : St 52
Fe 410 or E 250	255 MPa	IS: 5986 or IS:2062	JIS 3101: SS 400 EN 10025 : S 235 JR DIN 17100 : St 42

3.1.2 Boltless Mobile Shelving System

Load bearing members & accessories shall be made up of relevant high strength steel & the different types of materials used shall be as below:

Copyright EIL – All rights reserved

Steel type	Minimum Yield Strength	Applicable Standard	Component Usage
Galvanised	210 MPa	IS:277	Upright, Shelf Panel, inner cladding
Galvanised	255 MPa	ASTM A 653M SS GRADE 37 (CLASS 1)	Shelf Clip, Cladding clamp
Hot Rolled (HR)	255 MPa	IS: 5986 – ISH410S / Equivalent (or) IS:2062 - E 250/ Equivalent JIS 3101: SS 400 EN 10025: S 235	Undercarriage 'C' Channels
Cold Rolled (CR)	210 MPa	IS:513 JIS; G3141	Peripheral Claddings, Top panel
SG 500	500 MPa	IS 1865: 1991	Stepped wheel, Plain wheel

3.2 Pre-treatment of Steel Components

Before providing the final finish, all steel components shall be pre-treated. The pre-treatment shall consist of:

- Degreasing comprising of alkaline cleaning for removal of oils and other semi-solids from the metal surface by using caustic soda, soda ash, Tri sodium phosphate and sodium met silicate in the required concentrations and maintaining them at closely controlled temperatures. The degreasing and pickling shall be done in conformity to IS 6005:1970 or relevant international code.

- Rinsing in water for removal of alkaline impurities.

- Phosphating (for protection of any corrosive action) or transformation of metal surface into a new surface) comprising of treating the steel components with phosphoric acid with Sodium nitrite as the accelerator (imparting fine texture to the phosphate coating). The Phosphating process shall be done in conformity with IS 3618:1966 or relevant international code.

- Rinsing with De-mineralized water.

3.3 Finishing

All steel components shall be finished with powder coating (minimum 35 microns thickness) in approved colour. It shall be applied by means of electrostatic spray equipment. The components/ coated objects shall then be treated in oven to form a smooth surface.

The finished (coated) surface of the steel components shall have high quality smooth surface with no runs or drips, shall have high impact, abrasion and scratch resistance.

The finished surface shall be good enough to withstand roughs of loading, transportation, unloading, assembly, installation of stacks in position. No peeling of coats noticed shall be acceptable. However, any minor scratches etc. shall be made good at site.

Copyright EIL – All rights reserved

3.4 Components of Racking System

Components of Racking system shall be as per approved Manufacturers specification, profiled and sized as required for meeting storage and loading requirement, table below and as approved.

3.4.1 Components of Heavy-Duty Shelving System

The table below is not comprehensive and does not include each and every items and details. The racking system shall be complete in all respect including items and details not mentioned in the table but required for completeness of the system in accordance with standard specifications of approved Manufacturer's approved specification.

Sr. No.	Component	Specification	remarks
1	Frame	Frame shall be load bearing supports consisting of vertical uprights and bracings fixed to floor with base plate.	the racking system shall be completely knock down construction. the racks are grouted on the floor using expansion bolts. no welding will be carried out at site.
2	Upright	Uprights shall be made of roll formed steel having slots @ 50mm for adjustability of beam levels and of single piece without welded joints and shall be finished with powder coating.	Material Quality: Min Ys=355Mpa Mfg Process: Roll Formed Finish : Powder Coated/Galvanised
3	Bracings	Diagonal and horizontal bracings shall be roll formed steel lipped channel sections. These shall be bolted to connect uprights to make frames.	Finishing: Galvanized Profile: Lipped Channel Mfg Process: Roll Formed No of Bend: 4
4	Base plate	Base plates shall be press formed steel construction bolted to upright. They shall be anchored to ground using torque type mechanical anchor bolts. Floor level variation shall be adjusted with shim.	Finishing: Powder Coated
5	Stiffeners	Stiffeners shall be of steel channel sections and shall be provided if required to increase load bearing capacity of uprights.	Material: Min Ys=210 Mpa Finishing: Powder Coated / Galvanized
6	Beams	Beams shall be made of hot rolled steel with powder coating finish for connecting two frames that support the decking panels.	
7	Decking panels	Decking panels shall be bend steel panels interconnected with spacer/ connector/ panel supporting bars. Panel dividers shall be provided for separating items.	Finishing: Powder Coated / Galvanized

Copyright EIL – All rights reserved

Sr. No.	Component	Specification	remarks
8	Mesh/ sheet cladding	Welded steel Mesh (4mm dia, 50mm x 50mm mesh size, powder coated) cladding with framing or Powder coated sheet cladding shall be bolted at rear and side to prevent fall of small items. Type of cladding shall be as specified or approved.	Material: Min Ys=210 Mpa Finishing: Powder Coated
9	Row connector	Row connectors shall be provided to connect back-to back racks.	Material: Min Ys=210 Mpa Finishing: Powder Coated
10	Tie Beam	Tie beams shall be provided to connect frames for stability of the system	Material: Min Ys=255 Mpa Finishing: Powder Coated
11	Walkway floor	Walkway floors shall be roll formed perforated type or grating type as required for loading/unloading equipment and shall have galvanized finish.	Material: Min Ys=255 Mpa Finishing: Galvanized (275 GSM)
12	Staircase	Steel staircase with railing shall be provided for access to various levels.	Finishing: Powder Coated
13	Railings	Railings with kick-plate shall be provided for safety having provision for removal required for loading/ unloading.	Finishing: Powder Coated
14	Safety signage	Load warning signage conforming to EN:15635 shall be provided.	
15	Aisle Packard, Label Holders	Aisle Packard, Label Holders shall be provided for easy identification.	
16	Material lifting equipment	Material lifting equipment such as chutes, lift etc. shall be provided if specifically mentioned/ included.	

3.4.2 Components of Boltless Mobile Shelving System

Sr. No.	Component	Specification	Remarks
1	Undercarriage Movable & Fixed	Under carriage shall be made up of 'C' Profile and shall be adequate to carry entire pay-load and weight of super structure. This shall have anti tipping element for operational safety.	Mfg. Process – Forming Finish – Powder Coated
2	Rail Assembly	Rails shall be made up of 25x16mm rectangular bars, enabling movement of undercarriage in a guided path with anti-tilt assembly. It shall be provided with slope	Mfg. Process: Forming & Welding Finish: Powder Coated (Top surface of the rails are without powder coating)

Copyright EIL – All rights reserved

Sr. No.	Component	Specification	Remarks
		plates at both sides to avoid hindrance to people who are walking at the system. Rail material shall confirm to IS:2062	
3	Drive Unit Assembly	Drive unit assembly shall be a mechanism that transfers the driving force to wheel. The rotation of hand-wheels by the operator shall be transferred to the wheel through the chain mechanism to reduce the efforts of the operator.	Material of handle: ABS (Acrylonitrile Butadiene Styrene) Plastic. Finish of handle: Molded Matt Finish Drive Force Transfer: Through chain (RS40)
4	Upright	Uprights shall be made of roll formed steel having slots @ 50mm for adjustability of beam levels and of single piece without welded joints, minimum yield strength shall be 210 Mpa.	Mfg. Process: Forming Finish: Powder Coated
5	Bracings	Bracing shall be a formed single piece section which connects two vertical uprights & makes a frame.	Mfg. Process: Forming Finishing: Powder Coated
6	Shelf Panel	Shelf panels shall be the load carrying members which are hooked into the uprights via shelf clips. There shall be slots for mounting dividers at the pitch of 50mm. Panel levels shall be adjustable in the pitch of 25mm.	Mfg. Process: Roll Forming Finishing: Powder Coated No of bend: 14
7	Shelf Clip	Shelf panels shall be mounted on the upright using this clip.	Mfg. Process: Blanking & Punching
8	Back Tie	Back ties shall ensure stability. Back tie rod cleat shall be inserted into upright & then turn buckle shall be hooked to it. Then back tie rod shall be hooked to turn buckle & back tie rod cleat.	Mfg. Process Tie Rod: Forming Finishing: Galvanized
9	Upright connector	Upright connector shall be provided to connect two uprights back to back when required for desired configuration.	Mfg. Process: Forming Finishing: Galvanized
10	Front Box Cladding (FBC) & Rear Box Cladding (RBC)	Front box cladding (the cladding on the drive handle side) and Rear box cladding (the cladding on the side opposite to drive handle side) shall be assembly of	Mfg. Process: Forming Finishing: Powder Coated

Copyright EIL – All rights reserved

Sr. No.	Component	Specification	Remarks
	Assembly	either single / '3' pieces / '6' pieces together to form a front fascia. The cladding shall ensure preventing of un-authorized access of material from front side & also pilferage.	
11	End Box Cladding (EBC) Assembly	End box cladding shall be provided at the extreme sides to prevent the access of material from outside and improves the overall aesthetics.	Mfg. Process: Forming Finishing: Powder Coated
12	Label Holder	One label holder shall be provided in every bay for inserting labels	Material: Acrylic
14	Safety signage	Load warning signage conforming to EN:15635 shall be provided.	

4.0 INSTALLATION

Installation shall be done by approved Manufacturer in accordance with approved design and fabrication drawings.

5.0 SUBMITTALS BY THE CONTRACTOR

Contractor shall submit following :

1. Structural design calculations of the system.
2. Material, finishing & other specification of components
3. Fabrication drawings including lay-out, sizing of components, fixing/ connection details, installation drawings.
4. Installation Manual of Racking System
5. Stability Certificate of Racking System

6.0 WARRANTY

Warranty of minimum 12 months (from the date of completion of work at site) shall be provided by contractor for any damage /defect of complete system. Any damage /defect (excepting damage /defect caused by the third party and causes not attributable to contractor) within the warranty period shall be modified by the contractor at his own cost to the satisfaction of Engineer-In-Charge or end user.

Copyright EIL – All rights reserved

एल्यूमीनियम समग्र पैनल (एसीपी) क्लैडिंग सिस्टम के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR ALUMINIUM COMPOSITE PANEL (ACP) CLADDING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
0	03.03.23	ISSUED AS STANDARD SPECIFICATION	SANDEEP	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing and Materials
AAMA	:	American Architectural Manufacturers Association
ACP	:	Aluminium Composite Panel
BS	:	British Standard
BIS	:	Bureau of Indian Standards
EN	:	European Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
PVDF	:	Polyvinylidene Fluoride
RCC	:	Reinforced Cement Concrete
SS	:	Stainless Steel

Architecture Standards Committee

Convenor: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumdar (Strl)
Mr. Charanjeet Singh (Proj.)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4

2.0 REFERENCES 4

3.0 MATERIALS 5

4.0 DESIGN AND DETAILING OF ACP CLADDING SYSTEM 6

5.0 INSTALLATION 6

6.0 TESTING 7

7.0 DELIVERABLES BY THE CONTRACTOR 8

8.0 WARRANTY 8

Copyright EIL – All rights reserved

1.0 GENERAL

This Specification covers requirements of ACP cladding on building facades, building or Architectural or structural elements and as interior or exterior finishing or decorations etc. This specification shall be read in conjunction with project specific job specification.

2.0 REFERENCES

The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document title
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
AAMA 501.1	Standard Test Method For Water Penetration Of Windows, Curtain Walls And Doors Using Dynamic Pressure
AAMA 501.4	Recommended static testing method for evaluating curtain wall & storefront systems subjected to seismic & wind induced interstory drift
AAMA 501.2	Quality assurance & Diagnostic Water leakage field check of Installed storefronts, curtain walls , and sloped glazing systems
ASTM E547	Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Differential.
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E547	Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Differential.
EN 485	Aluminium and aluminium alloys - Sheet, strip and plate - Part 1: Technical conditions for inspection and delivery
EN 13501-1	Fire classification of construction products and building elements - Part 1
IS 1608	Metallic materials - tensile testing at ambient temperature
IS 8402	Methods of Sampling and Test for Pressure Sensitive Adhesive Tapes
IS 17682	Aluminium Composite Panel Specification
ISO 868	Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)

Copyright EIL – All rights reserved

3.0 MATERIALS

3.1 Aluminium Composite Panel (ACP)

ACP shall be external grade mineral core fire retardant type. The panels shall consist of two outer aluminium alloy skins and mineral filled core in between the skins and shall meet the requirements below:

Property	Specification
Grade of the panel	Grade 3 (external grade mineral core fire retardant ACP) conforming to IS 17682 Or Grade B- s1, d0 conforming to EN- 13501-1
Thickness	Overall thickness – 4 mm (+/- 0.2mm)
Outer skins	0.5 mm thick aluminium alloy sheets of any of the following designations. 1. 3150B with conditions H x 6 or H x 8 conforming to IS 737 2. 3105 with H14/16 conforming to EN485
Mineral core	Minimum 3 mm thick, Non combustible type, comprising of 70% inorganic compound 30% virgin polymer laminated and bonded to outer skins. Density of core – 1.5-1.7 gram/ cubic centimeter
Weight of the panel	Minimum 7.5 Kg per square metre
Tensile strength	Minimum 45 N/ square mm when tested as/ IS 1608 (part 1)
Yield strength	Minimum 38 N/ square mm when tested as/ IS 1608 (part 1)
Elongation %	Minimum 5 when tested as/ IS 1608 (part 1)
Peel strength N/10 mm width	Minimum 6 when tested as/ IS 8402
Coating on front side of aluminium alloy skin	PVDF – Minimum 25 microns Pencil hardness – 2H The coating shall consist of chromate conversion, inhibitive primer and fluoropolymercolour coats in approved colour, texture.
Finishing on backside of aluminium alloy skin	Bare aluminium finish
Peel-off protection	The finished surfaces of ACP shall be factory protected with self adhesive peel-off foil having a thickness of 80 microns.
Profiling of panels	The panels shall be in tray/pan profiles. They shall be adequately reinforced at their back side meeting structural design and deflection criteria.

3.2 Supporting frame work

Materials for supporting framework shall be as tabulated below:

Copyright EIL – All rights reserved

Aluminium sections and profiles	Aluminium profiles shall be of Aluminium (6063 T 5 grade as per EN 485-2).Permissible deflection shall be L/175. They shall be coated with PVDF (minimum 45microns).
Brackets	Mild steel or Aluminium
Screws and fasteners	Stainless steel (SS), 304 grade
Anchor bolts	Stainless steel (SS), 316 grade
Weather sealant	Non bleeding and non staining type having minimum tearing strength of 4.00 N/ mm and shore A hardness of 24 (as/ ISO 868) as approved by the Engineer-In- Charge.
Structural sealant	In accordance with design load as approved by the Engineer-In-Charge.

Other components of the frame work not listed in the table shall be in accordance with the detail design and specification of the system prepared by the Contractor and approved by Engineer- In- Charge.

4.0 DESIGN AND DETAILING OF ACP CLADDING SYSTEM

4.1 Design, structural analysis and detailing including preparation of fabrication drawings of the complete system shall be done by the Contractor or agencies engaged by the Contractor subjected to approval by the Engineer- In- Charge.

4.2 The design, finished surface (pattern, shape, colour, texture etc.)and detailing shall be in accordance with the drawings, requirements of this specification and other requirements issued by Engineer-In-Charge for the purpose.

4.3 ACP cladding system shall comprise of ACP fixed on background (such as masonry, block-work, RCC, steel etc) by means of supporting framework in accordance with approved design and drawings.

4.4 Design shall also include structural analysis and design of the supporting frame work in accordance with relevant Indian or International codes as mentioned or as agreed by the Engineer-In-Charge considering stability, durability, water tightness and other design conditions.

4.5 Contractor or agency engaged by him shall do and submit all necessary structural analysis, calculations and prepare all detailed fabrication drawings for approval by the Engineer-In-Charge.

4.6 The finished surface shall be either with open type grooves or with closed grooves (silicone filled grooves) as mentioned in drawings, item descriptions etc.

If not mentioned specifically, open type grooves shall be provided.

In both the cases grooves shall be in the pattern / design in accordance with approved design and drawing.

5.0 INSTALLATION

5.1 Installation of the complete system shall be done by agency approved by the Engineer-In-Charge.

5.2 Installation shall be done in accordance with design and drawings approved by the Engineer-In- charge.

Copyright EIL – All rights reserved

5.3 The finished surface shall be true to the plane, water-tight. The groove lines of panels shall be uniform and truly aligned in the continuity.

5.4 The aluminium profiles of framework shall be fixed to background surface by means of fixing to brackets (fixed to the background surface) with SS bolts and nuts. The brackets shall be with serrations and serrated washers for arresting wind load movement.

5.5 Nylon separators shall be provided to prevent bi-metallic contacts in the system.

5.6 The panels shall be cut to size and shape, routed, corners notched and bent as required. Aluminium cleats shall be fixed to the backside edges of the panels using aluminium pop rivets. The panels shall be fixed to the framework using SS screws.

5.7 The gaps (12 – 16 mm) in between the panels shall be uniform in width.

5.8 In case of closed groove system, the gaps between panels shall be filled up with closure profile, backer rod and weather sealant.

5.9 Gaps upto 10 mm between the peripheral panels and backing surface shall be sealed by inserting adequate sized backer rod and sealant. Gaps more than 10 mm shall be sealed by providing and fixing of 2 mm thick aluminium sheet (finished with 60-8- micron thick super durable polyester coating) flashing profiled as per site requirement.

5.10 The termination of the panels shall be suitably detailed and executed using flashing, bending/ continuing the panels etc. for stopping water ingress.

5.11 Necessary weep holes shall be provided in the system for draining out trapped water/ moisture.

5.12 After the installation is completed, peel-off foils shall be removed from the panels and the panel surfaces shall be cleaned and washed with mild soap water with soft dry cotton cloth.

6.0 TESTING

The completed ACP system shall be tested for water tightness as per following method.

Testing Method	Document title
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
AAMA 501.1	Standard Test Method For Water Penetration Of Windows, Curtain Walls And Doors Using Dynamic Pressure
AAMA 501.4	Recommended static testing method for evaluating curtain wall & storefront systems subjected to seismic & wind induced interstory drift
AAMA 501.2	Quality assurance & Diagnostic Water leakage field check of Installed storefronts, curtain walls , and sloped glazing systems
ASTM E547	Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Differential.

Copyright EIL – All rights reserved

In case water penetrations are noticed, necessary rectifications shall be done by the Contractor to stop such water ingress as acceptable to the Engineer- In – Charge.

7.0 DELIVERABLES BY THE CONTRACTOR

With regards to documents and drawings, the Contractor shall furnish following deliverables:

1. Structural analysis and calculations
2. Fabrication or shop drawings
3. Test certificates in support of compliance with the specifications.

8.0 WARRANTY

The complete system including ACP, framework, sealants, fittings and fixtures and all components shall be warranted by the Contractor for a period of 5 years. Any defective work or material found within this period shall be repaired/ replaced/ re-done by the Contractor at his own cost.

Copyright EIL – All rights reserved

स्ट्रक्चरल ग्लेज़िंग सिस्टम के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR STRUCTURAL GLAZING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
0	03.03.23	ISSUED AS STANDARD SPECIFICATION	SANDEEP	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing and Materials
AAMA	:	American Architectural Manufacturers Association
BS	:	British Standard
BIS	:	Bureau of Indian Standards
EN	:	European Standards
EPDM	:	Ethylene propylene diene monomer
IS	:	Indian Standards
NBC	:	National Building Code of India
NFPA	:	National Fire Protection Act
PVDF	:	Polyvinylidene Fluoride
RCC	:	Reinforced Cement Concrete
SS	:	Stainless Steel
SHGC	:	Solar Heat Gain Coefficient
UV	:	Ultra Voilet
WWR	:	Window Wall Ratio
VLT	:	Visual Light Transmittance

Architecture Standards Committee

Convenor: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumdar (Strl)
Mr. Charanjit Singh (Proj.)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 04

2.0 REFERENCES 04

3.0 MATERIALS 05

4.0 DESIGN AND DETAILING OF STRUCTURAL GLAZING SYSTEM 08

5.0 FABRICATION, PROCURMENT & TRANSPORTATION 09

6.0 INSTALLATION 09

7.0 DELIVERABLES BY THE CONTRACTOR 10

8.0 TESTING 10

9.0 WARRANTY 11

Copyright EIL – All rights reserved

1.0 GENERAL

This Specification covers requirements of the semi-unitized and unitized Curtain wall Structural Glazing System of buildings. This specification shall be read in conjunction with project specific job specification.

2.0 REFERENCES

The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document title
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
ASTM E 331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
AAMA 501.1	Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure.
AAMA 501.4	Recommended static testing method for evaluating curtain wall & storefront systems subjected to seismic & wind induced inter story drift.
AAMA 501.2	Quality assurance & Diagnostic Water leakage field check of Installed storefronts, curtain walls, and sloped glazing systems.
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
BS 1474	Specification for Wrought Aluminium and Aluminium Alloys for General Engineering Purposes: Bars, Extruded Round Tubes and Sections.
BS 4255	Rubber Used in Preformed Gaskets for Weather Exclusion from Buildings - Part 1: Specification for non-cellular gaskets.
EN 573 -3	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 3: Chemical composition and form of products.
EN 13501-1	Fire classification of construction products and building elements - Part 1
IS 3400	Methods of Test for Vulcanized Ruber
IS 8183	Bonded Mineral Wool - Specification
IS 15601	Automotive Vehicles – Flammability requirements
ISO 868	Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness).

Copyright EIL – All rights reserved

3.0 MATERIALS

3.1 Aluminium Extrusions

3.1.1 Aluminium alloy extrusions, sections and profiles such as Transom, Transom Connector, Mullion, Mullion Sleeve, Glazing insert, Toggle cleat, Pressure plate, Pressure cap, Aluminium bracket, etc. shall be made of Aluminium alloy and temper 6063 T5 or T6 grade as per BS 1474 or EN AW 6060 T66 conforming to EN 573 part-3 as mentioned in drawings, item descriptions or job specifications.

