JOB SPECIFICATION

FOR

BIPOLAR CONCRETE PENETRATING CORROSION INHIBITING ADMIXTURE

TO

PROTECT EMBEDDED STEEL REINFORCEMENT IN CONCRETE

PROJECT : DAHEJ PETROCHEMICALS COMPLEX

OWNER : ONGC PETRO additions LTD.

PMC : ENGINEERS INDIA LTD.

JOB NO. : 6987

Rev. No	Date	Purpose	Prepared	Checked	Approved
0	26-06-09	ISSUED AS JOB SPECIFICATION	PM	AS	SC

CONTENTS

1.0 SCOPE

1.1 This specification prescribes the requirements and test methods of physico – chemical characteristics including performance test for evaluating the efficiency of the product in the laboratory for protecting steel reinforcement embedded in concrete from corrosion.

1.2 This standard prescribes the requirements and methods of test for the material known as Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (CPCIA). The CPCIA shall be concrete penetrating type which upon addition into the concrete matrix inhibits the corrosion process. It need not be in direct contact with the steel. Its vapours penetrate through fissures, honeycomb structure of concrete, pure water solution added in concrete and seals steel reinforcement at both anodic & cathodic sites, for inhibition. This is due to the bipolar mechanism property of the system. Non-concrete penetrating, nitrite & nitrate corrosion inhibitors are excluded from this scope. The product shall be suitable to protect embedded steel reinforcement bars used in concrete structures from corrosion.

2.0 TERMINOLOGY

2.1 For the purpose of this standard the definitions as given in latest versions of ASTM-G1, ASTM-G3, ASTM-G109, ASTM-C 1202, JIS-Z-1535, AASHTO T259, IS:101(Part1/sec.5)-89, IS:456-2000, IS:1202-97, IS:1448-67, IS:1786-85, IS:9103-99 etc. shall apply.

2.2 Rounding off, of observed values on different tests shall be in accordance with IS: 2-1960.

3.0 SAMPLING

3.1 The representative samples of the material shall be drawn by the purchaser or the Inspecting authority as per the table given below:

Scale of Sampling for CPCIA

No. of containers lot (N)	No. of containers to be selected for sampling (N)
Up to 50	1
51-100	2
101-200	3
201-300	3
301-500	4
501-800	5
801-above	6

4.0 PROPERTIES

4.1 The material shall comply with the requirements specified in Clause 5.0, Table-I and Table-II of this specification.

4.2 Unless otherwise specified, the following testing conditions shall apply.

4.2.1 All the tests shall be conducted at room temperature 27± 2°C and relative humidity at 65±5 % in a well ventilated chamber free from draught and dust.

5.0 REQUIREMENTS

5.1 The admixture shall be supplied in one pack.

5.2 There are two types of requirements that the material should meet in order to be considered for usage.

5.2.1 Properties which can be evaluated in short duration as laid down in Table –I. It can be performed at a laboratory or at sites with proper testing facilities.

5.2.2 Properties which can be evaluated by performing long duration tests as laid down in Table–II.

5.2.3 All the tests performed under Indian Tropical Conditions mentioned in Table-I & Table-II are mandatory requirement for the approval of product.

5.2.4 Approving authorities certificate for long term tests and Suppliers test certificate meeting the short term requirements may be accepted by the purchaser. However, short term tests may be cross checked with NABL accredited laboratory if desired.

5.3 The recommended dosage of CPCIA in concrete shall be preferably 1% (w/w of Cement) or as recommended by the manufacturer.

5.4 Tests specified in Table II shall be performed in triplicate.

TABLE –I

REQUIREMENT OF BIPOLAR CONCRETE PENETRATING CORROSION INHIBITING ADMIXTURE (Short Term Tests)

Sr. No .	Characteristics	Requirements	Methods of Tests
1.	Appearance	Brownish Liquid free from any visible residual deposits	Visually
2.	Odour	Mild Ammonical Odour	By smell
3.	Skin irritation	No irritation	By applying on reverse of the palm for 05 minutes.
4.	pH i) As in supplied condition ii) 1% dilution ,w/w	i) 9.0-11.0 ii) 9.0-11.0	pH meter / Standard pH paper
5.	Specific Gravity at 27 ± 2°C	1.04-1.06	IS 1448-1967