If not mentioned specifically, they shall be made of Aluminium alloy and temper 6063 T5 or T6 grade as per BS 1474.

3.1.2 All extruded aluminium sections exposed to outside environment shall be anodized in approved color to a minimum thickness of 20 microns or shall be PVDF coil / spray coated in approved colour and shade with metallic colours to a minimum thickness of 35 microns as mentioned in drawings, item descriptions or job specifications.

If not mentioned specifically they shall be PVDF coil / spray coated in approved colour and shade with metallic colours to a minimum thickness of 35 microns.

3.1.3 The colour and the finish shall be uniform and free of streaks. The aluminium sections, before coating, shall be suitably cleaned, rinsed, buffed properly and sealed and protected after anodizing / PVDF coating, till the completion of the work.

3.1.4 The members of aluminum extruded sections for mullions, transoms, members of sub frames & sash frames shall be in single piece. Jointing of pieces in length and height shall not be permitted excepting the cases where the required length is more than maximum length as manufactured.

3.2 Glass

3.2.1 The infill glazing panel shall be factory made glazed unit of size, thickness and type and in compliance with climatic zones, vertical fenestration requirements (as mentioned below) for all three incremental energy efficiency levels, i.e. ECBC, ECBC+, and Super ECBC as mentioned in drawings, item descriptions or job specifications.

a) Maximum allowable Window Wall Ratio (WWR) is 40% (applicable to buildings showing compliance using the Prescriptive Method, including Building Envelope Trade-off Method)
b) Minimum allowable Visual Light Transmittance (VLT) is 0.27
c) Assembly U-factor includes both frame and glass area weighted U-factors.

Vertical Fenestration Assembly U-factor and SHGC Requirements for ECBC Buildings in various climates:

	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U-factor ($W/m^2.K$)	3.00	3.00	3.00	3.00	3.00
Maximum SHGC Non-North	0.27	0.27	0.27	0.27	0.62
Maximum SHGC North for latitude $\geq$ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.27	0.27	0.27	0.27	0.62

Copyright EIL – All rights reserved

Vertical Fenestration U-factor and SHGC Requirements for ECBC+ buildings and Super ECBC buildings in various climates:

	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U-factor (W/m².K)	2.20	2.20	2.20	3.00	1.80
Maximum SHGC Non-North	0.25	0.25	0.25	0.25	0.62
Maximum SHGC North for latitude ≥ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.25	0.25	0.25	0.25	0.62

3.2.2 However, as a minimum requirement, glass shall be toughened type and 6mm thick.

3.3 Gaskets

3.3.1 Gaskets and seals shall be of approved quality compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be silicon gaskets, which are UV resistant. They shall not degenerate, discolour or leach on exposure to solar radiations/ rains/ pollutants etc.

3.3.2 Gaskets shall have following properties:

Property	Value	Reference code/ standard
Material	Microwave cured EPDM	BS 4255
Performance capability	Temperature range of -40 Deg C to +120 Deg C	-
Fire resistance (Horizontal burning)	Not exceeding 35 mm/Minute	IS 15601
Fire resistance (Vertical burning)	Not exceeding 15 mm/Minute	IS 15601
Heat stability, mechanical properties etc	Compliance with reference code/ standard	IS 3400
Ozone resistance	Passing the test for 200 hours	-

3.4 Sealants

3.4.1 Sealants shall be in conformity with the performance requirements specified in job specification etc. as per the recommendations of the sealant manufacturer and as approved by the Engineer-In-Charge.

3.4.2 Structural sealant

The silicone bite for the structural sealant shall be designed for the design loads as specified and likely to come during the life of the curtain glazing system. It shall be two part pump-filled Silicone sealant.

Copyright EIL – All rights reserved

3.4.3 Weather sealant

Weather sealant shall be Non bleeding and non staining type silicone sealant having minimum tearing strength of 4.00 N/ mm and shore A hardness of 24 (as/ ISO 868) as approved by the Engineer-In- Charge.

3.5 Fire smoke seal

Smoke seal/fire stop using extruded aluminum channel with cap shall be provided for continuous structurally glazed framing system. The thickness of channel shall be 2 mm and material and coating finish shall be similar to extruded profile section as per clause no. 3.1.

3.6 Insulation on spandrel panel

Insulation on spandrel system shall be 50 mm thick semi-rigid fibre glass wool insulation panel of minimum density of 48 kg per cubic metre conforming to IS 8183 and 1.5 mm thick anodized (10 microns) solid aluminium sheet tray by using suitable stainless steel rivets/ nuts, bolts and washers to hold the insulation panel in position.

3.7 Flashing

All flashings shall be made from minimum 1.0 mm thick solid aluminium sheet anodized to a minimum thickness of 10 microns. It shall be fixed using stainless steel screws dipped in weather silicone sealant or by welding,

3.8 Aluminium decorative capping

Aluminium decorative capping etc. shall be made out of extruded profile section and material and coating finish per clause no. 3.1 and as per approved design.

3.9 Brackets/supports

The brackets shall have suitable lengths and sections to align curtain glazing in one face, as required as per the Architectural drawings. The brackets shall be fabricated from M.S rolled sections / plates to have the design strength. The quality of the weld shall also be ensured as per the standards. These shall be provided corrosion protection treatment by Hot Dipped Galvanizing. The mass of the zinc coating to be not less than 610 gm. per sqm of steel area to be galvanized.

Each bracket shall be fixed to the R.C.C using anchor fasteners of suitable capacities and in numbers as required as per the design requirements. The brackets shall be fixed to the structural steel members of the building using stainless steel bolts & nuts / fasteners of required capacity and in numbers as per the design requirement.

3.10 Fasteners

Bolts, anchors and other fastening devices like screws, nuts, washers etc. shall be of stainless steel and of approved types as required for the strength of the connections, shall be self-locking, unless otherwise specified.

Anchor fasteners shall be of stainless steel grade 316. Screws, Nuts, Bolts, Washers shall be of stainless steel grade 304. Rivets, toggles and the like shall be of stainless steel grade 304.

Copyright EIL – All rights reserved

3.11 Fittings

All hardware and fittings such as patch fittings, handles, locks, stay-arms, floor springs, friction stays etc. for doors , windows and open able panels shall be of heavy duty type and of approved make as specified.

Hinges for open able panels shall be heavy duty top hung stainless steel friction hinges selected for specified wind load and dead loads.

3.12 Others

Other materials not mentioned above shall be in accordance with the detail design and specification of the system prepared by the Contractor and approved by Engineer- In- Charge.

4.0 DESIGN AND DETAILING OF STRUCTURAL GLAZING SYSTEM

4.1 Design, structural analysis and detailing including preparation of fabrication drawings of the complete system shall be done by the Contractor or agencies engaged by the Contractor subjected to approval by the Engineer- In- Charge.

4.2 The design and detailing shall be in accordance with the drawings, requirements of this specification and other requirements issued by Engineer-In-Charge for the purpose.

4.3 Design shall also include structural analysis and design of the supporting frame work in accordance with relevant Indian or International codes as mentioned or as agreed by the Engineer-In-Charge considering stability, durability, water tightness and other design conditions.

4.4 Contractor or agency engaged by him shall do and submit all necessary structural analysis, calculations and prepare all detailed fabrication drawings for approval by the Engineer-In-Charge.

4.5 The system shall consist of structural framing and supporting system to support glazed/non glazed panels including transoms, mullions, vision panels and spandrel panels, openable top hung window, swing glazed doors, decorative capping, fire & smoke seal, flashing including gaskets, sealants, fasteners, brackets, necessary fittings & accessories as part of the system in accordance with approved design and drawings.

4.6 The System shall be designed for maximum design wind pressure and lateral forces, moments, stresses, deflections, thermal expansion, weather resistant etc. (test pressure equivalent to 1.5 time the maximum design wind pressure) considering stability, durability, water tightness and other design conditions.

4.7 The System shall be designed with air pressure equalization chamber and concealed continuous gutter vertically and horizontally at all levels as self drainage barrier to achieve water tightness besides providing EPDM gaskets on the frame and EPDM gasket/ sealant on the external groove as air and water barrier.

4.8 The system shall be designed to meet the requirements of thermal performance.

4.9 The system shall be aesthetically pleasant and in accordance with approved design.

Copyright EIL – All rights reserved

5.0 FABRICATION, PROCURMENT & TRANSPORTATION

5.1 Fabrication including procurement & transportation of all material shall be done in accordance with the approved system design, detailing & drawings and requirements the specification (s).

5.2 Before fabrication, Contactor or agency shall conduct the site survey prior to and after preparation of shop drawing and accommodating the site conditions in the system at appropriate levels etc shall lies solely with the agency executing the work.

5.3 Before the fabrication and site installation is taken up and after the approval of shop drawings by the Engineer-in-Charge, a mock-up of the system shall be prepared by the Contractor. The mock-up shall be essentially put up at site for final approval of all materials and installation details by the Engineer-in-Charge. It shall be dismantled and taken away by the contractor as directed by the Engineer-in-Charge.

5.4 The system shall be erected on extruded main frame & transom fixed on supporting system at site. The panels shall be supplied and fabricated with the specified glass on the secondary frame at factory.

5.5 Factory made glazing units /components shall be transported , handled, stored in a manner to prelude damage of any nature.

5.6 All materials delivered to site shall be stored in allocated spaces where it shall not be exposed to rainwater, moisture or damage. All Material shall be stored neatly and properly handled . Defective/damaged components shall be replaced by contractor.

6.0 INSTALLATION

6.1 Installation of the complete system shall be done by agency approved by the Engineer-In-Charge.

6.2 Installation shall be done in accordance with approved design and drawings.

6.3 The finished surface shall be true to the plane and water-tight. The lines of panels shall be truly aligned in the continuity or as per drawings.

6.4 The aluminium profiles of framework shall be fixed to building structure and background surface by means of fasteners as per approved design and drawing.

6.5 Nylon/ inert polymeric material separators shall be provided to prevent bi-metallic contacts in the system.

6.6 Transom connectors shall be fixed to the mullions using screws/ other suitable method as recommended by the system supplier. Mullion Sleeve shall be used in mullion-mullion joints.

6.7 Glazing gaskets shall be installed and compressed into the cavity as applicable.

6.8 The glazing panels shall be cut to size and shape, routed. Glass shall be fixed using pressure plate (with gaskets)/ any other approved vendor detail on horizontals and verticals. There shall be provisions of Horizontal and Vertical Capping as per the design intent.

6.9 The gaps (12 – 20 mm) in between the panels shall be uniform in width.

6.10 The gaps upto 10 mm between the peripheral panels and backing surface shall be sealed by inserting adequately sized backer rod and weather sealant. Gaps more than 10 mm shall be

Copyright EIL – All rights reserved

sealed by providing and fixing of 2 mm thick aluminium sheet (finished with 60-8- micron thick super durable polyester coating) flashing profiled as per site requirement.

6.11 The cover caps shall be clipped on to the pressure plates and secured by screws where recommended by manufacturer.

6.12 The termination of the panels shall be suitably detailed and executed using flashing, bending/ continuing the panels etc. for stopping water ingress.

6.13 All the joints in aluminium framing system and factory glazed panels shall be fully sealed and made air, water and weather tight preventing seepage of rain water under heavy wind pressures.

6.14 Gap between the building face and structural glazing system at soffit level between the successive floors shall be closed with required fire rated fire stop cum smoke seal.

6.15 After the installation is completed, panel surfaces shall be cleaned with soft dry cotton cloth.

7.0 DELIVERABLES BY THE CONTRACTOR

With regards to documents and drawings, the Contractor shall furnish following deliverables:

1. Structural analysis and calculations
2. Fabrication or shop drawings
3. Test certificates in support of compliance with the specifications.
4. Samples for materials, components, accessories.
5. Product data sheets, installation & maintenance manuals.
6. Mock-up of complete structural glazing system including glass depicting all important components
7. U-Value Calculation for the proposed Glazing.
8. U-Value (composite) calculation for the proposed structural glazing system including glazing and framework.
9. Report on Stability analysis of Glazing panel of all sizes.

8.0 TESTING

The following performance tests are to be conducted on structural glazing system if area of structural glazing exceeds 2500 Sqm from the certified laboratories accredited by NABL (National Accreditation Board for Testing and Calibration Laboratories) or Department of Science & Technologies, India.

1.	Performance Laboratory Test for Air Leakage Test (-50pa to -300pa) & (+50pa to + 300 pa) as per ASTM E-283-04 testing method for a leakage limit of 1 to 200 mVhr.
2.	Static Water Penetration Test (50 pa to 1500 pa) as per ASTM E -331-09 testing method for a range up to 2000 ml.
3.	Dynamic Water Penetration (50 pa to 1500 pa) as per ASTM E -331-09 testing method for a range upto 2000 ml.
4.	Structural Performance Deflection and deformation by static air pressure test (1.5 times design wind pressure without any failure) as per ASTME-330-10 testing method for a range upto 50 mm.
5.	Seismic Movement Test (upto 30 mm) as per AAMA 501.4-09 testing method for Qualitative test. Tests to be conducted at site.
6.	Onsite Test for water leakage for a pressure range 50kpa to 240 kpa (35psi) upto 2000ml.

Copyright EIL – All rights reserved

9.0 WARRANTY

The complete structural glazing system including Glazing, framework, sealants, fittings and fixtures and all components shall be warranted by the Contractor for a period of 10 years. Any defective work or material found within this period shall be repaired/ replaced/ re-done by the Contractor at his own cost. In case of any damage, water leakage etc. due to deficiencies in design, materials and workmanship, the contractor shall replace or rectify the damaged works at his own cost to the acceptance of approving authority.

Copyright EIL – All rights reserved

उपस्कर एवं यंत्रों की स्थापना हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	30.03.2019	Reaffirmed & Reissued	RJ	MI	RP	RKT
3	21.01.2013	Revised & Reissued	MA	RS	VK	DM
2	03.09.2008	Revised & Reissued	DM	PKR	AA	VC
1	30.05.2008	Revised & Reissued	DM	PKR	AA	VC
0	25.04.2001	Issued as Standard Specification	DM	AM	MR	MI

Copyright EIL – All rights reserved

Abbreviations:

ASME	:	American Society of Mechanical Engineers
EC	:	Erection Contractor
EIC	:	Engineer-in-charge
ELCB	:	Earth Leakage Circuit Breaker
GAD	:	General Arrangement Drawing
IS	:	Indian Standard
NDT	:	Non Destructive Testing
SS	:	Stainless Steel

General Engineering Standards Committee

Convenor : Ms R Priyamvada

Members : Mr BR Bhogal (Elect.)
Mr Rajan Srivastava (Strl.)
Mr RB Bhutda (EWS)
Mr Amrendra Kumar (Piping)
Ms NP Guha (Projects)
Mr Amit Prakash (FEM)
Mr KJ Harinarayanan (SME)
Mr VK Tonger (Process-1)
Mr Satyabrata Biswas (Process-2)

Copyright EIL – All rights reserved

CONTENTS

1.0 SPECIFICATION FOR ERECTION OF EQUIPMENT AND MACHINERY 4

2.0 ERECTION OF COLUMNS, TANKS, VESSELS AND DRUMS ETC. 5

3.0 ERECTION OF MECHANICAL EQUIPMENT 8

4.0 HEAT AND MASS TRANSFER EQUIPMENT 10

5.0 ERECTION OF ROTATING EQUIPMENT 16

6.0 EQUIPMENT GROUTING 19

7.0 REFERENCE EIL STANDARDS/ SPECIFICATIONS 22

Copyright EIL – All rights reserved

1.0 SPECIFICATION FOR ERECTION OF EQUIPMENT AND MACHINERY

1.1 Scope

This specification covers technical requirements for erection of all static and rotating equipment by erection contractor at site. This specification is applicable for all the erection tenders operated by EIL.

1.2 General

1.2.1 All necessary handling equipments, tools, tackles and precision instruments for carrying out the works as specified shall be provided by the Erection Contractor (EC) at his cost. EC must provide all tools and gauges for erection and alignment. Special tools, if any, received as part of machinery, will be given to EC for erection purposes, which shall be returned in good condition after use. Suitable deductions will be made by the Engineer-in-Charge (EIC) in case of loss or damage of the special tools. The value of such loss or damage will be decided by the EIC and EC shall be bound by such a decision.

1.2.2 Equipment Manufacturer's recommendations regarding preservation during storage at site and detailed specifications for the installation alongwith layout drawings, general arrangement/equipment outline drawings and sub-assembly drawings of the various equipment and machinery will be provided to EC during the performance of work. The requirements stipulated in these shall be fulfilled by EC in addition to what is stated in this specification. Erection shall be carried out as per the instructions and supervision of Machinery manufacturer's representative, wherever such supervisory services are applicable.

1.2.3 All the items of work covered in the tender shall be carried out as per this Specification and other details to be furnished to EC. However, EIC reserves the right to give additional/alternative specifications and instructions, at any time, for execution of any particular work and EC shall execute such works in accordance with such additional/alternative specifications and instructions of the EIC. Such a step taken by the EIC shall not constitute a breach of the contract.

1.3 Preparation for Erection

1.3.1 EC shall be responsible for organising the lifting of the equipment in the proper sequence, so that orderly progress of the work is ensured and access routes for erecting the other equipment are kept open.

Rigging procedure for all the major lifts (above 10 MT) and at maximum crane capacity shall be submitted by EC for the approval of EIC. However, approval to rigging procedure proposed by EC shall not relieve EC from his responsibility in following the proper lifting/erection methods on ensuring orderly.

1.3.2 Orientation of all foundations, elevations, length and disposition of anchor bolts and diameter of holes in the supports saddles shall be checked by EC, well in advance. Minor rectifications including chipping of foundations as the case may be, shall be carried out by EC after obtaining prior approval of EIC. EC shall also be provided with the necessary structural drawings and piping layouts etc. wherever required for reference. EC shall crosscheck such piping and structural drawings with actual construction at site and in case of any mismatch inform the EIC before taking up the erection.

Copyright EIL – All rights reserved

1.3.3 During the performance of the work, EC shall keep structures, materials or equipments adequately braced by guys, struts or otherwise approved means which shall be supplied and installed by EC as required till the installation work is satisfactorily completed. Such guys, shoring, bracing, strutting, planking supports etc. shall not interfere with the work of other agencies and shall not damage or cause distortion to other works executed by him or other agencies.

2.0 ERECTION OF COLUMNS, TANKS, VESSELS AND DRUMS ETC.

2.1 Scope of work of Erection Contractor

(a) Preparation of erection scheme and rigging procedure and obtaining its approval from EIC wherever necessary.

(b) Withdrawal of equipments from Owner's storage point, checking and reporting its conditions, transporting the same to EC's stores of work site including unloading etc.

(c) Erection on foundations furnished by Owner including aligning, levelling and grouting.

(d) Assembly and fixing of demisters, grids, internal distributors and other internal fittings in Columns, Vessels etc.

(e) Filling of Columns, Reactors, Vessels/ Drums etc. with Raschig rings, supporting elements, sand, concrete etc. as required.

(f) Welding of washers for equipments, erection of pipe davit & minor welding of their parts as per specifications and instruction of EIC.

(g) Assembly & erection of Agitator (Mixer) along with drive unit (Motor) including all accessories for vessels/drums/reactors (wherever indicated) as per specification drawings & instructions of EIC.

(h) Flushing, cleaning and drying of Columns, Vessels/Drums etc.

(i) Completing the equipments in all respects for commissioning the plant as per drawings, specifications & instructions of EIC.

(j) Any modification in the erected Columns, Reactors, Vessels/Drums to the complete satisfaction of EIC.

2.2 General Conditions of Erection

2.2.1 Unless otherwise specified Columns, Vessels, Drums etc. will be generally supplied to the Erection Contractor in single piece and EC will not be required to carry out any assembly or welding. In case column is supplied in multiple pieces and erection of the equipment is not possible in single piece, EC shall be responsible for lifting the pieces, for aligning, welding and hydrotest etc. in vertical position under the supervision of column Supplier (Fabricator). However, EIC shall be responsible for coordination between Erection Contractor & Fabricator. The schedule of quantities (SOQ) for equipment erection enclosed with the tender document outlines details of each equipment such as diameter, overall height, type of support (saddle/skirt/leg/bracket), position (horizontal or vertical) and approximate erection weight etc. However the erection elevation and location of equipment shall be as per the piping layout drawing enclosed with the tender.

Copyright EIL – All rights reserved

2.2.2 Rigging procedures and erection schemes for all the heavy lifts weighing 10 MT & above shall be prepared by EC and got approved by EIC. Approval by EIC shall not relieve EC of his responsibilities. The details to be submitted will include the location of equipment from where it will be lifted, location of crane(s), details of crane(s) (like configuration, boom length, operating radius, boom point elevation, clearance underside the boom and the equipment, lifting capacity, counter weights to be deployed, holds on any neighbouring foundations, structures, equipments etc.), the load chart of the crane(s), design of the lifting tackles like spreader beam, D-shackles, wire rope slings etc. Unless the erection scheme and rigging procedures are approved by EIC, erection of such equipments shall not be undertaken in any case by EC.

2.2.3 Before starting the erection of Columns, Vessels etc., top surface of the foundations is to be cleared/chipped, roughened to obtain proper bond, while grouting. Also the sleeves are to be cleaned before erecting the equipments. Line (orientation) and levels are to be marked on all the foundations to facilitate checking of alignment.

EC shall also check the correct elevation and orientation of civil, structural foundations, before proceeding with the erection work. Discrepancy, if any, shall be brought to the notice of EIC. However, minor rectifications and chipping of foundations upto a thickness of 15 mm in foundation height shall be carried out at no extra cost, by the EC. EC shall be responsible for supply of levelling plates, (if required) and shall carry out levelling of equipment under the directions of EIC.

2.2.4 While handling, transporting or erecting the equipments, care shall be taken not to damage the nozzles, instrument connections, structural clips etc. EC shall also take care of the orientation of the nozzles and other connections of the equipments while erecting the same and ensure compliance with the drawings and specifications supplied. Discrepancy, if any, in the number/orientation of the nozzles, cleats etc. should be brought to the notice of the EIC before actual erection is started.

2.2.5 Verticality of the Columns, Reactors/Vessels shall be checked with theodolites. After erection the equipment shall be levelled and properly aligned with necessary shims and wedges supplied by EC, at his cost. After the level, alignment and verticality etc. are checked and approved by EIC, EC shall carry out grouting.

2.2.6 EC shall produce recent test certificates of the slings which they will be using for erection work. However, retesting of the slings shall be done at site by EC at his cost, as and when required by EIC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by EC at his cost. Tested slings will be punched for test loads and date of testing as directed by EIC.

2.2.7 EC shall also carry out the assembly, erection, levelling and alignment of all types of weir plates, baffles, distributors, collectors, spray nozzles, demisters, grids and other internal fittings etc. Work shall be carried out as per manufacturer's standards/specifications which shall be made available to EC at the time of erection. Raschig rings, molecular sieves, intalax saddles packing and other types of tower packings such as sand, catalyst etc. and SS wire mesh shall be loaded into sections of Vessels, Columns as per specifications and drawings. Details for internals to be installed by EC shall be as per separate schedule of quantities enclosed with the tender document. All packings except clay and lime stone shall be washed with water before filling. Bottom layers, if required, shall be arranged as directed and random filling shall be done afterwards with equipment filled with water. Installation of packings, shall be done only after flushing and cleaning of Columns/Vessels and completed to the satisfaction of EIC.

Copyright EIL – All rights reserved

2.2.8 EC shall carry out minor welding for attachment of prefabricated pipe davit parts such as rain covers, handles etc. with pipe davit, during or after erection of the same as per the manufacturer's specifications, at no extra cost to the Owner.

2.2.9 EC shall execute erection of wooden pillow for saddle support for cold horizontal vessels wherever necessary as indicated on the drawings/ EIL STD 7-12-0003 and as per the instructions of EIC.

2.2.10 EC shall execute assembly & erection of agitator/mixer along with drive unit including all accessories as per supplier's instructions, specification drawings & instructions of EIC.

2.3 Flushing & Cleaning of Columns, Vessels, Drums etc.

2.3.1 After the erection, alignment and grouting of these equipments are complete, flushing and cleaning shall be carried out by EC as per specifications and instructions of EIC.

2.3.2 After flushing, cleaning and draining, equipments shall be dried by compressed air at the pressure and for duration decided by the EIC. The Vessel interior shall be thoroughly inspected to the complete satisfaction of EIC before it is finally boxed up. Boxing up of manholes and handholes shall be leak proof. All joints which need remaking, shall be remade. Compressed air for drying shall be arranged by EC.

2.4 Inspection and Acceptance Limits for Level and Alignment

2.4.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by EC.

2.4.2 Before equipments are placed on foundations, orientations shall be checked with respect to piping drawings.

2.4.3 When equipments are firmly bolted down but prior to grouting, verticality of all the Columns, vertical vessels etc. shall be checked by using theodolite. Tolerances for equipment after erection shall be as per EIL Standard 7-12-0001. The allowable deviation from plumb line shall be 1 mm per metre height, subject to maximum of 15 mm unless otherwise stated on the drawings.

2.4.4 Horizontal Vessels shall be checked for level across machined face of nozzle flanges with precision level.

2.5 Additional requirements for Underground buried vessels

2.5.1 **Underground vessels for operating temp upto 60°C**

The vessels shall be supplied at site with one coat of inorganic zinc silicate primer duly applied on its external surfaces as per Spec. 6-79-0020. All other works such as application of coaltar enamel, as per EIL Spec. 6-79-0020 and wrapping and coating as per EIL Spec. 6-79-0011 shall be carried out by EC. This shall include necessary materials, tools and tackles to complete the Job in all respect as per the instructions of EIC.

2.5.2 **Underground Vessels for operating temp. Above 60°C and upto 300°C**

The vessels shall be supplied at site with one coat of inorganic zinc silicate primer as per Spec. 6-79-0020 duly applied on its external surfaces. EC shall be required to carryout touch-up and repair of outside primer before erection of equipment.

Copyright EIL – All rights reserved

2.5.3 EC shall do the necessary excavation, backfilling and removal of surplus earth at the site as per the directions of the EIC. EC's rate shall include the excavation, blast cleaning, painting, wrapping by kraft paper, placing and fixing of Vessels, backfilling and removal of excess earth.

3.0 ERECTION OF MECHANICAL EQUIPMENT

3.1 Scope of Work of Erection Contractor

The scope of EC shall consist of withdrawal and transportation of equipments and accessories from Owner's stores to site, assembly of loose supplied components/parts erection of equipment on foundations, levelling, aligning and grouting, preparation of equipments for trial runs and hand over in fit condition for the start up of the plant as per instructions of EIC.

3.2 Details of Owner Supplied Equipments

Equipments to be erected shall be supplied by the owner. Equipments may be supplied in any of the following conditions.

- Single equipment such as filter, static mixer, silencer etc.
- Skid mounted equipment, fully assembled.
- Skid mounted equipment with some items supplied loose or as subassemblies involving interconnections also.
- System comprising of many equipments, skids with interconnected piping & hook up.

3.3 Technical Requirements

3.3.1 All equipment/machinery erection shall be done by experienced fitters. For this purpose EC shall employ an experienced erection supervisor and crew who have done similar jobs.

3.3.2 EC shall study the layout drawings, for the machineries and equipments with their auxiliaries, controls defining scope of supply.

3.3.3 Equipments shall be checked for any damages as a result of transport, handling and defects, if any, shall be reported to the EIC. Rectification of defects shall be carried out in accordance with approved procedure.

3.3.4 Correct procedures for handling of equipment & installation on the foundation shall be followed as given in the manufacturer's manual. In case of non-availability of such procedures, EC shall develop & submit handling procedures for all equipment weighing more than 10 metric tonnes. The handling procedure shall be approved by the EIC.

3.3.5 EC shall check the correctness of equipment foundations or supporting structures as per the drawings. Equipment/Skid foot print dimensions shall be verified to match with the foundation. Minor chipping of foundation, pockets if required shall be carried out by EC.

3.3.6 All accessories like pressure gauges, seal oil, cooling water & Lube oil headers etc., shall be tagged and separately kept in Contractor's stores till erection. All flanged connections and openings shall be kept blanked with dummies, plugs to prevent entry of foreign particles.

3.3.7 Equipments shall be installed on the foundations in proper sequence. Incase the equipments are delivered in subassemblies, EC shall do the assembly work as per manufacturer's instructions.

3.3.8 Equipments shall be installed in the correct orientation and alignment.

Copyright EIL – All rights reserved

3.3.9 After installation and levelling the equipment shall be grouted with the specified grouting applied to the baseplate and support.

3.3.10 EC shall remove all the packing and protective devices used during transport and handling from the equipment such as shock absorbent materials from machined faces, blocking of shafts or rolling bearings & restraining devices from instruments, safety devices and protective equipments.

3.3.11 After the grouting is set & cured, the foundation bolts shall be checked to make sure that they are in straight and vertical position and properly tightened. Shims, if used, shall be on either side of the foundation bolts.

3.3.12 Desiccant, catalyst where supplied loose shall be loaded on to the respective vessels in specified quantities as per the suppliers instructions.

3.3.13 Internals, where supplied loose shall be assembled as per the drawings and manufacturer's instructions.

3.3.14 Unless otherwise specified, all the instruments such as pressure gauges, sight glasses temperature recorders etc. including instrument panels, if any, supplied along with the equipment with necessary connections, shall be installed by EC as part of Equipment erection.

3.3.15 Equipments shall be checked for final cleanliness before boxing up.

3.3.16 Any interconnected piping & ducting shall be properly installed and supported. EC shall connect the gas, steam, air, utility piping, instruments, oil piping etc. as per manufacturer's drawings, specifications and instructions of the EIC.

3.3.17 Safety devices shall be correctly installed.

3.3.18 Ladders, platforms, walkways shall be correctly installed with handrails, and flooring shall be properly secured.

3.3.19 Field welding, where specified shall be in accordance with the specified procedures and NDT tests where specified shall be carried out. Results of NDT tests shall be recorded.

3.3.20 Equipment alignment & couplings shall comply with tolerances specified in manufacturer's drawings and manuals. Provisions of dowel pins or similar arrangements for retaining the alignment shall be carried out.

3.3.21 After the piping has been connected, the alignment shall be checked by EC again, to ensure that piping connections do not induce any undue stresses on the Equipments. After making necessary corrections on the piping, if any, realignment shall be done by EC to ensure that no undue stresses are induced on the equipment.

3.3.22 Painting, insulation & fireproofing where specified shall be carried out in accordance with the applicable specifications attached in the tender document.

3.3.23 Any alterations, deviations made during equipment erection with respect to manufacturer's drawings or instructions shall be duly recorded and approval shall be taken from the EIC.

3.3.24 Any special tools, tackles supplied along with the equipment and used during installation shall be returned to the stores through the EIC.

3.3.25 Any protection of the equipment after installation, if required shall be carried out in accordance of the instructions of the EIC.

Copyright EIL – All rights reserved

3.4 Trial Runs

3.4.1 Wherever specified, Machinery & Equipment erected & installed by EC under the supervision of Machinery/Equipment supplier shall be subjected to trial runs in accordance with clause 5.4 of this specification. Job specific trial run procedure, if specified, supersedes the trial run procedure as described in clause 5.4.

3.5 System Start-up

During this phase of work, EC shall provide as part of his work necessary skilled personnel as per requirement of EIC. Any defects noticed in the Equipment shall be made good by EC at his cost if such defects are attributable to him.

4.0 HEAT AND MASS TRANSFER EQUIPMENT

This section covers the minimum requirements for erection of the following equipment by the EC.

- Deaerator
- Trays/ Tower Internals and Tower Packings
- Separators and Internals
- Shell and Tube Heat Exchangers
- Double Pipe Exchangers
- Electric Heaters
- Plate Exchangers
- Plate Fin Exchangers
- Sulphur Recovery Unit Equipment like Combustion Chambers, Waste Heat Boilers, Sulphur Condensers, Incinerators, Burners, Etc.
- Waste Heat Recovery Units
- Desalters
- Vacuum Ejectors
- Ejector Condensers

4.1 Scope of Work of Erection Contractor

4.1.1 Preparation of erection scheme and rigging procedure and obtaining its approval from EIC wherever necessary.

4.1.2 Withdrawal of equipment from Owner's storage point, checking and reporting its conditions, transporting the same to EC's stores and work site including unloading etc.

4.1.3 Preparation of foundation by chipping & installation of base plates for foundations. Minor rectifications & chipping of foundations up to a thickness of 15 mm due to error in foundation height, shall be carried out by the EC at no extra cost

4.1.4 Before starting the erection, top surface of the foundations are to be cleaned/chipped/roughened to obtain proper bond while grouting. Line (Orientation) & Levels are also to be marked on the respective foundations prior to erection to facilitate checking of alignment.

4.1.5 Supply of necessary shims, levelling plates, wedges, sliding base plate.

4.1.6 Erection on foundations furnished by Owner including aligning, levelling and grouting.

Copyright EIL – All rights reserved

4.1.7 Assembly and fixing of trays, tower internals (distributor, bed limiter, support plate, chimney trays, vapour distributor etc.), demisters, grids, internal distributors and other internal fittings in columns, vessels etc.

4.1.8 Installation of transformers on desalters and their electrical connection to electrode grid etc.

4.1.9 Welding of chimney trays, lattice girders, beams etc. wherever required.

4.1.10 Carrying out minor adjustments, modifications, seal welding of seal plates etc. wherever necessary during installation.

4.1.11 Checking of installed trays & tower internals and filling of installation formats as referred in 6-14-0016.

4.1.12 Filling of columns, vessels/drums etc. with Raschig rings/Pall rings/ Structured packing, as required.

4.1.13 Welding of washers for equipment, erection of pipe davit & minor welding of their parts as per specifications and instruction of EIC.

4.1.14 Hydrotesting of shell and tube heat exchangers if the time gap between last hydrotest is more than six months or in case it is found to be necessary by EIC. Procedure is given in para 4.3 & 4.4 below. EC to note that any equipment which are refractory lined at shop shall not be hydrotested.

4.1.15 Flushing, cleaning and drying of equipment using compressed air and blinding to prevent ingress of rain, dust etc.

4.1.16 Installation of refractory lining, brick lining, ceramic boards etc., as per specifications, recommendations of manufacturer and instructions of EIC.

4.1.17 Mounting of instruments like safety valves, rupture disks, sight glasses etc as required.

4.1.18 Completing the equipment in all respects for the commissioning of the plant as per drawings, specifications & instructions of EIC.

4.1.19 Any modification in the equipment to the complete satisfaction of EIC.

4.1.20 In addition to the above EC may be called upon to do other jobs like rectification of defects etc. as per instructions of EIC.

4.2 General Conditions of Erection

4.2.1 All carbon steel components of trays/tower internals shall be cleaned to remove rust preventive coating.

4.2.2 All welding shall be done by qualified welders only. The electrodes/filler material to be used shall be compatible with the metallurgy of component and shall be used only after prior approval of EIC.

4.2.3 A proposed Welding Procedure Specification (WPS) shall be submitted to EIL/ Owner's Inspector for his approval. On approval, a Procedure Qualification Test (PQT) shall be conducted which shall be witnessed by EIL/Owner's Inspector. On acceptance of all tests as per ASME Section IX, a final WPS along with Procedure Qualification Record (PQR) shall be submitted. Production welding shall start only after approval of final WPS/PQR and

Copyright EIL – All rights reserved

qualification of welders as per ASME Section IX. EIL/Owner's Inspector may accept previously qualified WPS/PQR at his sole discretion.

4.2.4 Lattice girders wherever provided for supporting tray & tower internals have been designed in such a way that various components pass through column manway. Components/parts of lattice girders are to be welded inside the column as per respective drawings. EC shall also ensure that all parts of lattice girder are properly welded & levelness of the lattice girder shall be checked before & after the welding. The limits of levelness as mentioned in GA drawings shall be adhered to.

4.2.5 The rigging procedure shall include the following as a minimum:

Location of equipment from where it will be lifted, location of crane(s), details of crane(s) (like configuration, boom length, operating radius, boom point elevation, clearance underside the boom and the equipment, lifting capacity, counter weights to be deployed, holds on any neighbouring foundations, structures, equipment etc.), the load chart of the crane(s), design of the lifting tackles like spreader beam, D-shackles, wire rope slings etc. Unless the erection scheme and rigging procedures are approved by the EIC, erection of equipment shall not be undertaken in any case by the EC.

4.2.6 While handling, transporting or erecting the equipment, care shall be taken not to damage the nozzles, instrument connections, structural clips, refractory lining etc. EC shall also take care of the orientation of the nozzles and other connections of the equipment while erecting the same and ensure compliance with the drawings and specifications supplied. Discrepancy, if any, in the number/orientation of the nozzles, cleats etc. should be brought to the notice of the EIC before actual erection is started.

4.2.7 After erection, the equipment shall be levelled and properly aligned with necessary shims and wedges supplied by EC, at his cost. After the level, alignment and verticality etc. are checked and approved by EIC, EC shall carry out grouting.

4.2.8 EC shall produce recent test certificates of the slings which they will be using for erection work. However, retesting of the slings shall be done at site by the EC at his cost, as and when required by the EIC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by EC at his cost. Tested slings will be punched for test loads and date of testing as directed by EIC.

4.2.9 EC shall also carry out the assembly, erection, levelling and alignment of all types of weir plates, baffles, distributors, collectors, spray nozzles, demisters, grids and other internal fittings etc. Work shall be carried out as per manufacturer's standards/specifications which shall be made available to EC at the time of erection. Raschig rings/Pall rings/Structured packing, molecular sieves, intalox saddles packing and other types of tower packing such as sand, catalyst etc. and SS wire mesh shall be loaded into sections of vessels, columns as per specifications and drawings. Details for internals to be installed by EC shall be as per separate schedule of quantities enclosed with the tender document. All packing except clay and lime stone shall be washed with water before filling. Bottom layers, if required, shall be arranged as directed and random filling shall be done afterwards with equipment filled with water. Installation of packing, shall be done only after flushing and cleaning of columns/vessels and completed to the satisfaction of EIC.

4.2.10 EC shall carry out minor welding for attachment of prefabricated pipe davit parts such as rain covers, handles etc. with pipe davit, during or after erection of the same as per the manufacturer's specifications, at no extra cost to the Owner.

4.2.11 EC shall install base plate over the sliding end foundation before erection of shell and tube exchangers.

Copyright EIL – All rights reserved

4.2.12 Levelling and plumbness shall be approved by EIC and shall be checked using theodolite before grouting and final finishing of the foundations. The record of the same shall be maintained.

4.2.13 EC to ensure that shell and tube exchangers shall be firmly bolted down to foundations at the fixed end. Further EC to ensure that foundation bolts at the sliding saddle end are at the centre of slotted holes & nuts at sliding end are only hand tightened. Projected bolt threads shall be properly protected by application of grease etc. to avoid rusting and for facilitating free movement of nuts.

4.2.14 EC shall ensure that no equipment is subjected to any corrosion during any stage during his period of work till handling over to EIC/Client.

4.2.15 Instruments, as required, shall be mounted by EC. On instructions of EIC, EC shall also remove and hand over the instruments to EIC for calibrations. During this period, EC shall cover all openings to protect the equipment.

4.2.16 Before transportation to site, EC shall check and report to EIC on the condition of equipment, specifically highlighting the nitrogen pressure indicated in the nitrogen gauges and the absence of blinds on any of the nozzles.

4.2.17 In case the shell and tube exchangers are to be stacked, but have been stored as single shells at the store, then EC shall erect the bottom most shell, then erect other shell(s) sequentially using the nozzle gaskets/bolting and saddle bolting supplied by owner. Additional shims, if necessary, shall be supplied by EC. If the exchangers do not have interconnecting nozzles, then nozzle elevations shall be maintained as per piping GAD.

4.2.18 All equipment, consumable and other accessories required for completion of the job shall be arranged by the EC. This would include but not limited to cranes, tools and tackles, manpower etc; machinery for cutting, grinding , drilling etc. of base plates; instruments like dumpy level, plumb lines, Engineer's levels, precision levels, theodolite, straight edges etc. for checking the alignment/erection accuracy, hydrostatic testing pumps, potable water for hydrotesting, necessary materials including making the arrangements for hydro-testing, hoses, compressed air supply, pressure gauge, sealing taps, blinds, shims and wedges for alignment etc.

4.2.19 EC shall execute the erection of wooden pillows for saddle supports for cold equipment as indicated in schedule of quantities, EIL standard 7-12-002 and instructions of EIC.

4.2.20 For bought out items like plate exchangers, plate fin exchangers, electric heater, etc. vendor's instructions shall be followed.

4.2.21 For erection of piping of ejector system, EC shall follow relevant erection specification of piping for the project.

4.2.22 EC shall check the health of the equipment refractory lined at shop on receipt and shall report any defect or damage in the same to EIC. During installation all precautions shall be taken to avoid any damage to refractory lining. Any damage to refractory during erection shall be repaired by EC at his own cost without loss of time.

4.2.23 Wherever equipment with refractory are bolted or welded at the girth joints, the gaps between the refractory shall be suitably filled with ceramic fiber of suitable grade as given in the drawings or other relevant documents of the equipment.

4.2.24 Refer section 1.0 (General) for additional requirements.

Copyright EIL – All rights reserved

4.3 Hydrotesting of Shell and Tube Exchangers including Condensers

4.3.1 These shall hydrotested at site using potable water. Hydrotesting of both shell and tube sides shall be carried out as per procedure given below or as per instructions of EIC. For exchangers fitted with SS bellow or SS part, potable water with max. 25 ppm chlorides shall be used for hydrotesting.

4.3.2 Suitable pump set, piping, test pressure gauges and other instruments, water-hoses, temporary gaskets, metallic blinds, bolts, nuts, consumable and other temporary arrangements and equipment for testing shall be provided by the EC at his cost. Test pressure gauges shall be calibrated by the EC and got approved from EIC.

4.3.3 Stacked exchangers shall be hydrotested in stacked conditions.

4.3.4 Test pressure shall be as indicated in the name plates mounted on each exchangers. Duration of hydrotest shall be at least one hour. Test pressures and duration of hydrotest may be reduced by EIC. Minimum test water temperature shall be 20°C.

4.3.5 Any defects noticed during hydrotesting shall be repaired by EC as per the procedure approved by EIC. Cost for rectifying defects, not attributable to the EC shall be paid separately.

4.3.6 No equipment shall in general form part of the piping loop during hydrotesting and shall be blinded off, except when instructed otherwise by EIC.

4.3.7 EC to take adequate care during pressurising & depressurising the equipment. EC shall also take care of any instruction given regarding hydrotest in the exchanger drawing.

4.4 Hydrotesting Procedure

4.4.1 Shell side & tube side shall be hydrotested separately, unless specified otherwise. If both sides are to be tested together, a warning plate would be fixed to the exchanger, and the instructions given therein are to be followed.

4.4.2 The side, shell or tube which ever to be tested at higher pressure shall be taken first.

4.4.3 During hydrotest all gasket joints should be checked for any leakage. In case of leakage from any gasket joint, bolting at that joint shall be further tightened following proper tightening sequence (bolts should not be overtightened or tightened by hammering). In case it is not possible to stop leakage by bolt tightening, drain the water in exchanger & replace gasket at that joint by new gasket (gasket will be supplied by owner). After replacing gasket exchanger must be again hydrotested with same procedure to ensure leak tightness.

4.4.4 In case of floating head heat exchangers, if it is found during hydrotest that the pressure is dropping, while the external gasketed joints are not leaking, this could be due to floating head gasket joint leakage. This shall be further investigated, by removing shell cover & pressurising tube side to check the floating head gasket joint leakage. In case of leakage observed at floating head flange joint, replace floating head gasket by new gasket. After replacing gasket exchanger must be again hydrotested first on tube side & then on shell side with same procedure to ensure leak tightness of gasket joints.

In case of heat exchangers with shell side hydrotest pressure higher than tube side, it is possible that above procedure (with tube side hydrotest to detect floating head gasket leakage) may not help. Absence of leakage during this test is not conclusive in such a case, as the shell side pressure was dropping during hydrotest. In such a case, floating head gasket shall in any case be replaced and then equipment retested to ensure leak tightness.

Copyright EIL – All rights reserved

4.4.5 When hydrotested as per above procedure after floating head gasket replacement, if it is observed that test pressure is still dropping, this could mean leakage from tube to tubesheet joint. For such cases matter shall be reported to EIC for further investigations/instructions.

4.5 Flushing & Cleaning

4.5.1 After the erection, alignment and grouting of these equipment are complete, and after hydrotest if any, flushing and cleaning shall be carried out by EC as per specifications and instructions of the EIC.

4.5.2 After flushing, cleaning and draining, equipment shall be dried by compressed air at the pressure and for duration decided by EIC. The equipment interior shall be thoroughly inspected to the complete satisfaction of EIC before it is finally boxed up. Boxing up of manholes and handholes shall be leak proof. All joints which need remaking, shall be remade. Compressed air for drying shall be arranged by EC at his cost.

4.6 Inspection and Acceptance Limits for Level & Alignment

4.6.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by EC.

4.6.2 Before equipment are placed on foundations, orientations shall be checked with respect to piping drawings.

4.6.3 When equipment are firmly bolted down but prior to grouting, verticality of all equipment shall be checked by using theodolite. Tolerances for equipment after erection shall be as per EIL Standard 7-12-0001. The allowable deviation from plumb line shall be 1 mm per metre height, subject to maximum of 6 mm.

4.6.4 Horizontal equipment shall be checked for level across machined face of nozzle flanges with precision level.

4.6.5 Difference in elevation of centerline from one end to the other end shall not be more than 1 mm per meter and limited to ± 3 mm maximum. Further elevation difference shall be such as to ensure complete draining of equipment.

4.6.6 Survey of column inside and checking the levelness of support rings, location of bolting bars to ensure that the same are as per column drawings and within tolerances specified in standard 7-14-0001. In case these are not within permissible tolerances, the same shall be reported to EIC for necessary rectification/modification.

4.7 Safety, Health & Environment

EC shall install an exhaust fan for exhaling welding/ cutting fumes etc. and to maintain adequate oxygen level, before any work is started inside confined spaces (i.e. columns). Adequate ventilation shall be maintained at all times. Gas/LPG cylinders shall not be taken inside confined space. When a worker/supervisor enters a confined space, it shall be mandatory to have a second man as standby. Safety belts shall be worn while entering columns, if there is a danger of falling. All ladders/stair cases shall be in place before any item is offered to owner's inspectors. Rope ladders/scaffolding shall be provided inside the column in case tower internals are not easily approachable from column manhole. Low voltage (24 V) lamps equipped with guards shall be used to prevent accidental contact with bulb. All electrical connections shall be through ELCB's and proper earthing shall be ensured. Acids and other materials used for pickling shall be disposed off to a designated place as directed by owner/EIL. All statutory Regulations and owner's safety, health and environment requirements

Copyright EIL – All rights reserved

shall be complied with. Inspection aids for carrying out the inspection of internals shall also be provided.

5.0 ERECTION OF ROTATING EQUIPMENT

5.1 Scope of Work of Erection Contractor

The scope of work shall consist of transportation of Rotating Equipments and accessories from Owner's stores to site, assembly of sub-assemblies/parts, erection of Rotating Equipments on foundations, levelling, aligning and grouting, preparation of Rotating Equipments for trial runs, carrying out no load/trial runs, return of any unused material to the owners stores and hand over in fit condition for the start- up of the Plant, as per instructions of EIC.

Defects due to EC's fault noticed during trial runs shall be rectified by him. Schedule of Quantities, indicate estimated numbers, dimensions and weights of the Rotating Equipments. The actual data on dimensions and weights will be in the vendor data manuals.

The term 'Rotating Equipment' includes all pumps, compressors, steam & gas turbines, fans and blowers, diesel engine/steam turbine/gas turbine generator sets along with drivers accessories & auxiliary systems.

5.2 General Conditions of Erection

5.2.1 All Rotating Equipment erection shall be done by experienced fitters. For this purpose EC shall employ experienced and suitably qualified erection supervisor and crew who have done similar jobs.

5.2.2 The Rotating Equipment manufacturer's instructions as available regarding installation and trial runs will be passed on to EC during the course of work. The requirements prescribed therein shall be met in addition to what is stated in this specification. Erection shall be carried out as per instructions of the Rotating Equipment manufacturer's representative and under their supervision whenever the manufacturer is present at site. In all other cases instructions of the EIC, regarding procedure/sequence of erection shall be binding on EC.

5.2.3 For all Rotating Equipment, EC shall follow the proper sequence for assembly and erection. For Rotating Equipment received along with driver in coupled condition, the coupling bolts shall be dismantled by EC, and alignment shall be rechecked. Realignment, if required, shall be done before recoupling.

Where drivers and couplings are provided separately, drilling and tapping of holes in the base plates for fixing drivers, fixing of couplings on shafts, after enlarging the pilot bores to the correct size with key way etc. and dowelling including provision of dowel pins, alignment screws, jack-up screws or similar arrangements for retaining the alignment shall be carried out by EC as part of erection work. Shims & wedges as required for alignment shall be supplied by EC.

5.2.4 Process and utility (such as cooling water, steam flushing, quenching, lubricating oil, sealing etc.) connections connected with rotating equipment and its auxiliaries shall be fabricated and/or installed by EC from materials supplied by the Owner as per drawings, specifications and instructions of the EIC.

5.2.5 Piping and accessories supplied with the rotating equipment such as seal oil/Gas system, cooling water system & Lube oil system etc. shall be tagged separately and kept in EC's stores till erection. All flanged connections and openings shall be kept blanked with dummies/plugs to prevent entry of foreign matter.

Copyright EIL – All rights reserved

5.2.6 The local mounted instruments such as pressure gauges, sight glasses, temperature gauges etc. and Local instrument panels, if any, with necessary connections, shall be installed by EC as part of rotating equipment erection.

5.2.7 After initial alignment, the Rotating Equipments shall be properly grouted. Grouting shall be carried out as per this specification. Wherever grout holes are provides in the base plates, grout shall be filled through them also.

Epoxy grout where recommended by the rotating equipment manufacturer, shall be provided by EC and shall be as specified in this standard.

5.2.8 Alignment between the Driver and driven equipment shall be done without connecting the equipment nozzles to respective piping. After completion of alignment, the equipment shall be connected to Piping. After the piping has been connected, the alignment shall be re-checked by EC, to ensure that piping connections do not induce any undue stresses on the Rotating Equipments. After making necessary corrections on the piping, if any, re-alignment shall be done by EC and he will ensure that no undue stresses are induced on the Rotating Equipment.

5.3 Special Instructions

EC in addition to general instructions for erection as out lined in para 5.2 above, shall also follow the following special instructions.

5.3.1 Pumps

Depending upon the size of equipment, Pump train will be supplied for erection in any of the following modes :

(a) Pumps with drivers and accessories fully assembled on a common skid (Base plate).

(b) Pumps mounted on base plate and couplings and driver supplied loose in separate packs.

(c) Various major components such as pump, drivers, couplings, gear boxes & base plates auxiliary systems like lube, seal flush equipment in separate packs.

5.3.2 Reciprocating Type Compressors

5.3.2.1 Reciprocating compressors may be supplied for erection in knocked down condition in multiple packaged subassemblies such as frame assembly, distance pieces, fly wheels, cylinder block assemblies, valve assemblies etc. and other accessories such as, drivers, couplings, gear boxes (if any), control panels, gauge boards, coolers, lube oil systems, cooling water systems, etc. would be in separate packages.

Besides the above there would be other packages for loose supplied items such as instruments, pre-fabricated piping, and piping/tubing in commercial lengths.

Lifting devices for erection shall be arranged by EC depending on the weight of packages and elevation of installation.

5.3.2.2 In case of Rotating Equipments received in knocked down condition, the various parts shall be assembled as per instructions of the EIC and as per manufacturer's instructions. All parts of the Compressor shall be thoroughly cleaned with solvents to remove protective compounds if any, before assembly.

Copyright EIL – All rights reserved

5.3.2.3 The compressor, driver and other accessories shall be erected on their respective foundations and the compressor, couplings, gear box and driver shall be aligned and grouted as per the manufacturer's instructions and instructions of EIC and the manufacturers supervisor (when present). There-after all process and utility, drain & vent connections shall be completed as per the relevant drawings/instructions of equipment manufacturer and advice of EIC.

5.3.2.4 Final alignment shall be done after all the piping connections such as water, steam, drains and connection to coolers etc. are made. Tolerances for alignment shall be maintained as specified in the Manufacturer's Instruction Manual. To ensure that piping connections do not induce any undue stresses on the Rotating Equipment, the alignment shall be checked once again by EC after the piping has been connected. Any correction necessary for proper alignment shall be done by EC.

5.3.2.5 EC shall carefully study the vendor drawings, manuals and other data before start of the job to ensure correct erection, alignment and commissioning.

5.3.3 **Centrifugal Compressors & Expanders**

5.3.3.1 Centrifugal Compressors are supplied for erection in multiple packages such as,

- Compressor casings
- Drivers (Electrical motors, Steam/Gas turbines -♦)
  {♦ : Steam/Gas turbines would be further supplied in multiple packages}
- Base plates (or skids)
- Lube oil/control oil systems
- Sealing systems
- Air filters (for gas turbines & compressors for air service)
- Temporary strainers
- Couplings
- Gear boxes
- Coolers
- Gauge boards
- Control panels
- Lube & Seal Oil tanks
- Fire systems (for gas turbines)
- Condensers (for steam turbines)
- Condensate systems (for steam turbines)
- Loose supply items
- Pre-fabricated & Commercial lengths piping, tubing.
- Other miscellaneous packages

5.3.3.2 Other requirements shall be same as defined in para's 5.3.2.2 to 5.3.2.5 above.

5.4 Trial Runs of Machinery

5.4.1 Any construction defects shall be intimated to EIC before start-up. All protective and safety guards shall be installed and rotating equipment shall be checked for free movement by manual barring over. All foundation bolts and alignment shall be checked before starting the trial runs, if damaged, rotating equipment may have to be opened and repaired as directed by EIC. Prior to carrying out the trial runs, the rotating equipment will be subjected to necessary checks by the EIC and the trial runs shall be commenced only after the approval of the EIC.

Copyright EIL – All rights reserved

5.4.2 Unless otherwise specified, all the rotating equipment will be subjected to trial runs for a continuous operation of 72 hours. In case of motor driven rotating equipments, motors shall be decoupled and turned over to other agencies doing electrical work for testing and no load running of motors. After the no load runs of motors are satisfactorily completed, EC shall recouple the motors to the rotating equipment and recheck the alignment. The trial run of the rotating equipment shall be started only after the above is completed. EC shall provide, as part of his work, necessary skilled personnel (excluding the operating personnel) for conducting the trial runs round the clock during the trial runs period. The duration of trial run may be extended if it is considered necessary in the opinion of EIC and EC shall provide personnel for such extended period also. Final inspection of bearing etc. shall be carried out by EC after the Machinery had gone through the trial run and defects, if any, shall be made good for rendering the rotating equipment ready for start up.

5.4.3 During the trial runs, readings of bearing temperature, cooling water inlet and outlet temperatures, lube oil inlet/outlet temperature and pressure, rotating equipment discharge pressure and temperature, starting in current, no load/full load current etc. shall be recorded, wherever necessary, by EC. Trial reports shall be prepared in the approved proforma by EC containing all the above details and submitted to the EIC as part of completion documents.

5.4.4 EC shall also provide necessary improvised fencing and watch & ward personnel as safety measures during trial runs.

5.5 System Start up

During start-up, EC shall provide necessary skilled personnel as per requirement of EIC, to rectify defects noticed in the rotating equipment, if such defects are attributed to him.

6.0 EQUIPMENT GROUTING

All anchor bolt sleeves/pockets and space under Base plates/machine base frames/shoe plates, etc. shall be grouted with either free flow non shrink cementitious or epoxy grout as per the following categorisation:

Sr. No.	Type of Grout	Application
1	Non shrink cementitious grout	All static and rotating equipments, unless covered in 2) below, viz Static equipments like tall columns, vertical silo, blender etc. and horizontal vessel, drum, sphere, bullets, filter, heat exchangers, coolers etc. and other similar equipments, steel stack/chimney, furnace etc. Low frequency, medium frequency, high frequency rotating machines like compressors (centrifugal, reciprocating, diaphram, screw, gear type etc.). Induced draft fan, forced draft fan, air blowers, pumps (centrifugal, reciprocating, diaphram, gear type etc.), expanders, turbine, generator, diesel generator, air coolers (fin fan cooler) and other similar equipment. Machine like screen vibrator, extractor, centrifuge pulverizer, dryer, drop hammer, ball mill, crushers, bagging machine and general workshop equipment.
2	Epoxy grout	Specifically if requested by the Machine Vendor.

Copyright EIL – All rights reserved

6.1 Grout (Material)

All material used for grout shall be in EC's scope. Only approved grout material shall be used. EC shall submit details of grout materials for prior approval of EIC.

6.1.1 Non-Shrink Grout

Non-shrink grout shall be premix type of cementitious (cement pregraded fibre and additive) non-shrink, ready to use grout in dry powder form. It shall have free flow property when mixed with required quantity of water. It shall have initial setting time of 30 minutes.

It shall have the following features:

- Non corrosive to anchor bolts, base plate/saddle/frame, sliding plate.
- Not harmful to concrete and reinforcing steel.
- Non toxic
- Frost, oil and fire resistant
- Require normal curing
- Suitable to use under restraints and grout thickness required
- Expansive to counteract initial shrinkage
- Ensure high early strength without surface crack.
- Suitable for temperature of above 0 deg.C to 200 deg.C.
- Maximum flow distance is compatible to the dimensions of base plate/ saddle/frame.
- It should be resisted to the chemicals, gases etc. being handled in equipment/machines.

It should have the following physical properties:

-	Min. Compressive strength at	3 days 7 days 28 days	25 N/mm^2 30 N/mm^2 40 N/mm^2
-	Min. Tensile strength at	28 days	3.5 N/mm^2
-	Min. Bond strength at	7 days	12 N/mm^2
-	Max. Onstrained Expansion in	2 hours	4%
-	Min. Density		2000 kg/m^3

6.1.2 Epoxy Grout

Epoxy grout shall consist of epoxy resin base, hardener and filler component like graded and blended aggregate. Components of epoxy grout shall be of desired grade and mixed in proportion recommended by manufacturer such that it is injectable under base plate/frame/saddle etc., has low viscosity to meet the flow distances according to dimensions of base plate saddle/frame, it is suitable for the desired thickness, it is homogenous, free from segregation, attains high early and high final strength. It shall have minimum Pot life of 30 minutes. It shall have all the features as specified in clause 6.1.1 except for expansive properties.

It should have the following physical properties :

-	Min. compressive strength at	1 day 7 days	75 N/mm^2 85 N/mm^2
-	Min. Flexural strength	7 days	25 N/mm^2

Copyright EIL – All rights reserved

6.2 Grouting (Placement)

6.2.1 Surface Preparation

Prior to positioning of equipment/machine etc. over concrete pedestal, foundation, slab, beam, etc. all laitance & loose material shall be removed by wire brushing & chipping. The bearing concrete surface shall be sufficiently levelled, hacked with flat chisels to make it rough, clean (using compressed air). Additional chipping, if required, to suit level of base plate and/or minimum thickness of grout shall also be done. In case of use of cementitious grout surface shall be thoroughly wet. All pockets for anchor bolts shall also be similarly cleaned. Any excess water shall be removed. In case of use of epoxy grout, it shall be ensured that surface/pocket to receive grout is totally dry. After erection, alignment/plumbing of equipment/machine in required level, orientation and plumb and installation of sliding plate. Forms shall be constructed around and joints made tight to prevent leakage of the grout.

6.2.2 Preparation of Grout

6.2.2.1 In case of premix type of grout water shall be added in required quantity as specified by supplier and/or EIC. Any specific instruction of manufacturer will be strictly followed.

6.2.2.2 In case of epoxy grout required quantity of all constituents shall be mixed in proportion recommended by manufacturer/supplier and/or EIC. All specific requirements of manufacturer/ supplier shall be strictly followed.

6.2.2.3 Required quantity of grout shall be made considering initial setting/pot life of grout. Any grout not used within initial setting time/pot life shall be rejected and in no case used for grouting.

6.2.3 Placement of Grout

6.2.3.1 Placing of grout shall be taken up only after level, orientation, alignment of equipment/machine has been approved by EIC and anchor bolts are placed in pocket.

6.2.3.2 In case of epoxy grout EC shall give details of grouting scheme and get approval of EIC.

6.2.3.3 The grout mixture shall be poured/injected continuously (without interruption till completion) by grouting pump/injecting gun from one side of base plate and spread uniformly with flexible steel strip and rammed with rods till the space is filled solidly and grout mixture carried to the other side of base plate and fill all pockets. Any specific requirement of manufacturer/ supplier shall be strictly followed. Epoxy grout shall be done by or under supervision of manufacturer/supplier and/or agency having adequate experience in this field as per direction of EIC.

Total work shall be done under supervision and direction of EIC and care shall be taken that alignment of equipment/machine is not disturbed.

6.2.3.4 Grout mixture shall be allowed to harden for a period of minimum 7 days or as required by manufacturer/supplier of grout and/or as decided by EIC. At the end of this period, the shims/edges/pack plate may be removed and anchor bolts tightened uniformly. Alignment of equipment/machine shall be rechecked and if found correct, the voids left by the removal of shims/wedges/pack plate (if removed) must be filled up with a similar mixture of grout. In case after checking, serious misalignment is indicated, the grout shall be removed completely and fresh grouting is done after making appropriate correction of alignment.

6.2.3.5 Minimum thickness of grout shall be 25mm for all types of grout and maximum thickness shall be 40mm for non-shrink grout. For epoxy grout the maximum thickness shall be as per manufacturer's recommendation and/or as specified in drawing.

Copyright EIL – All rights reserved

7.0 REFERENCE EIL STANDARDS/ SPECIFICATIONS

6-14-0003	Installation Procedure for Trays & Tower Internals
6-14-0011	Specification for Packing the Column
6-14-0016	Standard Specification for Review of Site Installation of Column Internals.
6-79-0011	Standard Specification for Corrosion Protection Tape Coating for Underground Steel Piping.
6-79-0020	Standard Specification for Surface Preparation and Protective Coating (New Construction)
7-12-0001	Vessel Tolerances.
7-12-0002	Support for Horizontal Vessel
7-12-0003	Wooden Pillow for Saddle Support
7-12-0004	Skirt Base Details
7-12-0024	Lifting Lug Top Head Type
7-14-0001	Construction Tolerance for Welded Supports for Tray / Tower Internals

Copyright EIL – All rights reserved

पाइपिंग के निर्माण के लिए वेल्डिंग विनिर्देश

WELDING SPECIFICATION FOR FABRICATION OF PIPING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	24/10/24	REVISED & REISSUED AS STANDARD SPECIFICATION	UTTAM	PRABHAKAR	R CHITARA	M NANDI
4	8/07/14	REVISED & REISSUED AS STANDARD SPECIFICATION	P CHOWDHARY	S GHOSAL	P P LAHIRI	S CHANDA
3	28/12/07	REVISED & REISSUED AS STANDARD SPECIFICATION	MPJ	VRK	VRK	VC
2	08/02/02	REVISED TO INCLUDE CHECK RADIOGRAPHY	GC	RN	TVD	
1	15/05/98	REVISED & REISSUED AS STANDARD SPECIFICATION	MPJ	TVD	JRP	AS
0	31/07/87	ISSUED AS STANDARD SPECIFICATION	TVD	TVD	JRP	AK

Copyright EIL – All rights reserved

ABBREVIATIONS

ASME	:	American Society of Mechanical Engineers
ASNT	:	American Society for Nondestructive Testing
AWS	:	American Welding Society
AUT	:	Automated Ultrasonic Testing
BPVC	:	Boiler & Pressure Vessel Code
CFH	:	Cubic Feet per Hour
DWDI	:	Double Wall Double Image
DWSI	:	Double Wall Single Image
GTA	:	Gas Tungsten Arc
GTAW	:	Gas Tungsten Arc Welding
IBR	:	Indian Boiler Regulations
IQI	:	Image Quality Indicator
NDT	:	Non Destructive Testing
PQR	:	Procedure Qualification Record
RT	:	Radiographic Testing
SMAW	:	Shielded Metal Arc Welding
SWSI	:	Single Wall Single Image
UTS	:	Ultimate Tensile Strength

Welding Standard Committee

Convenor : Mr. Rajesh Chitara (SMMS)

Members : Mr. Ayush Mathur (Project)
Mr. P Thulasimani (SCM-Inspection)
Mr. RK Medhavi (Project)
Mr. K Anjaneyulu (SMED)
Mr. RV Rao (Construction)
Dr. Arijit Roy (SMMS)
Mr. Prabhakar Chowdhary (SMMS)
Mr. Lokesh Singh Jangpangi (Piping)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4
2.0 APPLICABLE CODES & STANDARDS 4
3.0 BASE METAL 5
4.0 WELDING PROCESS 5
5.0 WELDING CONSUMABLES 5
6.0 SHIELDING & PURGING GAS 6
7.0 EQUIPMENTS & ACCESSORIES 6
8.0 EDGE PREPARATION 7
9.0 ALIGNMENT & SPACING 7
10.0 WEATHER CONDITIONS 8
11.0 WELDING TECHNIQUE 8
12.0 HEAT TREATMENT 9
13.0 CLEANING OF THE WELD JOINT 11
14.0 INSPECTION AND TESTING 11
15.0 REPAIRS OF WELDS 15
16.0 DOCUMENTS TO BE SUBMITTED BY CONTRACTOR (4 COPIES EACH) 16
EXHIBIT – A: ELECTRODE QUALIFICATION TEST RECORD 17
EXHIBIT – B: STRESS RELIEF HEAT TREATMENT PROCEDURE 21
EXHIBIT-D: FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR) 25
EXHIBIT – E: FORMAT FOR MANUFACTURER'S RECORD FOR WELDER OR WELDING OPERATOR QUALIFICATION TESTS 28
EXHIBIT – F: RADIOGRAPHIC PROCEDURE QUALIFICATION RECORD FOR PIPE WELDING 30
EXHIBIT – G: WELDER'S IDENTIFICATION CARD 31
EXHIBIT – H: Type of Source and Films to be used for RADIOGRAPHY 32
EXHIBIT – I: ULTRASONIC TESTING (UT) 33
EXHIBIT – J: COMPUTED RADIOGRAPHY 42
EXHIBIT – I: AUTOMATED ULTRASONIC TESTING 32
EXHIBIT – J: COMPUTED RADIOGRAPHY TESTING 41

Copyright EIL – All rights reserved

1.0 GENERAL

This specification shall be followed for the fabrication of all types of welded joints of piping system within the battery limits of the plant. This specification shall be used in conjunction with Welding Specification Charts for Piping.

The welded pipe joints shall include the following:

a) All pipe joints, longitudinal butt welds, circumferential butt welds and socket welds.

b) Attachments of forgings, flanges and other supports to pipes.

c) Welded manifold headers and other sub-assemblies.

d) Welded branch connections with or without reinforcing pads.

e) Joints in welded/fabricated piping components.

f) The attachments of smaller connections for vents, drain drips and other instrument tappings.

Any approval granted by the Engineer-in-Charge or Owner's inspector, shall not relieve the Contractor of his responsibilities and guarantee.

This specification shall not be applicable for welding of pipelines for transportation of liquid petroleum, gas and other similar products in onshore and offshore.

2.0 APPLICABLE CODES & STANDARDS

All welding work, equipment for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the following accepted standards and procedures unless otherwise specified in the EIL Standard Welding Specification Chart (6-77-0005) or Job Welding Specification Charts for Piping and the Technical Notes attached thereof. In the case of conflicting requirements, the requirements mentioned in Welding Specification Chart/Technical Notes shall be applicable.

i) ASME B31.3: Process Piping, ASME Code for Pressure Piping, B31

ii) ASME Boiler & Pressure Vessel Code, Sec II Part C: Specifications for Welding Rods, Electrodes and Filler metals.

iii) ASME Boiler & Pressure Vessel Code, Section V: Non destructive examination.

iv) ASME Boiler & Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.

v) The Indian Boiler Regulations - I.B.R.

vi) 6-44-0016: Standard Specification for Non-Destructive Examination Requirements of Piping.

vii) 6-77-0005: Welding Specification charts for Piping Classes.

viii) API 582: Welding Guidelines for the Chemical, Oil, and Gas Industries.

ix) 5-1940-7040: Procedure for permitting Welding consumables.

In the event of any differences due to the additional requirements mentioned in this specification, over and above those obligatory as per codes, this specification shall be binding.

Copyright EIL – All rights reserved

3.0 BASE METAL

3.1 In general, use of carbon steel, alloy steel and stainless steel is envisaged. The details of the material specifications are given in the Welding Specification Chart.

3.2 The Contractor shall provide the manufacturer's test certificates for every batch of the materials supplied by him.

4.0 WELDING PROCESS

4.1 The welding processes to be employed are given in the Welding Specification Chart. In addition to Shielded Metal Arc Welding Process (SMAW) and Gas Tungsten Arc Welding Process (GTAW), Welding of various materials under this specification may be carried out using one or more of the following processes with the approval of the Engineer-in-Charge.

- Gas Metal Arc Welding (GMAW)
- Flux Cored Arc Welding (FCAW)
- Flux Cored Arc Welding (FCAW) - Orbital
- Submerged Arc Welding (SAW)

The limitations given in the API 582 for various welding processes shall be complied with.

4.3 The Welding procedure could be employed for a particular joint only after duly qualifying the welding procedure to be adopted. Previous qualified welding procedures may be permitted if agreed by the Engineer-in-charge.

4.4 FCAW with external gas shielding (FCAW-G) shall be used for pressure-retaining welds and structural welds. FCAW-G shall be used for filler and cap passes of butt welds.

4.5 GMAW process shall be used in Pulsed mode only for root pass welding of pipes.

5.0 WELDING CONSUMABLES

5.1 The Contractor shall provide, at his own expense, all the welding consumables necessary for the execution of the job such as electrodes, filler wires, argon etc. and these should bear the approval of the Engineer-in-Charge.

5.2 The welding electrodes and filler wires supplied by the Contractor shall conform to the class specified in the Welding Specification Chart. The materials shall be of the make approved by the Engineer-in-Charge. Usage of non-purge filler wires may be permitted only after taking approval in the Welding Specification Charts.

5.3 Electrode qualification test at site shall be done as per document number 5-1940-7040 and Welding specification chart for Piping, 6-77-0005. Electrode qualification test records should be submitted as per the Exhibit-A (attached) in respect of the electrodes tested by the Contractor, for obtaining the approval of the Engineer-in-Charge. It shall record the minimum test results required for classification of welding consumables as per ASME Section II part C.

5.4 The Contractor shall submit batch test certificates from the electrode manufacturers. All the test certificates shall be duly endorsed by the vendors/stockiest.

5.5 All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. Contractor shall use vacuum-packed electrodes for pressure-retaining welds for LTCS, Hydrogen, Amine, Caustic, NACE, Alloy steels, stainless steels, Non-ferrous alloys. The electrodes removed from the containers shall be kept in baking ovens at temperatures recommended by the electrode manufacturer. "Out of the oven time" of electrodes, before they are consumed, shall not exceed the limits recommended by the electrode manufacturer.

Copyright EIL – All rights reserved

The electrodes shall be handled with care to avoid any damage to the flux covering and proper records of both holding and baking time needs to be recorded by the Contractor.

5.6 All low hydrogen type of electrodes and others, shall be baked as per manufacturers recommendation and stored in holding ovens at temperature recommended by the manufacturer.

5.7 The electrodes, filler wires and flux used shall be free from rust, oil, grease, earth and other foreign matter which affect the quality of welding.

5.8 Tungsten electrodes used shall conform to ASME Sec.II C SFA 5.12 specification. Thoriated Tungsten electrodes shall not be permitted due to possible radiation hazard. Instead, ceriated Tungsten Electrodes (EWCe-2 or equivalent) shall be used for GTA Welding.

6.0 SHIELDING & PURGING GAS

6.1 Argon gas used in GTA welding shall be as per SFA 5.32 of ASME Section II part C. The purity of the gas shall be certified by the manufacturer. The rate of flow for shielding purposes shall be established through procedure qualification tests.

6.2 When GTAW process alone or a combination of GTAW and SMAW/FCAW/SAW processes is recommended for the production of a particular joint, the purging shall be maintained during the root pass and for the first filling pass to minimize oxidation on the inner side of the pipe, unless otherwise specified in Welding Specification Chart.

6.3 Initial purging shall be maintained for sufficient period of time so that at least 4-5 times the volume between the dams is displaced, in order to completely remove the entrapped air. In no case should the initial purging period be less than 10 minutes. High gas pressure should be avoided.

6.4 After initial purging, the flow of the backing gas should be reduced to a point where only a slight positive pressure prevails.

6.5 Gas backing (purging) is not required for socket type of welded joints.

6.6 Dams, used for conserving inert gas during purging, shall be removed after completion of the welding, and shall be accounted for. Wherever, removal of dams is not possible after welding, use of water-soluble dams should be made.

7.0 EQUIPMENTS & ACCESSORIES

7.1 All the equipment for performing the heat treatment, including transformers, thermocouples, pyro-meters, automatic temperature recorders (with suitable calibration arrangement etc.) shall be provided by the Contractor at his own expense along with certificate traceable to national /international standard.

7.2 Contractor shall make necessary arrangements at his own expense, for providing the radiographic equipment, radiographic films, processing equipment all other darkroom facilities and all the equipment/materials required for carrying out the dye-penetrant/magnetic particle test/ultrasonic testing.

7.3 Contractors shall use only calibrated panels and digital recorders for carrying out PWHT activities.

Copyright EIL – All rights reserved

8.0 EDGE PREPARATION

8.1 General

The edges to be welded shall be prepared to meet the joint design requirements by any of the following methods recommended:

(a) Carbon Steel
Gas cutting, machining or grinding methods shall be used. After gas cutting, oxides shall be removed by chipping or grinding.

(b) Low Alloy Steels (containing up to 5% Chromium).
Gas cutting, machining or grinding methods shall be used. After gas cutting, machining or grinding shall be carried out on the cut surface.

(c) High alloy steel (> 5% Chromium) and stainless steels, nickel alloys:
Plasma cutting, machining or grinding methods shall be used. After plasma cutting, cut surfaces shall be machined or ground smooth.

8.2 The beveled edges shall be masked with tape after fit-up. The welding shall preferably be completed within a week after fit-up.

8.3 Cleaning

(a) The ends to be welded shall be properly cleaned to remove paint, oil, grease, rust, oxides, sand, earth and other foreign matter. The ends shall be completely dry before the welding commences.

(b) On completion of each run, craters, welding irregularities, slag etc., shall be removed by grinding and chiseling. Wire brushes used for cleaning stainless steel joints shall have stainless steel wires and the grinding wheels used for grinding stainless steel shall be of a suitable type. Separate grinding wheels and wire brushes shall be used for carbon steels and stainless steels. Mixing of usage of carbon steel grinding wheels on stainless steels is not permitted.

9.0 ALIGNMENT & SPACING

9.1 Components to be welded shall be aligned and spaced as per the requirements laid down in applicable code. Special care must be taken to ensure proper fitting and alignment when the welding is performed by GTAW process. Flame heating for adjustment and correction of ends is not permitted unless specifically approved by the Engineer-in-Charge.

9.2 A wire spacer of suitable diameter may be used for maintaining the weld root opening while tacking, but it must be removed after tack welding and before laying the root bead.

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

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

Copyright EIL – All rights reserved

9.5 Tacks should be equally spaced. Minimum number of tacks shall be:

3 tacks - for 2 1/2" and smaller dia. pipes.
4 tacks - for 3" to 12" dia. pipes.
6 tacks - for 14" and larger dia. pipes.

9.6 Welding shall commence only after approval of fit-up by the Engineer-In-Charge.

10.0 WEATHER CONDITIONS

10.1 The parts being welded and the welding personnel should be adequately protected from rain and strong winds. In the absence of such a protection no welding shall be carried out.

10.2 During field welding, particular care shall be exercised to prevent any air current affecting the welding process.

11.0 WELDING TECHNIQUE

11.1 Root Pass

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

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

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

(d) Any deviation desired from the recommended welding technique and electrodes indicated in the welding specification chart should be adopted only after obtaining express approval of the Engineer-in-Charge.

(e) Root welding shall be uninterrupted. No joint shall be left alone after the root pass. Hot pass shall be deposited prior to stoppage of work.

(f) While the welding is in progress care should be taken to avoid any kind of movement of the components, shocks, vibrations and stresses to prevent occurrence of weld cracks.

(g) Peening shall not be used.

11.2 Joint Completion

(a) Joint shall be completed using the class of electrodes, recommended in the Welding Specification Chart. Size of the electrode shall not exceed 4 mm in diameter for stainless steels and alloy steels used for low temperature applications.

(b) Two weld beads shall not be started at the same point in different layers.

Copyright EIL – All rights reserved

(c) Butt joints shall be completed with a cover layer that would affect good fusion at the joint edges and a gradual notch free surface.

(d) Each weld joint shall have a workmanship like finish. Weld identification work shall be stamped clearly at each joint, just adjacent to the weld. Metal stamping shall not be used on thin pipe having wall thickness less than 3.5mm. Suitable paint shall be used on thin wall pipes for identification.

(e) Rust preventive/protective painting shall be done after the weld joint has been approved.

11.3 Dissimilar Welds

(a) Where welds are to be produced between carbon steels (P No. 1) and alloy steels (P No. 4, 5A, 5B), preheat and post weld heat treatment requirements shall be those specified for corresponding alloy steels. The preferred filler wire/electrodes shall correspond to ER70S-2 or E-7016/7018 type.

(b) For welds between two dissimilar Cr-Mo low alloy steels (P No. 4, 5A, 5B), preheat and post weld heat treatments shall be those specified for higher alloy steel and electrodes preferred shall match steel of lower alloy content. For dissimilar metal welds between 9Cr-1Mo-V (P No. 15E) and lower-alloy steel (e.g 2.25Cr-1Mo)/carbon steel, Cr-Mo (P No. 5B) to carbon steel (P No.1), consideration should be made to insert a small transition piece (e.g 2.25Cr-1Mo, 5Cr-0.5Mo) to allow a lesser gradient in the chemical composition.

(c) For carbon steel or alloy steel to stainless welds, use of filler wire/electrodes E/ER-309/ERNiCr-3/E Ni Cr Fe-3/ENiCrMo-3 shall be made. E/ER-309 shall not be used above design temperature of 315°C. The welding procedure, electrodes/filler wires to be used shall be approved by the Engineer-in-Charge.

(d) Dissimilar metal welds joining carbon steels and low alloy steel to stainless or nickel base alloys shall be avoided in the severe thermal cycling service and in sour services.

12.0 HEAT TREATMENT

12.1 Preheating and Interpass Temperature

a) No welding shall be performed without preheating the joint to 10°C (50°F) when the ambient temperature is below 10°C.

b) Preheating and Interpass temperature requirements for the various materials shall be as per the Welding Specification Chart attached.

c) Preheating shall be performed using resistance or induction heating methods. Preheating by gas burners, utilizing oxy-acetylene or oxy-propane gas mixtures, with neutral flame may also be carried when permitted by the Engineer-in-Charge.

However, preheating in lieu of PWHT carried out in carbon steel piping above 25 mm thickness shall be done using coil heating and monitored using thermocouples.

d) Preheating shall extend uniformly to at least three times the thickness of the joint, but not less than 50 mm, on each side of the weld.

e) Preheating temperature shall be maintained over the whole length of the joint during welding. Temperature recorders shall be provided by the Contractor to record the

Copyright EIL – All rights reserved

temperature during alloy steel welding. For carbon steel piping, preheat temperature shall be ensured by use of temperature indicating crayons, pyrometers or other suitable means. Digital hand-held contact thermocouples are preferred over crayons for austenitic stainless steels, DSS, and nickel alloys.

f) If a welding is interrupted for more than 3 minutes without maintenance of minimum preheat before a minimum of 10mm deposits or 25% of the total joint thickness is completed (whichever is less), surface NDE shall be performed before welding is restarted.

12.2 Post Heating

In case of alloy steel materials (P-Nos. 5B, 15E), if a weld joint is not completed on the same day or the postweld heat treatment is not performed immediately after welding, the weld joint and adjacent portion of pipe, at least 50 mm on either side of weld, shall be uniformly heated to 350°C for 1 hour per inch with 1 hour minimum and then wrapped with mineral wool before allowing it to cool to room temperature. Post-weld heat treatment as specified in the Welding Specification Chart shall be carried out later on.

12.3 Post-Weld Heat Treatment (PWHT)

a) Post-weld heat treatment, wherever required for joints between pipes, pipes and fittings, pipe body and supports shall be carried out as per the welding specification chart, applicable codes standards and the instructions of the Engineer-in-Charge. In this regard, procedure qualification shall be done before carrying out PWHT on production welds.

b) The Contractor shall submit for the approval of the Engineer-in-Charge, well before carrying out actual heat treatment, the details of the post-weld heat treatment procedure as per Exhibit B attached, that he proposes to adopt for each of the materials/assembly/part involved.

c) Post-weld heat treatment shall be done in a furnace or by using an electric resistance or induction-heating equipment, as decided by the Engineer-in-Charge.

d) While carrying out local post-weld heat treatment, technique of application of heat must ensure uniform temperature attainment at all points of the portion being heat-treated. Care shall be taken to ensure that width of heated band over which specified post-weld heat treatment temperature attained is at least that specified in the relevant applicable standards/codes. Control of temperature shall be done using microprocessor/computer-controlled system.

e) Throughout the cycle of heat treatment, the portion outside the heated band shall be suitably wrapped under insulation so as to avoid any harmful temperature gradient at the exposed surface of pipe. For this purpose, temperature at the exposed surface should not be allowed to exceed 50% of the peak temperature.

f) The temperature attained by the portion under heat treatment shall be recorded by means of thermocouple pyrometers. Adequate number of thermocouples should be attached to the pipe directly at equally spaced location along the periphery of the pipe joint. Minimum number of thermocouples required different pipe diameters is given in the table below. However, the Engineer-in-Charge can increase the required number of thermocouples to be attached if found necessary.

Copyright EIL – All rights reserved

Pipe outside diameter, inch	No. of thermocouples
Up to 6"	1
8" - 10"	2
12" - 20"	3
24" - 36"	4
42" - 54"	5
56" - 92"	8
104"	10

g) Automatic temperature recorders, which have been suitably calibrated, shall be employed for measuring & recording temperature. The time-temperature graph shall be submitted to Engineer-in-Charge immediately on completion of Stress Relieving Cycle. The calibration record of each recorder should be submitted to the Engineer-in-Charge prior to starting the heat treatment operations and his approval should be obtained.

h) Manufacturer's test certificate shall be submitted for the thermocouples materials and record shall be maintained by the Contractor.

i) Immediately on completion of the Heat Treatment, the Post-Weld Heat Treatment charts/records along with the hardness test results on the weld points, wherever required as per the Welding Specification Chart, shall be submitted to Engineer-in-Charge for his approval.

j) Each weld joint shall bear a unique identification number, which shall be maintained in the piping sketch to be prepared by the Contractor. The weld joint identification number should appear on the corresponding post weld heat treatment charts. The chart containing the identification numbers and piping sketch shall be submitted to the Engineer-in-Charge in suitable folders.

13.0 CLEANING OF THE WELD JOINT

All weld joints shall be free from adherent weld spatters, slag, swarf, dirt or foreign matter. This can be achieved by brushing. For stainless steels, brushes with only stainless-steel bristles shall be used.

14.0 INSPECTION AND TESTING

14.1 General

(a) The Owner's inspector shall have free access to all concerned areas, where the actual work is being performed. The contractor shall also accord the Owner's Inspector all means and facilities necessary to carry out inspection.

(b) The Owner is entitled to depute his own inspector to the shop or field where prefabrication and erection of pipe lines is in progress for (but not limited to) the following objectives:

i) To check the conformance to relevant standards and suitability of various welding equipments and the welding performance.

ii) To witness the welding procedure qualification.

iii) To witness the welder performance qualification.

Copyright EIL – All rights reserved

iv) To check whether shop/field welding being executed is in conformity with the relevant specifications and codes of practice followed in piping construction.

(c) Contractor shall intimate sufficiently in advance the commencement of qualification tests, welding works and acceptance tests, to enable the Owner's inspector to be present to supervise them, as decided by the Engineer-In-Charge.

14.2 Welding Procedure Qualification

(a) Welding procedure qualification shall be carried out in accordance with the applicable requirements of ASME Sec. IX latest edition and/or other applicable codes and the job requirements.

(b) The contractor shall submit the welding procedure specification in format as per Exhibit-C (attached) immediately after the receipt of the order. For shop/field welding, WPS format given in ASME Section IX may also be used.

(c) Owner's inspector will review, check and approve the welding procedure submitted and shall release the procedure for qualification tests. The procedure qualification test shall be carried out by the Contractor at his own expense. A complete set of test results in the format as per Exhibit-D (attached) or ASME Section IX shall be submitted to the Owner's inspector for his approval immediately after completing the procedure qualification test and at least 2 weeks before the commencement of actual work. For shop welding, PQR format given in ASME Section IX may also be used.

(d) Standard test as specified in the code shall be carried out in all cases. In addition to these tests, other tests like macro/micro examination, hardness tests, dye penetrant examination, Charpy V-notch, Corrosion tests etc. shall be carried out on specimens depending upon the type of base material, operating conditions and requirements laid down in the detailed drawings, specifications and welding charts. It shall be the responsibility of the Contractor to carry out all the tests required to the satisfaction of the Owner's inspector.

(e) Contractor may submit old PQR conducted at other sites under EIL supervision. Engineer-In-Charge may permit the use of old PQR if found acceptable.

14.3 Welder's Qualification

(a) Welders shall be qualified in accordance with the ASME Section-IX or other applicable codes. The Owners inspector reserves the right to witness the test and certify/approve the qualification of each welder separately. Only those welders who have been approved by the Owner's Inspector shall be employed for welding. Contractor shall submit the welder qualification test reports in the format as per Exhibit-E (attached) and obtain express approval before commencement of work. It shall be the responsibility of Contractor to carry out qualification tests of welders. For welding of the steam piping, falling under the purview of Indian Boiler Regulations, only those welders with IBR Certification, qualified by Boiler Inspectorate, and acceptable to the local Boiler Inspector authority shall be employed.

(b) The welders shall always have in their possession, an identification card containing information contained in Exhibit-G and shall produce it on demand by the Engineer-In-Charge or his representative. It shall be the responsibility of the Contractor to issue the identify cards after it has been duly certified by the, owner's Inspector.

(c) No welder shall be permitted to work without the possession of the identify card.

Copyright EIL – All rights reserved

(d) If a welder is found to perform a type of welding or in a position for which he is not qualified, he shall be debarred from doing any further work. All welds performed by an unqualified welder shall be cut and redone by a qualified welder at the expense of the Contractor

14.4 Visual Examination

Visual Examination of all welds shall be carried out as per the latest editions of the applicable codes and EIL Standard 6-44-0016. All finished welds shall be visually inspected for parallel and axial alignment of the work, excessive reinforcement, concavity of welds, shrinkage cracks, inadequate penetration, unrepaired burn-through, under cuts, dimensions of the weld, surface porosity and other surface defects. Undercutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard/code.

14.5 Radiographic Examination

(a) Radiography shall be carried out by Conventional radiography or Close proximity radiography or Computed Radiography (CR) using Phosphor Imaging Plate (IP) as described in ASME Section V Article 2 Mandatory Appendix VIII. The details of the Computed Radiography is covered in Annexure J. Digital Radiography (DR) as described in ASME Section V Article 2 Mandatory Appendix IX may be permitted for vendor shop weld inspection after review and approval of the procedure by EIL Inspector or Owner's Third Party Inspector (TPI).

(b) The extent of Radiography shall be as per the EIL Standard NDT specifications (6-44-0016) or job specification given elsewhere in the Tender. For field weld joints, Contractor shall propose among suitable Radiographic methods given in clause 14.5 (a) depending on the actual field condition for approval of Engineer-in-charge. For welds between dissimilar materials, the extent of Radiographic Examination shall be the more stringent of the two recommended for the materials being welded. Wherever random Radiography is called for, in a particular piping class, the dissimilar materials weld joints shall essentially be included.

(c) The Radiographic Examination procedures shall be submitted by the contractor as per Exhibit-F for approval from the Owner's Inspector prior to employment. A person qualified to ASNT Level-II or ASNT Level-III in Radiographic testing shall prepare the procedure. The Radiography Procedure shall be established to demonstrate that the required sensitivity can be consistently achieved under the most unfavorable parameters (e.g. source to film distance, geometric unsharpness, thickness etc.). The radiographic technique and procedure adopted shall conform of the requirements mentioned in Article 2 as well as Article 22 of ASME Section V. The IQI sensitivity obtained shall be equal to or better than the requirements mentioned in Article 2 of ASME Section V. Source side penetrameter shall be used in establishing radiographic procedure/ technique. The acceptance criteria shall be as per the relevant codes of Fabrication and overriding requirements if mentioned elsewhere in the technical specifications of the contract. The Contractor shall be responsible for carrying out Radiography; rectification of defects and re-radiography of welds repaired/rectified at his cost.

(d) Depending on the site condition, decision to use close proximity radiography shall be taken by Engineer-in-charge. Close Proximity Radiography (CPR) with conventional film radiography or Computed Radiography shall be used. The cordoning distance for close proximity radiography shall be 4 to 5 meters maximum. The permissible maximum pipe thickness and minimum pipe size shall be 12 mm and 3" respectively for use of Close Proximity Radiography.

Copyright EIL – All rights reserved

(e) Type of Radiation source and film to be used shall be as per Exhibit-H for carrying out radiographic examination. However, if specifications (as given elsewhere in the contract) for some critical material require usage of X-Ray Radiation, then Radiography shall be done using X-Rays only.

(f) The Contractor shall fulfill all the statutory and owner's safety requirements while handling X-ray and Gamma-ray equipment.

(g) In case of random radiography, the joints for Radiography shall be selected by the Owner's Inspector and the Radiography shall be performed in his presence, if he instructs the contractor to do so. The contractor shall furnish all the radiographs, to the Owner's Inspector immediately after processing along with evaluation by a person qualified to ASNT Level-II in Radiographic testing, inline with Article 2 of ASME Section V. The certificate of ASNT/ISNT Level II qualification of the NDT personnel shall be submitted to owner's inspector for his approval prior to start of job.

(h) The Contractor shall provide the Owner's Inspector, all the necessary facilities at site such as a dark room with controlled temperature, illuminator (viewer) suitable for varying densities, a duly calibrated electronic densitometer with batteries, magnifying glass, tracing papers, ruler, marking pencils etc. to enable him to review the radiographs.

(i) For each weld performed by a welder found unacceptable, two additional checks shall be carried out on welds performed by the same welder. This operation is iterative and the of two additional welds for each weld deemed unsatisfactory shall be continued till such time that two consecutive welds of satisfactory quality are found for every defective weld.

(j) The Contractor shall carry out these additional radiographic testing at his own expense. To avoid the possibility of too many defective welds by a single welder remaining undetected for a long period to time, the Contractor shall promptly arrange for Radiographic Examination so that there is no accumulation of defective joints.

14.5.1 Check shots

(a) Owner / Engineer-in-charge or his representative shall select 5% of the total number of weld joints accepted in first attempt in radiography for check shots. CONTRACTOR shall take check shot in one segment instead of all segments of each selected joints if agreed by the Engineer-in-charge.

(b) Weld profiles of check shots shall be compared with weld profile observed in the earlier Radiographs. In the event of any one variation in the check shots and earlier Radiographs, contractor shall re-shoot the entire lot of joints radiographed by particular Radiography agency on the particular date. All the re-shot films shall be compared with the originally submitted films.

14.6 Liquid Penetrant and Magnetic Particle Examination

(a) Whenever such tests are specified, the tests shall be carried out on joints chosen by the Owner's inspector, as per ASME Section V article 6 and 7 respectively. The tests are to be performed by a person possessing a valid ISO/ASNT/ISNT Level-II qualification in the method being used.

(b) For austenitic stainless steels and other nonmagnetic materials, liquid (dye) penetrant test shall be carried out. For carrying out this test, the materials shall be brought within a temperature limit of 15^0 to 50^0C.

Copyright EIL – All rights reserved

14.7 Ultrasonic examination (UT)

(a) Ultrasonic testing (UT) can be used in place of radiographic examination when permitted by ASME B31.3 with prior approval of Engineer-in-charge.

(b) The Ultrasonic testing procedure to be adopted shall be submitted by the CONTRACTOR in line with EXHIBIT-I and get it approved from EIL/OWNER.

(c) The CONTRACTOR shall make all the arrangements for the Ultrasonic Testing of work at his expense. The CONTRACTOR shall furnish all the reports to the EIL/OWNER, immediately after examination together with the corresponding interpretation reports on the approved format. The details of the AUT reports along with the joint identification number shall be duly entered in a register and signed by the CONTRACTOR and submitted to the EIL/OWNER for approval. The EIL/OWNER will review all the Ultrasonic Testing records of welds and inform the CONTRACTOR to those welds, which are unacceptable. The decision of the COMPANY shall be final and binding in this regard.

(d) In addition, Radiography examination shall be carried out when in the opinion of EIL/OWNER, Radiography inspection is required to confirm or clarify defects indicated by Ultrasonic examination.

(e) The ultrasonic testing system used for inspecting welds shall be approved by EIL/OWNER.

14.8 Hardness Test

Hardness requirements for welds shall be as per the Welding Specification Chart/Non-Destructive Examination Specification attached elsewhere in the contract. Hardness testing shall be carried out by Vickers Hardness Tester during welding procedure qualification and shall be cross sectional. For production welds, hardness testing shall be carried out by portable digital hardness testers. Poldi hardness tester shall not be permitted. Contractor shall produce documentary evidence/calibration certificate to the Owner's Inspector and obtain approval of the hardness testing equipment. Contractor shall mobilize standardized test block with hardness value punch and calibration certificate. Digital hardness tester shall be checked prior to each shift using standardized test block.

14.9 Proof Tests

Hydrostatic and pneumatic tests shall be performed as per the requirements laid down by respective flushing and Testing specification/applicable codes to demonstrate the soundness of the welds. The tests shall be conducted after fulfilling the requirement of visual examinations, radiography etc., and after the entire work has been certified by the Owner's inspector to be fit for being subjected to such tests.

15.0 REPAIRS OF WELDS

(a) No repair shall be carried out without prior permission of the Owner's inspector.

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

(c) Defects ascertained through the inspection methods, which are beyond acceptable limits shall be removed after the joint is completely radiographed by the process of chipping and grinding. The repaired welds shall be subjected, as a minimum requirement to the same testing and inspection requirements as the original weld.

Copyright EIL – All rights reserved

(d) The number of times repair welding can be permitted for the same weld shall be governed by the standard specification, 6-44-0016.

(e) When the entire joint is judged unacceptable, the welding shall be completely cut and edges suitably prepared as per required alignment tolerances. The rewelded joint shall again be examined following standard practices.

(f) After attending repairs for alloy steel (P No.4, 5) joints, full joint to be re-radiographed after completion of PWHT.

16.0 DOCUMENTS TO BE SUBMITTED BY CONTRACTOR (4 COPIES EACH)

(a) Electrode and Welding Consumable Qualification Records as per Exhibit-A, for the Welding Consumables tested and approved for the work.

(b) Batch Test Certificates, for the Electrodes used, obtained from the Electrode Manufacturers.

(c) Proposed Heat Treatment Procedure as per Exhibit-B.

(d) Heat Treatment Charts.

(e) Weld joint hardness test results.

(f) Welding Procedure Specifications as per Exhibit-C immediately after receipt of the order.

(g) Welding Procedure Qualification records as per Exhibit-D.

(h) Welder Performance Qualification records as per Exhibit-E immediately after conducting Welder Qualification Tests.

(i) Radiography Procedure as per Exhibit-F and other NDT procedures.

(j) Radiographic test Report along with Radiographs and other NDT reports.

(k) Piping Sketch (Isometric) giving all the details regarding the pipe specifications, welded joints, joints radiographed magnetic particle, tested, ultrasonic tested, penetrant tested, joints heat treated, WPS used, welders identification number, etc.

Copyright EIL – All rights reserved

EXHIBIT – A: ELECTRODE QUALIFICATION TEST RECORD

Date:

Test started on:

Test completed on:

A: DETAILS

CONTRACTOR

Tested at (Site name)

Code of Reference (used for testing) :

Special Requirements (if any) :

Sl. No.	Classification of electrode	Size of electrode	Batch no.	Manufacturer name/brand/date of manufacture	Intended for welding in position	Remarks

B : All-weld Tensile Test

Base Material used :

Buttering used : Yes/No

Pre-heat temperature :

Inter-pass temperature :

Post weld heat treatment details :

Visual examination :

Radiographic examination results :

Tensile test results :

Copyright EIL – All rights reserved

Sl.No.	Batch no./ identification no.	Size of electrode	Current & polarity	UTS		YS		% elongation		Remarks
				As per code	Actual	As per code	Actual	As per code	Actual	

C. Impact Test Results

Test Temperature : Notch in :

Type of Specimens (Charpy) : Size of Specimens :

Sl.No.	Batch no./ identification no.	Size of electrode	Current & polarity	Impact value							Remarks
				As per code, max./avg.	1	2	3	4	5	Average	

Format No. 8-00-0001-F1 Rev. 0

Copyright EIL – All rights reserved

D. Chemical Analysis Results

Sl.No.	Batch no./ identification no.	Size of electrode	Current & polarity		% C	% Mn	% Si	% P	% S	% Cr	% Ni	% Mo	% V	others	Remarks
				As per code											
				Actual											
				As per code											
				Actual											

E. Fillet Weld Test Results :

Base Materials :

Sl. No.	Batch no./ identification no.	Size of electro de	Current & polarity	Welding position	Visual	Macro	Fracture	Remarks
				Horizontal				
				Vertical				
				Overhead				
				Horizontal				
				Vertical				
				Overhead				

F. Other Test Results :

1. Transverse tensile test :

In combination with :

Base material used :

Position of welding :

Preheat temperature :

Post weld heat treatment :

Radiography :

Copyright EIL – All rights reserved

	Identification No.	U.T.S.	Fracture in	Remarks

2. Guided Bend Test :

Position	Identification No.	Root, Face or Side Bend	Remarks
	1		
	2		
	3		
	4		
	5		

G. Any other tests :

H. Conclusions :

PREPARED BY	REVIEWED BY	APPROVED BY
(CONTRACTOR)	(CONTRACTOR)	(EIL/OWNER)

Copyright EIL – All rights reserved

EXHIBIT – B: STRESS RELIEF HEAT TREATMENT PROCEDURE

LSTK CONTRACTOR : _____

Name of the Heat treater : _____

Name of the Project : _____

Specification /Reference No. :

Line no./Joint No.

1. General Details — Other Details

Name of the Equipment : _____

Material : _____

Type of Heating : Elec. Res./ Induction
(Tick mark applicable method)

Maximum Permissible Temp at Uncovered Parent Metal _____

Width of heated band _____
Width of Insulation _____

No. of Themo couples (dia wise) _____

Type of Thermo couples _____

3. Heat Treatment Cycle Details

Charging Temp °C _____
Rate of heating °C /Hr. _____
Soaking Temperature, °C _____
Soaking Time, Hrs. _____
Rate of Cooling °C /Hr. _____
Method of Cooling _____

4. Other details, if any _____

Copyright EIL – All rights reserved

EXHIBIT – C: FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)

Company Name _____ By _____

Welding Procedure Specification No. _____ Date _____ Supporting PQR No. (S) _____

Revision No. _____ Date _____

Welding Process (es) _____ Type (s) _____
(Automatic, Manual, Machines or Semi Auto)

JOINTS

Joint Design _____
Backing (Yes) _____ (No) _____
Backing Material (Type) _____
Sketches Production Drawings. Weld Symbols Written
Description should show the general arrangement of the parts to be welded. Where applicable, the root specing and the details of weld groove may be specified.
(At the option of the Manufacturer sketches may be attached to illustrate joint design weld layers and bead sequence e.g. for notch toughness procedures, for multiple process procedures, etc.)

BASE METALS

P.No. _____ Group No. _____ to P. No. _____ Group No. _____

OR

Specification type and grade _____
to Specification type and grade _____

OR

Chem. Analysis and Mech. Prop. _____
to Chem. Analysis and Mech. Prop. _____
Thickness Range :
Base Metal : Groove _____ Fillet _____
Deposited Weld Metal : Groove _____ Fillet _____
Pipe Dia Range : Groove : _____ Fillet _____
Other _____

Copyright EIL – All rights reserved

FILLER METALS

F.No. _____ Other _____
A.No. _____ Other _____
Spec. No. (SFA) _____
AWS No. (Class) _____
Size of filler metals _____
_____
(Electrodes, Cold Wire, Hot Wire etc.)
Electrode-Flux (Class) _____
Flux Trade Name _____
Consumable Inset _____
Each base metal/filler metal combination should be recorded individually.

WPS NO. _____ Rev. _____

POSITIONS:	**POSTWELDED HEAT TREATMENT**
Position (s) of Groove _____ Welding Progression : UP ____ Down ____ Position (s) of Fillet _____	Temperature Range _____ Time Range _____
PREHEAT Preheat Temp. Min. _____ Interpass Temp. Max. _____ Preheat Maintenance _____	**GAS** Shielding Gas (es) _____ Percent Composition (mixtures) _____ _____ Flow Rate _____ Gas Backing _____ Trailing Shielding Gas Composition _____

ELECTRICAL CHARACTERISTICS

Current AC or DC _____ Polarity _____
Amps (Range) _____ Volts (Range) _____
(Amps and volts range should be recorded for each electrode size, position, and thickness, etc. This information may be listed in a tabular form similar to that shown below).

Tungsten Electrode Size and Type _____
(Pure Tungsten, 2% Ceriated, etc)
Mode of Metal Transfer for GMAW _____
(Spray arc, short circuiting arc, etc.)
Electrode Wire feed speed range _____
_____

Copyright EIL – All rights reserved

TECHNIQUE

String or Weave Bead _____

Orifice or Gas Cup Size _____

Initial and Interpass Cleaning (Brushing, Grinding, etc.) _____

_____

Method of Back Gouging _____

Oscillation _____

Contact Tube to Work Distance _____

Multiple or Single Pass (per side) _____

Multiple or Single Electrodes _____

Travel Speed (Range) _____

Peening _____

Other _____

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Others
		Class.	Dia.	Type Polarity	Amp. Range			
								e.g. Remarks, Comments, Hot wire Addition, Technique Torch Angle, etc.

Copyright EIL – All rights reserved

EXHIBIT-D: FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)

RECORD OF ACTUAL CONDITIONS USED TO WELD TEST COUPON

Company Name _____
Procedure Qualification Record No. _____ Date _____
WPS No. _____

Welding Process (es) _____
Types (Manual, Automatic, Semi-Auto) _____
_____

JOINTS

Groove Design of Test Coupon

(For combination qualification the deposited weld metal thickness shall be recorded for each Filler metal or process weld)

_____

BASE METALS Material Sepc. _____ Type of Grade _____ P.No. _____ to P.No. _____ Thickness of Test Coupon _____ Diameter of Test Coupon _____ Other _____	**POSTWELD HEAT TREATMENT** Temperature _____ Time _____ Other _____ _____ _____
FILLER METALS Weld Metal Analysis A No. _____ Size of Filler Metal _____ Filler Metal F.No. _____ SFA Specification _____ AWS Classification _____ Other _____	**GAS** Type of Gas/Gases _____ Composition of Gas Mixture _____ Other _____ _____ _____
POSITION Position of Groove _____ Weld Progression (Uphill, Downhill) _____ Other _____ _____	**ELECTRICAL CHARACTERISTICS** Current _____ Polarity _____ Amps. _____ Tungsten Electrode Size _____ Other _____
PREHEAT Phreheat Temp. _____ Interpass Temp. _____ _____	**TECHNIQUE** Travel Speed _____ String or Weave Bead _____ Oscillation _____ Multipass or Single Pass (per side) _____ Single or Multiple Electrodes _____ Other _____

SHEET 1 OF 3

Copyright EIL – All rights reserved

TENSILE TEST

Specimen No.	Width	Thickness	Area	Ultimate total force, kgf	Ultimate tensile stress, Kgf/mm^2	Type & location of failure

GUIDED BEND TESTS

Type of Figure No.	Result

TOUGHNESS TESTS

Specimen No.	Notch Location	Notch Type	Test Temp.	Impact Value	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break

FILLET WELD TEST

Result - Satisfactory : Yes _____ No ____ Penetration into Parent Metal : Yes ___ No. ____

Marco - Results _____

Format No. 8-00-0001-F1 Rev. 0

Copyright EIL – All rights reserved

OTHER TESTS

Type of Test _____

Deposit Analysis _____

Other _____

_____

Welder's Name _____ Clock No. _____ Stamp No. _____

Test Conducted by _____ Laboratory Test No. _____

We certify that the statements in this record are correct and test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date _____ Manufacturer _____

By _____

(Detail of record of tests are illustrative only and may be moulded to conform to the type and number of tests required by codes and specifications).

Copyright EIL – All rights reserved

EXHIBIT – E: FORMAT FOR MANUFACTURER'S RECORD FOR WELDER OR WELDING OPERATOR QUALIFICATION TESTS

Welder Name _____ Check No. _____ Stamp. No. _____

Using WPS No. _____ Rev. _____

The above welder is qualified for the following ranges

Variable	Record Actual Values Used in Qualification	Qualification Range
Process	_____	_____
Process Type	_____	_____
Backing (metal, Weld metal, flux, etc)	_____	_____
Material Spec.	_____ to _____	_____ to _____
Thickness		
Groove	_____	_____
Fillet	_____	_____
Diameter		
Groove	_____	_____
Fillet	_____	_____
Filler Metal		
Spec. No.	_____	_____
Class	_____	_____
F. No.	_____	_____
Position	_____	_____
Weld Progression	_____	_____
Gas Type	_____	_____
Electrical Characteristics	_____	_____
Current	_____	_____
Polarity	_____	_____

Copyright EIL – All rights reserved

Guided Bend Test Results

Type and Fig. No.	Result

Radiographic Test Results
For alternative qualification of groove welds by radiography

Radiographic Results _____

Fillet Weld Test Results

Fracture Test (Describe the location, nature and size of any crack or tearing of the specimen___
Length and Per Cent of Defects _____ inches _____ %
Macro Test - Fusion _____
Appearance - Fillet Size (ing) _____ x _____ Convexity or Concavity _____
_____

Test Conducted by _____ Laboratory - Test No. _____

We certify that the statements in this record are correct and that the test welds were prepared. Welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date _____ Organization _____
By _____

(Details of record tests are illustrative only and may be modified to conformation to the type & number of tests required by the Code).

Note: Any essential variables in addition to those above shall be recorded.

Copyright EIL – All rights reserved

EXHIBIT – F: RADIOGRAPHIC PROCEDURE QUALIFICATION RECORD FOR PIPE WELDING

1. Location
2. Date of Testing
3. Name of the LSTK CONTRACTOR/Agency
4. Material: Carbon steel/Alloy Steel/Stainless Steel

4 A. Technique: DWSI/SWSI/DWDI

5. Diameter & Thickness:
6. Type of Weld Joint:
7. Radiation Source:
8. Intensifying Screens/Lead Screens:
9. Geometric Relationship:
10. Limit of Film Coverage:
11. Film Type and Make:
12. Exposure Time:
13. Processing:
14. Density:
15. Sensitivity:

16.* Type of penetrameter: (Source side)

17.* Type of penetrameter: (Film side)

Signature of LSTK CONTRACTOR/Agency with Seal

Approval of OWNER/ PMC's Inspector

* Ref. Para regarding recommended practice on placement of penetrameters Article 22, SE 142, ASME Sec. V.

* For "Random Radiography" lines placement of penetrameters as per Article 2, ASME, Sec. V is permitted.

Copyright EIL – All rights reserved

EXHIBIT – G: WELDER'S IDENTIFICATION CARD

1.	Name:
2.	Identification:
3.	Date of Testing:
4.	Process
5.	Thickness range
6.	Diameter range
7.	P. No.
8.	Date of approval of welding
9.	Position(s)

Photograph

Approved by:

Employer's Signature with Seal

Copyright EIL – All rights reserved

EXHIBIT – H: Type of Source and Films to be used for RADIOGRAPHY

NOMINAL WALL THICKNESS (T) IN mm		SHOP WELDED JOINTS		IN-SITU WELDS	
		SOURCE	FILM : CEN Class	SOURCE	FILM : CEN Class
T > 19	All Materials	Gamma Ray	C 5	Gamma Ray	C 5
8 ≤ T < 19	Carbon Steel	Gamma Ray	C 4	Gamma Ray	C 4
	All other materials	Gamma Ray	C3	Gamma Ray	C 3
< 8	Carbon Steel Other than Inspection Class IV *	Gamma Ray	C 3	Gamma Ray	C3/C1
	All other materials and Carbon Steel of Inspection Class IV *	X-Ray	C 4	X-ray with C4 or Equivalent to be used. Gamma Ray (Se 75 Source only) with C3/C2 Equivalent may be allowed only if in the assessment of the owner's inspector, Joints are inaccessible for X-ray equipment and radiographic sensitivity is achieved.	

Note: Integral to above table

1) Films slower than the above may have to be used, if required radiographic sensitivity is not achieved consistently.

* Piping classes where 100% RT is specified. Refer Std. Spec. No. 6-44-0016

COMPARISON OF FILMS FROM DIFFERENT MANUFACTURERS

CEN Classification	KODAK	AGFA	FUJI
---	CX	D8	---
C5	AA400	D7	IX100
C4	T200	D5	IX80
C3	MX125	D4	IX50
C2	M100	D3	---
C1	DR50	D2	IX25
---	SR**	---	---

** *Special films, extremely fine grain & very high resolution*

Copyright EIL – All rights reserved

EXHIBIT – I: ULTRASONIC TESTING (UT)

1.0 INTRODUCTION

2.0 REFERENCE DOCUMENTS

3.0 AUT SYSTEM

4.0 COUPLANTS

5.0 CALIBRATION/DEMONSTRATION BLOCK

6.0 CALIBRATIONS

7.0 PROCEDURE

8.0 TRAINING AND QUALIFICATION

9.0 EVALUATION AND ACCEPTANCE CRITERIA

Copyright EIL – All rights reserved

1.0 INTRODUCTION

The specification shall be applicable for Automated Ultrasonic Testing (AUT) system or Semi-Automated Ultrasonic Testing suitable for full penetration butt-welds of piping. The system shall incorporate Phased array probes and Time of Flight Diffraction (TOFD) probes plus pulse echo probes. The procedure shall evaluate the performance of Phased Array Ultrasonic examination instruments and system. This specification is intended to be used on thickness of 8.0 mm and greater. TOFD probes shall be used above 12mm thickness. Lesser thicknesses may be tested using the standard practice if the technique can be demonstrated to provide adequate protection on mockups of the same wall thickness and geometry.

2.0 REFERENCE DOCUMENTS

The latest edition with addendum of the following standards shall be referred here:

a) ASME B31.3 – Process piping
b) ASME Section V- Non Destructive Examination (Latest edition)
c) ASNT SNT-TC-1A - Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

3.0 AUT SYSTEM

3.1 Instrument Requirement

The ultrasonic examination shall be performed using a system employing automated/ semi-automated scanning with computer-based data and analysis abilities.

The instrument shall be capable of real-time sectorial scan (also called an S-scan) image during scanning to assure that proper data has been collected, generating and displaying sectorial-scan image, which can be stored and recall for subsequent review.

The system shall provide an adequate number of examination channels to ensure the complete volumetric examination of the weld through the thickness in one circumferential scan.
The instrument linearity should be such that the accuracy is within 5%.

Each examination channel should be selective for pulse-echo or through transmission mode gate position and length for a minimum of two gates and gain.

TOFD techniques & B-scan mapping should be available to improve characterization. Recording thresholds should be selectable to display signals between 0 and 100% of full screen height for simple amplitude and transit time recording and it should be from 0 to 100% for B-scan or mapping type recording of data. Two recordable signals output per gate should be available being either analog or digital and representative of signal height and time of flight. Measuring distance accuracy of circumferential weld shall be within 1.0 cm from zero (0) position.

Electronic noise shall be lower than acoustical noise in all channels for the probes and sensitivities to be used during inspection. The signal to noise ratio for each channel during examination shall be at least $\geq$ 20 dB for shear waved probes.

The Contractor shall provide the detail information of the equipment like model, trade name, software used to the OWNER/EIL.

3.2 Probes

The phased array search unit frequency shall be between 1 MHz and 10 MHz depending on material type and thickness. The Contractor shall provide the detail information of the probe frequency, no. of elements, size, pitch etc. to the OWNER/EIL.

Copyright EIL – All rights reserved

3.3 Wedge

Phased array wedges shall be of a design to accommodate phased array search unit. Nominal refracted-wedge angles shall be possible from 35 to 75 degrees to ensure 100 % coverage of the weld and heat affected zone. The Contractor shall provide the detail information of the wedge to the OWNER/EIL.

3.4 Encoder

The encoder shall be capable of permitting a scan resolution of 1.0mm as minimum.

4.0 COUPLANT

The couplant shall be obtained by using a medium suitable for the purpose. It shall be suitable for the temperature used. The couplant, including additives, shall not be detrimental to the material being examined. Couplants used on nickel base alloys shall not contain more than 250 ppm of sulfur. Couplants used on austenitic stainless steel shall not contain more than 50 ppm of halides (chlorides plus fluorides). A method should be employed to determine that constant coupling is achieved during examination. An examination of the test piece with its surface wiped dry should produce a record showing an absence of the couplant recording signal.

The same couplant shall be used during calibration and examination.

5.0 CALIBRATION/DEMONSTRATION BLOCK

5.1 Calibration/Demonstration Block Material

5.1.1 Material selection

The material from which the qualification and calibration blocks are fabricated shall be of the same product form and material specification or equivalent P-number grouping as one of the materials being examined.

5.1.2 Heat treatment

The calibration and qualification blocks shall receive at least the minimum tempering treatment required by the material specification for the type and grade. If the calibration and qualification blocks contains welds other than cladding, and the component weld at the time of the examination has been heat treated, the block shall receive the same heat treatment.

5.1.3 Reflectors

a) Calibration blocks reflectors: Side drilled holes shall be used to confirm adequate sensitivity settings.

b) Demonstration blocks reflectors: Surface and sub-surface notches

5.1.4 Quality of calibration and demonstration blocks

Prior to fabrication, the block material shall be completely examined with a straight beam search unit. Areas that contain an indication exceeding the remaining back-wall reflection shall be excluded from the beam paths required to reach the various calibration reflectors.

5.1.5 Cladding

When the component material is clad, the block shall be clad by the same welding procedure as the production part. It is desirable to have component materials, which have been clad before the dropouts, or prolongations are removed. When the cladding is deposited using an automatic welding process, and, if due to block size, the automatic welding process is impractical, deposition of clad may be by the manual method.

5.1.6 Surface roughness of calibration and demonstration blocks

The roughness of the Demonstration and calibration surfaces of the blocks shall be representative for the scanning surface of the components to be examined.

Copyright EIL – All rights reserved

5.2 Calibration Blocks

5.2.1 Standard block
IIW V1 calibration block or V2 or equivalent calibration block are a recognized test reference for sweep range scale, index point of shear wave transducer, and refracting angle.

5.2.2 Calibration reference block
Reference block shall be made with notch and side-drilled hole as per ASME Section V article 4, Fig.T-434.2.1 and Fig.T-434.3 and shall be used for gain calibration and construction of reference curves. The reference calibration block shall be a section of pipe of the same nominal and schedule and normally be manufactured from the actual material examined and have approved dimensions.

5.2.3 Non-piping Calibration block
The basic calibration block configuration and reflectors shall be as shown in ASME Section V article 4, Fig.T-434.2.1. The block size and reflector locations shall be adequate to perform calibrations for the beam angles used.

5.2.4 Piping Calibration block
The basic calibration block configuration and reflectors shall be as shown in ASME Section V article 4, Fig.T-434.3. The block size and reflector locations shall be adequate to perform calibration for the beam angles used.

5.2.5 Block Curvature
The block curvature shall be as per ASME Section V article 4.

5.3 Demonstration Block

5.3.1 Preparation
A demonstration block shall be prepared by welding or, provided the acoustic properties are similar, the hot isotactic process (HIP) may be used.

5.3.2 Thickness
The demonstration block shall be within 25% of the thickness to be examined. For welds joining two different thickness of material, demonstration block thickness shall be based on the thinner of the two materials.

5.3.3 Weld joint configuration
The demonstration blocks weld joint geometry shall be representative of the production joints details.

5.3.4 Flaw location
Unless specified otherwise by the referencing Code Section, the demonstration block which three EDM notches oriented and major groove faces. The flaws shall be located at or adjacent to the blocks groove faces as follows:

(a) One surface flaw on the side of the block representing the component O.D. surface
(b) One surface flaw on the side of the block representing the component I.D. surface
(c) One subsurface flaw

When the scan plan to be utilized subdivides a weld into multiple examination zones, a minimum of one flaw per zone is required.

5.3.5 Flaw Size
Demonstration block flaw sizes shall be based on the demonstration block thickness and shall be no larger than that specified by the referencing Code Section.

Copyright EIL – All rights reserved

(a) Maximum acceptable flaw height for material less than 1 in. (25 mm) thickness, or
(b) 0.25 aspect ratio acceptable flaw for material equal to or greater than 1 in. (25 mm) thickness based on the demonstration block

5.3.6 Single I.D. / O.D. flaw alternative
When the demonstration block can be scanned from both major surfaces during the qualification scan [e.g., joint I.D. and O.D. have a similar detail, diameter of curvature is greater than 20 in. (500 mm), no cladding or weld overlay present, etc.], then only one surface flaw is required.

5.3.7 One-sided exams
When, due to obstructions, the weld examination can only be performed from one side of the weld axis, the demonstration block shall contain two sets of flaws, one set on each side of the weld axis. When the demonstration block can be scanned from both sides of the weld axis during the qualification scan(e.g., similar joint detail and no obstructions), then only one set of flaws is required.

6.0 CALIBRATION

6.1 General Calibration Requirements

1) Ultrasonic system: Calibration
Calibration shall be performed for complete ultrasonic system and shall be done prior to examination in the desired thickness range.
2) The surface condition of the calibration block shall be similar to that on which production test will be performed with respect to the surface geometry and cladding.
3) Same couplant shall be used for calibration as well as production testing.
4) Contact wedges, if used, shall be same for the calibration as well as for the production testing.
5) Any control, which affects instrument linearity (e. g. Filters, reject, or clipping), shall be in the same position for calibration, calibration checks, instrument linearity checks and examination.
6) Focal-Law: The focal law to be used during the examination shall be used for calibration.
7) Beam Calibration
All individual beams used in the examination shall be calibrated to provide measurement of distance and amplitude correction over the sound path employed in the examination. This shall include applicable compensation for wedge sound path variations and wedge attenuation effects.
8) The maximum temperature difference between test blocks and examination surface shall not exceed 14°C.

6.2 PA Instrument Linearity

The following requirements shall be met at intervals not to exceed one year or prior to first use thereafter.

1) Screen height linearity: The PAUT equipment's screen height linearity shall be evaluated in accordance with Mandatory Appendix I of ASME Sect. V, Art.4.

2) Amplitude control linearity: The PAUT equipment's amplitude control linearity shall be evaluated in accordance with Mandatory Appendix II of ASME Sect. V, Art.4 for each pulse-receiver circuit
3) Equipment linearity shall be such that accuracy of indicated amplitude or time is ±5% of actual full scale amplitude or time.

6.3 Phased array system calibration

Calibration shall be performed from the surface of the calibration block which corresponds to the component surface to be examined. System calibration shall include the complete

Copyright EIL – All rights reserved

ultrasonic system. Screen distance calibration shall be at least 1-1/2 "veepaths"(also known as skip) for the minimum angle that will be used during the examination.

The system shall be calibrated for velocity and wedge delay calibration, sensitivity calibration, Time Corrected Gain (TCG) calibration. Encoder calibration and confirmation of sensitivity.

The system shall require re-calibration due any of the following conditions:
1) Search unit transducer or wedge change.
2) Search unit cable or length change.
3) Ultrasonic instrument change.
4) Change in examination personnel.
5) Change in type of power source.

7.0 PROCEDURE

7.1 Safety

At first, safety supervisor or technician should be confirmed regarding safety matters before starting examination. Those are included mainly of scaffolding, ladder, lighting, electric conditions and personnel safety equipments have been checked by themselves as followed Project Safety Regulation. If there is not clear for safety questions for personnel, equipment and examination, the technician has right to stop his job whenever.

7.2 A detailed Automated Ultrasonic examination procedure shall be prepared and qualified for each wall thickness and joint geometry to be examined prior to the start of any NDT work. Repair procedure shall be separately qualified for each joint geometry. The procedure as a minimum shall include the following:

Scope; equipment; probe type and details; surface preparation, cleaning and couplant; technique sheet for each technique specified (number of techniques to be sufficient to cover all type of joints to be covered by the procedures scope); material; weld material (if different); sketch showing joint configuration, beam coverage; extent of scan; scanning pattern; material thickness and curvature; calibrations and frequency; means of setting and scanning sensivity levels and DAC curves; flaw location and size evaluation; acceptance criteria; reporting format; operator qualifications.

7.3 Lamination Check

A-UT shall be performed using a device employing automatic computer based data acquisition. The straight beam material examination (T-472 of Section V, Article 4) for reflectors that could interfere with the angle beam examination shall be performed:
a) Manually,
b) As part of a previous manufacturing process, or
c) During the A-UT examination provided detection of these reflectors is demonstrated.
d) The coverage shall be included minimum 100mm from centerline of welding.

7.4 Examination Coverage

The required volume of the weld and base material to be examined shall be scanned using a linear scanning technique with an encoder. Each linear scan shall be parallel to the weld axis at a constant standoff distance with the beam oriented perpendicular to the weld axis.

The ultrasonic examination area shall include the volume of the weld, plus the lesser of 25mm (1 in.) or "t" on each side of the weld.

A documented examination strategy or scan plan shall be provided, showing transducer placement, movement, and component coverage, that provides a standardized and repeatable methodology for weld acceptance. The scan plan shall also include ultrasonic beam angle

Copyright EIL – All rights reserved

used, beam directions with respect to weld centerline, and pipe volume examined for each weld. The documentation shall be made available to the owner's Inspector.

7.5 Examination side

Basically shall be examined on the both sides of welding line axis but can be examined from one side in case of another side is not available access under full coverage volume condition.

7.6 Surface condition

The contact surface shall be cleaned of weld spatter, dirt, pitting, rust and/or any other impurities or roughness that will interfere with the free movement of the ultrasonic transducers or would prevent adequate transmission of ultrasound. Prior to inspection the NDT technician shall judge the suitability of the surface and when required remedial action shall be taken.

7.7 Scanning

1) The search unit shall be maintained at a fixed distance from the weld axis by a fixed guide or mechanical means.

2) The examination angle(s) for E-scan and range of angles for S-scan shall be appropriate for the joint to be examined.

3) Scanning speed shall be such that data drop-out is less than 2 data lines per inch (25mm) of the linear scan length and that there arr no adjacent data line skips.

4) For E-scan techniques, overlap between adjacent active apertures (i.e., aperture incremental change) shall be a minimum of 50% of the effective aperture height.

5) For S-scan techniques, the angular sweep incremental change shall be a maximum of 1 deg or sufficient to assure 50% beam overlap.

6) When multiple linear scan are required to cover the required volume of weld and base material, overlap between adjacent linear scans shall be a minimum of 10% of the effective aperture height for E-scan or bean width for S-scan

7) Each scan shall have an overlap of minimum 1 in. (25 mm) - (in case of re-acquisition of missing or poor data line etc.)

8) TOFD channel

The TOFD gate start will be set 1 µSec before the arrival of the lateral wave and should extend up to the first back wall echo to achieve full cover of wall thickness.

7.8 Data Recording

A-scan data shall be recorded in an unprocessed form with on threshold, at a minimum digitization rate of five times the examination frequency, and recording increments of a maximum of

a) 0.04 in. (1 mm) for material < 3 in. (75 mm) thick

b) 0.08 in. (2 mm) for material ≥ 3 in. (75 mm) thick

7.9 Reflectors Transverse to the Weld Seam

As an alternate to line scanning, a manual angle beam examination may be performed for reflectors transverse to the weld axis. Manual angle beam UT shall be accordance with manual ultrasonic examination procedure based on (T-472 of Article 4, ASME Sec V).

7.10 Re-examination

1) Re-examination for repaired welds shall follow the same condition (same examination method, same acceptance criteria) as for the original weld.

Copyright EIL – All rights reserved

2) The additional testing shall be extent a length at least equal to 1 in.(25 mm) from the both end of repaired area.

3) Additional NDT methods of UT and MT shall be carried out to make ensure for the repaired area

8.0 TRAINING AND QUALIFICATION

All Inspectors of the EIL/OWNER (EIL/OWNER) shall be imparted training at the CONTRACTOR's cost. The inspector shall be provided complete awareness and knowledge regarding the equipment, limitations, capabilities complete range, method of operation, calibration, scanning, including development of suitable procedure, training on variables effecting the system performance and interpretation of results.

The Ultrasonic lead operator performing the examination shall be qualified in accordance with the EIL/OWNER's written practice, ASNT-TC-1A, ASME B31 Case 181-1. The minimum qualification of person interpreting the collected data shall be a ASNT Level III.

Only qualified UT personnel trained in the use of the equipment and who have demonstrated the ability to properly acquire examination data, shall conduct production scan.

Scanner technician, Band setter, scribe line technician shall have sufficient experience and capabilities to perform their duties to the satisfaction of AUT operator.

9.0 EVALUATION AND ACCEPTANCE CRITERIA

9.1 Evaluation

9.1.1 Data analysis criteria

Reflectors exceeding the limits in either a) or b) below, as applicable, shall be investigated to determine whether the indications originates from a flaw or is a geometric indication in accordance with Para. 9.1.3 (Flaw sizing) below.

a) For amplitude-based techniques, the location, amplitude, and extent of all reflectors that produce response greater than 20% of the reference level shall be investigated.

b) For non-amplitude based techniques, the location and extent of all images that have an indicated length greater than the limits, as applicable, shall be investigated.

9.1.2 Geometric

Ultrasonic indications of geometric and metallurgical origin shall be classified as follows:

1) Indications that are determined to originate from the surface configurations(such as weld reinforcement or root geometry) or variations in metallurgical structure of materials (such as cladding to base metal interface) may be classified as geometric indications, and

a) Need not be characterized or sized.
b) Need not be compared
c) Location shall be recorded

2) The following steps shall be taken to classify an indication as geometric:

a) Interpret the area containing the indication;
b) Plot and verify the indication coordinate, provide a cross-sectional display showing the indication position and surface discontinuity such as root or counter bore; and
c) Review fabrication or weld preparation drawings.

Copyright EIL – All rights reserved

3) Alternatively other NDE methods or techniques may be applied to classify an indication as geometric (e.g. alternative UT beam angles, radiography, ID and/or OD profiling).

9.1.3 Flaw sizing

The dimensions of the flaw shall be determined by the rectangle that fully contains the area of the flaw.

Flaw Sizing - Reflectors determined to be flaws shall be sized in accordance with a procedure demonstrated to size similar flaws at similar material depths. A flaw may be sized by manually analysis the data using sizing techniques that have been demonstrated on the calibration block. The dimension of the flaw shall be determined by the size of the rectangle that fully contains the area of the flaw.

9.1.4 Flaw evaluation

Flaws shall be evaluated for acceptance using the applicable criteria of ASME B31.3 Appendix R.

9.2 Acceptance criteria

Weld quality shall be judged on the basis of the acceptability criteria mentioned in ASME B31.3 Appendix R.

Copyright EIL – All rights reserved

EXHIBIT – J: COMPUTED RADIOGRAPHY

1.0 DIGITAL RADIOGRAPHY- INTRODUCTION

2.0 REFERENCE DOCUMENTS

3.0 DIGITAL RADIOGRAPHY SYSTEM

4.0 SYSTEM CHARACTERIZATION

5.0 QUALIFICATION PLANS44

6.0 TECHNIQUES

7.0 FILE FORMAT AND STORAGE

8.0 PERSONNEL REQUIREMENTS

Copyright EIL – All rights reserved

1.0 COMPUTED RADIOGRAPHY- INTRODUCTION

The minimum requirements for Computed radiography using phosphor image plates (films) is covered here. It is the CONTRACTOR'S responsibility to arrange and maintain Computed Radiographic System as required by this specification.

2.0 REFERENCE DOCUMENTS

The latest edition with addendum of the following standards shall be referred here:

a) ASME Section V, Mandatory Appendix VIII- Non Destructive Examination, Radiography using Phosphor Imaging Plate.
b) ASTM E2446- Practice of classification of computed Radiography system.
c) EN 14784-1: Industrial COMPUTED Radiography with storage Phosphor imaging plate.
d) ASNT SNT-TC-1A - Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

3.0 COMPUTED RADIOGRAPHY SYSTEM

3.1 Integral Image plate scanner and eraser unit Image plate scanner and eraser are single unit and integral. Scanner will be able to scan different sizes of imaging plates. Scanner will be able to provide simultaneous multi-scanning feature. Scanning speed will be 100 plates per hour for 3 X 12 @ 50 microns or better. Scanner will be able to provide flat horizontal transport system.

3.2 Imaging Plates/Cassettes

3.2.1 Image plates/Cassettes should have electron beam cured protection layer. Certification shall be as per EN 14784-1. Image plates and scanner, eraser & cassettes will be suitable for Radiography using X-ray, Ir-192, Selenium and Cobalt-60.

3.2.4 Images obtained by computer Radiography will give equivalent or better results in terms of shape/size, geometrical unsharpness and back scattering.

3.2.5 The offered image plates will not get exposed/deteriorated due to exposure to sunlight, room light etc.

3.2.6 No dark room will be used for handling & removing image plates from covers/cassettes, scanning & erasing. All the work will be done under tube lights illuminated ventilated room. The image plates should not have effect of such use on quality/results produced.

3.2.7 Image plate sizes shall be as per weld joint size.

3.2.8 Normally 50, 60 and 100 micron of IP plates are used for inspection of weld joints depending on type of energy source. 50 microns is used for X-ray and selenium source, 60 microns for IR-192 and 100 microns for Co-60 energy source. Different combination of IP plate and energy source may be used as advised by the IP plate manufacturer depending upon the job thickness and achievement of sensitivity. CONTRACTOR shall consider this clause as guideline only and select right combination of IP plate and source type after establishing the Digital Radiography procedure.

3.3 Software & High performance Laptop (Computer)

3.3.1 Software shall be user friendly and rugged. Software should be powerful to acquire, review, report and archive inspection data which should be compatible with Windows XP/Vista operating systems.

Line Profile - Software for image assessment should be capable of generating a line profile. This should include the ability to generate a line profile of a variable width specified by the user in order to be able to perform the testing specified in ASTM E2737.

Bad Pixel Presentation – Software for image assessment should be capable of turning on and off the display of bad pixels on demand by the user.

Image Enhancements – Software should have the capability of display images without image enhancements and then allow the user to apply filters, edge enhancements or contrast enhancements as desired.

Preservation of Original Data – Software should retain the original data if image enhancements are applied.

It should have wall thickness measurement tools and software.

Copyright EIL – All rights reserved

3.3.2 Software should be capable of saving images in a DICONDE compliant file format in accordance with ASTM E2339.

3.3.4 Generation of reports in Microsoft word and excels formats. System should be capable of saving data in DVDs.

4.0 SYSTEM CHARACTERIZATION

4.1 Prior to the approval of any item specific techniques, the system should be characterized to establish the capabilities of the system and determine the baseline for system performance. If any key components of a system are replaced, such as IP type, scanner model, scanner settings, software, etc; then this system characterization testing should be repeated.

4.2 *System Performance Baseline* - This system characterization should utilize Image Quality Indicators (IQIs) for quantitative measurement of *key system performance parameters.* The IQIs and test articles for this testing should be selected based upon materials and geometries that are representative of the system's intended application. The level III radiographer is responsible for developing the testing procedures for determining the system performance baseline. Equipment manufacturer assistance may be taken if required.

4.3 *Multiple Focal Spots* - Systems which have multiple focal spots that will be used for inspection should test system performance for each focal spot that will be used.

5.0 QUALIFICATION PLANS

5.1 CONTRACTOR is responsible for development and documentation of the qualification plans.

5.2 The qualification plans should include the following minimum details:

System configuration: The qualification plan(s) should include a complete and accurate listing of the CR inspection equipment. This should be a detailed listing of the CR system components by manufacturer, model and serial numbers. The software list should include details of software which is being used as part of the inspection process and its version information. This listing should be updated when key components are replaced or the system is modified.

Procedures – The qualification plan(s) should include a listing of the procedures used for operation, calibration and maintenance of the equipment.

Range of Items – The qualification plan(s) should specify the items, devices, materials, components, etc. that are covered by the qualification plan. This listing should identify specific items that are covered by the plan

Defects Covered – The qualification plan(s) should specify the types of defects that will be covered by the inspection. Whenever possible, the defects should be described quantitatively such as specifying the minimum dimensions for length, width and depth of cracks for specific materials.

Technique Verification Requirements – The qualification plan(s) should include a description of how the technique or techniques will be verified and the frequency of the verification. This includes a description and the quantity of the samples used for the technique verification and what IQIs and/or RQIs will be used.

Data Format and its Storage – The qualification plan(s) should include and documented about data format and its storage along with integrity & retrievability.

Revision – A qualification plan should be revised whenever any component specified above is changed.

6.0 TECHNIQUES

6.1 All techniques should be covered by a qualification plan approved by the level III radiographer.

6.2 *Filters and Collimators* – The written technique should specify the thickness, material and location of any beam hardening filters. The technique should also specify if a collimator is used to tighten the beam spread and the setting or position of the collimator if adjustable.

6.3 *Representative Quality Indicators* - Image quality indicators used shall be similar to conventional radiography as per this document.

Copyright EIL – All rights reserved

6.4 Type of radiation source shall be as per EXHIBIT-H in this document. Other radiation source might be used in consultation of CR System manufacturer considering energy level.

6.5 Filter Screens - Filter screens should be in intimate contact with the imaging plate with the exception of a thin layer or coating to prevent direct contact between the lead and the imaging plate.

6.6 *Backscatter* - Back filter screens should be used for protection from backscattered radiation. Lead or other suitable material should be used behind the imaging plate to prevent scattered radiation.

6.7 Viewing Adjustments – Standard digital image viewing software allows adjustment of Window/Level and Zoom. The technique should specify if these parameters may be adjusted during image assessment and the allowable range of adjustment.

6.8 Image Enhancements – All automated and manually applied image enhancements which manipulate the digital data, including digital filters, contrast or edge enhancements, etc. should be specified in the written technique unless specified in a system's operation procedure that is approved by the level III radiographer. Any manually controlled image enhancements specified in the technique should include the range of adjustment that is allowed.

6.9 Gray Value Range – Techniques should specify an acceptable gray value range of the area of interest, similar to a film density value used in film radiography. In addition, the gray value on the IQI should be within +/- 15% of the gray value as the area of interest.

6.8 Image Storage – The format for file storage should be specified in the written technique unless specified in a systems operation procedure that is approved by the level III radiographer.

6.9 Technique Verification– All techniques should be verified prior to approval by the level III radiographer. The verification should simulate the inspection as closely as is practical. This verification should ensure that the technique and inspection process are capable of detecting all defects specified in the inspection criteria and should be witnessed by a CLIENT representative.

6.10 Verification Personnel – During the validation, the inspection process should be performed by the same personnel who will be performing the inspection once the technique has been approved. The level III radiographer should witness the validation.

6.11 Written Technique – The technique used for the verification should be documented prior to the start of the verification. Changes made to the technique during the verification process may require the verification to be restarted at the discretion of the level III radiographer and/or CLIENT representative.

6.12 Samples for Demonstration - The preferred method of verification utilizes real or simulated defects (RQIs) in a blind test. At a minimum, the verification should be done using production representative samples.

7.0 FILE FORMAT AND STORAGE

7.1 *DICONDE* - Software should be capable of saving images in a DICONDE compliant file format in accordance with ASTM E2339. The full bit depth of the image should be retained in the saved image. Images should be saved in a lossless format.

7.2 *DVD* - Systems should be capable of saving data to DVDs. CDs may be used for smaller inspections; however, any inspection that cannot fit onto a single CD should be submitted on a DVD. DVDs used for submittal of images to the CLIENT should be write-once (DVD-R or DVD+R).

7.3 *DICONDE Headers* - Information stored in the DICONDE headers should contain as a minimum:-

- Detector manufacturer and model
- Viewing software and version number
- Pixel pitch (in microns)
- Part Name, such as nomenclature
- Part Identification, such as DODIC or drawing number
- Lot Number
- Date of Inspection
- Inspecting Activity

Copyright EIL – All rights reserved

7.4 Data Archival - Data should be archived in a secure location for the minimum duration specified in the contract.

7.5 Digital Annotation - If digital labeling is used, it should not permanently alter the nature of the image or hinder interpretation of an area within the image.

8.0 PERSONNEL REQUIREMENTS

Personnel should be trained and certified in accordance with an approved as established by ASNT-TC-1A or NAS-410. As a minimum, Level II and III individuals shall have 40 hours of training and 1 month of practical experience in the digital imaging process technique.

Copyright EIL - All rights reserved

बोलीकर्ता / आपूर्तिकर्ताओं / ठेकेदारों से गुणवत्ता प्रबंधन प्रणाली अपेक्षाओं हेतु विनिर्देश

SPECIFICATION FOR QUALITY MANAGEMENT SYSTEM REQUIREMENTS FROM BIDDERS / SUPPLIERS / CONTRACTORS

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convener	Approved by: Standards Bureau Chairman
3	29-09-2025	General Revision	QMS Standards Committee	QMS Standards Committee	AK	MN
2	12-06-2020	General Revision	QMS Standards Committee	QMS Standards Committee	SKB	SKS
1	12-03-2015	General Revision	QMS Standards Committee	QMS Standards Committee	MPJ	SC
0	04-06-2009	Issued as Standard Specification	QMS Standards Committee	QMS Standards Committee	SCT	ND

Copyright EIL – All rights reserved

Abbreviations:

EIL	Engineers India Limited
ISO	International Organization for Standardization
MR	Material Requisition
PO	Purchase Order
PR	Purchase Requisition
QMS	Quality Management System

QMS Standards Committee

Convener: Mr. Anil Kumar

Members: Mr. Himangshu Pal (SCM-Inspection)
Mr. Ravindra Kumar (Const.)
Mr. Vinod Kumar (CQA)
Mr. Swapnil Vaishnav (Projects)
Mr.Vijay Kumar Garg (SCM)
Mr.Raju Kumar Pandey (Equipment Division)

Copyright EIL – All rights reserved

CONTENTS

Clause	Title	Page No.
1.0	SCOPE	4
2.0	DEFINITIONS	4
3.0	REFERENCE DOCUMENTS	4
4.0	QUALITY MANAGEMENT SYSTEM – GENERAL	4
5.0	QUALITY SYSTEM REQUIREMENTS	4
6.0	AUDITS	6
7.0	DOCUMENTATION REQUIREMENTS	7

Copyright EIL – All rights reserved

1.0 SCOPE

This specification establishes the Quality Management System requirements to be met by BIDDER for following purpose:

- QMS requirements to be met by suppliers/contractors after award of work/duringcontract execution.

2.0 DEFINITIONS

2.1 Bidder

For the purpose of this specification, the word "BIDDER" means the person(s), firm, company or organization who is under the process of being contracted by EIL / Owner for delivery of some products (including service).The word "Bidder" is considered synonymous to supplier, contractor or vendor.

2.2 Project Quality Plan (PQP)

Document tailored from Standard Quality Management System Manual of BIDDER, specifying how the quality requirements of the project will be met.

2.3 Owner

Owner means the owner of the project for which services / products are being purchased and includes their representatives, successors and assignees.

3.0 REFERENCE DOCUMENTS

- Specification for Documentation Requirements from Contractors (Doc. No. 6-78-0002)
- Specification for Documentation Requirements from Suppliers (Doc. No. 6-78-0003)

4.0 QUALITY MANAGEMENT SYSTEM – GENERAL

Unless otherwise agreed with EIL / Owner, the BIDDER proposed quality system shall fully satisfy all relevant requirements of ISO 9001 "Quality Management Systems – Requirements."Evidence of compliance shall be current certificate of quality system registration to ISO 9001 or a recent compliance audit recommending registration from a certification agency.The quality system shall provide the planned and systematic control of all quality related activities for execution of contract.Implementation of the system shall be in accordance with BIDDER'S Quality Manual and PROJECT specific Quality Plan.

5.0 QUALITY SYSTEM REQUIREMENTS

5.1 BIDDER shall prepare and submit for review / record, Project Quality Plan / Quality Assurance Plan for contracted scope / job.The BIDDER'S Quality Plan shall address all of the applicable elements of ISO 9001, identify responsible parties within BIDDER'S organization, for the implementation / control of each area, reference the applicable procedures used to control / assure each area, and verify the documents produced for each area.The Project Quality Plan shall necessarily define control or make reference to the relevant procedures, for design and engineering, purchase, documentation, record control, bid evaluation, inspection, production/manufacturing, preservation, packaging and storage, quality control at construction site, pre-commissioning, commissioning and handing over (as applicable) in line with contract requirement and scope of work.

Copyright EIL – All rights reserved

5.2 BIDDER shall identify all specified or implied statutory and regulatory requirements and communicate the same to all concerned in his organization and his sub contractor's organization for compliance.

5.3 BIDDER shall deploy competent and trained personnel for various activities for fulfilment of PO / contract.BIDDER shall arrange adequate infrastructure and work environment to ensure that the specification and quality of the deliverable are maintained.

5.4 BIDDER shall do the quality planning for all activities involved in delivery of order.The quality planning shall cover as minimum the following:

- Resources
- Product / deliverable characteristics to be controlled.
- Process characteristics to ensure the identified product characteristics are realized
- Identification of any measurement requirements, acceptance criteria
- Records to be generated
- Need for any documented procedure

The quality planning shall result into the quality assurance plan, inspection and test plans (ITPs) and job procedures for the project activities in the scope of bidder. These documents shall be submitted to EIL/Owner for review/approval, before commencement of work.

5.5 Requirements for sub-ordering of outsourced items /sub-contracting / purchasing of services specified in MR/ contract / tender shall be adhered to. In general all outsourced items will be from approved vendors of EIL. Wherever requirements are not specified, or approved sub vendors do not exist, the sub-contractor shall establish and maintain a system for purchasing / sub-contracting to ensure that purchased product / service conforms to specified requirements in concurrence with EIL / Owner.Criteria for selection of sub-contractor, evaluation, re-evaluation, maintenance of purchasing data and verification of purchased product (sub-contractor services), constitute important components of this requirement.

5.6 BIDDER shall plan and carry production and service provision under controlled conditions.Controlled conditions shall include, as applicable

a) the availability of information that describes the characteristics of the product
b) the availability of work instructions
c) the use of suitable equipment
d) the availability and use of monitoring and measuring devices
e) the implementation of monitoring and measurement
f) the implementation of release, delivery and post-delivery activities

5.7 BIDDER shall validate any processes for production and service provision where resulting output cannot be verified by subsequent monitoring and measurement. This includes any process where deficiencies become apparent only after the product is in use or service has been delivered.

5.8 BIDDER shall establish a system for identification and traceability of product / deliverable throughout product realization.Product status with respect to inspection and testing requirements shall be identified.

5.9 BIDDER shall identify, verify, protect and safeguard EIL / Owner property (material / document) provided for use or incorporation into the product.If any Owner / EIL property is lost, damaged or otherwise found to be unsuitable for use, this shall be reported to the EIL / Owner.

Copyright EIL – All rights reserved

BIDDER shall ensure the conformity of product / deliverable during internal processing and delivery to the intended destination.Requirements mentioned in the MR/ tender shall be adhered to.

5.10 BIDDER shall establish system to ensure that inspection and testing activities are carried out in line with requirements.Where necessary, measuring equipment shall be calibrated at specified frequency, against national or international measurement standards; where no such standard exists, the basis used for calibration shall be recorded.The measuring equipment shall be protected from damage during handling, maintenance and storage.

5.11 BIDDER shall ensure effective monitoring, using suitable methods, of the processes involved in production and other related processes for delivery of the scope of contract.

5.12 BIDDER shall monitor and measure the characteristics of the product/deliverable to verify that product requirement has been met.The inspection (stage as well as final) by BIDDER and EIL / Owner personnel shall be carried out strictly as per the approved ITPs or ITPs forming part of the contract.Product release or service delivery shall not proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by relevant authority and where applicable by Owner / EIL.

5.13 BIDDER shall establish and maintain a documented procedure to ensure that the product which does not conform to requirements is identified and controlled to prevent its unintended use or delivery

5.14 All non-conformities (NCs) / deficiencies found by the BIDDER'S inspection / surveillance staff shall be duly recorded, including their disposal action shall be recorded and resolved suitably.Effective corrective actions shall be implemented by the BIDDER so that similar NCs including deficiencies do not recur.The BIDDER shall take appropriate actions to address the Risks and Opportunities in the project.

5.15 All deficiencies noticed and reported by EIL / Owner shall be analysed by the BIDDER and appropriate corrective actions shall be implemented.BIDDER shall intimate EIL / Owner of all such corrective action implemented by him.

5.16 BIDDER should follow the standards, specifications and approved drawings. Concessions/Deviations shall be allowed only in case of unavoidable circumstances. In such situations Concession/deviation request must be made by the BIDDER through online system of EIL vendor portal for document exchange. URL of EIL vendor portal for document exchange is http://edocx.eil.co.in/vportal. BIDDER shall have documented procedure for control of documents.

5.17 All project records shall be carefully kept, maintained and protected for any damage or loss until the project completion, then handed over to EIL / Owner as per contract requirement (Refer Specification Nos. 6-78-0002 - Specification for Documentation Requirements from Contractors and 6-78-0003 - Specification for Documentation Requirements from Suppliers), or disposed as per relevant project procedure.

6.0 AUDITS

BIDDER shall plan and carry out the QMS audit for the job. Quality audit program shall cover design, procurement, construction management and commissioning as applicable including activities carried out by sub-vendors and sub-contractors. This shall be additional to the certification body surveillance audits carried out under BIDDER'S own ISO 9001 certification scheme.

Copyright EIL – All rights reserved

The audit programs and audit reports shall be available with bidder for scrutiny by EIL / Owner.EIL or Owner's representative reserves the right to attend, as a witness, any audit conducted during the execution of the WORKS.

In addition to above, EIL, Owner and third party appointed by EIL/Owner may also perform Quality and Technical compliance audits.BIDDER shall provide assistance and access to their systems and sub-contractor / vendor systems as required for this purpose.Any deficiencies noted shall be immediately rectified by BIDDER.

7.0 DOCUMENTATION REQUIREMENTS

BIDDER shall submit following QMS documents immediately after award of work (Within one week) for record / review by EIL / Owner/ TPIA(Third Party Inspection Agency), as applicable:

- Organization chart (for complete organization structure and for the project)
- Project Quality Plan/Quality Assurance Plan
- Job specific Inspection Test Plans, if not attached with PR
- Job Procedures
- Inspection/Test Formats

In addition to above QMS documents, following documentation shall be maintained by the BIDDER for submission to EIL / Owner on demand at any point of time during execution of the project:

- Quality Manual
- Certificate of approval for compliance to ISO9001 standard
- Procedure for Control of Non-conforming Product
- Procedure for Control of Documents
- Sample audit report of the QMS internal and external audits conducted during last one year
- Customer satisfaction reports from at least 2 customers
- Project QMS audit report
- Technical audit reports for the project
- Corrective action report on the audits

Documents as specified above are minimum requirements. BIDDER shall submit any other document/data required for completion of the job as per EIL/Owner instructions.

Copyright EIL – All rights reserved

Page 3664 of 4087 : B895-TENDER_DOC-B895-999-85-41-EP-T-9802 : Rev. A

ठेकेदारों से प्रलेखन अपेक्षाओं हेतु विनिर्देश

SPECIFICATION FOR DOCUMENTATION REQUIREMENTS FROM CONTRACTORS

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
3	29-09-2025	General Revision	QMS Standards Committee	QMS Standards Committee	AK	MN
2	12-06-2020	General Revision	QMS Standards Committee	QMS Standards Committee	SKB	SKS
1	12-03-2015	General Revision	QMS Standards Committee	QMS Standards Committee	MPJ	SC
0	04-06-2009	Issued as Standard Specification	QMS Standards Committee	QMS Standards Committee	SCT	ND

Copyright EIL – All rights reserved

Abbreviations:

DEC	Detailed Engineering Contractor
DCI	Document Control Index
EIL	Engineers India Limited
EPCC	Engineering Procurement Construction Contract
FOA	Fax of Acceptance
IC	Inspection Certificate
IRN	Inspection Release Note
ITP	Inspection and Test Plan
LOA	Letter of Acceptance
LSTK	Lumpsum Turnkey
ODC	Over Dimension Consignment
PMC	Project Management Consultancy
QMS	Quality Management System
URL	Universal Resource Locator

QMS Standards Committee

Convener: Mr. Anil Kumar

Members:
Mr. Himangshu Pal (SCM-Inspection)
Mr. Ravindra Kumar (Const.)
Mr. Vinod Kumar (CQA)
Mr. Swapnil Vaishnav (Projects)
Mr.Vijay Kumar Garg (SCM)
Mr.Raju Kumar Pandey (Equipment Division)

Copyright EIL – All rights reserved

CONTENTS

Clause	Title	Page No.
1.0	SCOPE	4
2.0	DEFINITIONS	4
3.0	REFERENCE DOCUMENTS	4
4.0	DOCUMENTATION AND DATA REQUIREMENTS	4

Annexures:

S. No.	Title	Doc. No.
1.	Format for completeness of Final Documentation	Format No. 3-78-0004

Signature Not Verified
Digitally signed by MD MAZHER ALI
Date: 2026.03.17 18:12:37 IST
Location: eProcure-EPROC

Copyright EIL – All rights reserved