Sr. No .	Characteristics	Requirements	Methods of Tests
6.	Viscosity of the material as in supplied condition, by Ford cup No 4, at 27 ± 2°C	10 -20 sec.	IS: 101(Pt.1/Sec.5)1989
7.	Accelerated Corrosion Test, for 21 hrs. i) Raw water without CPCIA ii) ii) Raw water with CPCIA	i) Excessive corrosion spots. ii) There shall not be more than 1-2 corrosion spots.	Modified accelerated corrosion test (Based on Japanese standard JIS Z 1535)

TABLE –II

REQUIREMENT OF BIPOLAR CONCRETE PENETRATING CORROSION INHIBITING ADMIXTURE (Long Term Tests)

Sr. No .	Characteristics	Requirements	Methods of Tests
1.	Immersion test for 720 hrs. (Rebar weight loss method) i) With out CPCIA* ii) With 1% CPCIA*	i) 40.00 mpy, max. ii) 2.00 mpy, max.	Immersion Test (Rebar weight loss test)[as / ASTM G 1]
2.	Effect of Concrete admixture on compressive strength i) Wth out CPCIA* ii) With 1% CPCIA*	Concrete strength in sample with CPCIA* should be ≥concrete strength in sample without CPCIA*	Test for effect on compressive strength by addition of CPCIA [IS 9103-1999]
3.	Polarization test by Tafel polarization with 3.5% Sodium Chloride, for 20 days i) With out CPCIA* ii) With 1% CPCIA*	Rate of corrosion shall be i) 45 mpy, max. ii) 9 mpy, max.	Electrochemical polarization test conducted on steel rebars embedded in concrete [ASTM-G 3 and IS 9103-1999]
4.	Effect of CPCIA* on corrosion of embedded steel rebars exposed to chloride environments after 09 cycles (14 days wetting and 14 days drying) as per ASTM G109. i) With out CPCIA* ii) With 1% CPCIA*	Rate of corrosion shall be i) 25.00 Coulombs, max. ii) 0.50 Coulombs, max.	Long term corrosion test [ASTM G-109-2005]

Sr. No .	Characteristics	Requirements		Methods of Tests
5.	Chloride Migration profile properties of concrete with & without CPCIA	With out CPCIA*	With 1% CPCIA*	AASHTO T-259
		Chloride % shall be		
	i) Chloride % in concrete at 30 mm depth after 90 days. (For all types of cements e.g. OPC,PPC,PSC,SRC)	0.025%, max.	Nil	i)Chloride ion penetration (Salt ponding test) [IS:456-2000]
	ii) Ability to resist chloride ion penetration (RCPT) (For all types of cements e.g. OPC, PPC, PSC, SRC)	Resistance to chloride ion penetration shall be		ii) Electrical indication of Concrete ability to resist Chloride Ion Penetration (Rapid Chloride Permeability test) [ASTM C-1202 1997]
	a) Concrete grade M-30, Water cement ratio: 0.45	1650 Coulombs, max.	1000 Coulombs, max.	
	b) Concrete gradeM-40, Water cement ratio: 0.40	1550 Coulombs, max.	1000 Coulombs, max.	

Note

1 CPCIA* : Bipolar Concrete Penetrating Corrosion Inhibiting Admixture. The CPCIA shall be used as 1% w/w of cement or as recommended by the manufacturer for conducting the tests mentioned in Table-II except Immersion test for 720 hrs mentioned at S. No. 1 where it shall be used as 1% w/w of water or as recommended by the manufacturer.

2 Wherever required , rebars conforming to IS: 1786-1985 shall be used for testing purposes

6.0 SAFETY TO CONSTRUCTION MATERIAL

CPCIA should not degrade, or damage the construction materials.

i) Concrete

ii) Aggregates

iii) Steel reinforcement

iv) Form work/Shuttering

7.0 SAFETY FOR FABRICATION

The CPCIA should not cause harm to personnel by mean of inhalation or skin

contact. All precautionary measures shall be intimated by the manufacturers clearly in writing along with instructions of usages. However final decision about adoption of such measurers shall lie with the EIL or client and shall depend upon the conditions prevailing at the site.

8.0 WASTE WATER DISCHARGE

The waste discharge shall be in accordance with the laws of pollution control in force from time to time.

9.0 PACKING

The material shall be packed in suitable air tight polyethylene containers preferably of capacity 20 kg / 200kg or as agreed by purchaser and supplier.

10.0 MARKING

10.1 Each container shall be legibly and indelibly marked with the following:

a) Name of the material
b) Name of the manufacturer
c) Volume / weight of material
d) Specification number
e) Batch No. or Lot No. in code or otherwise
f) Month and year of manufacture

11.0 INSPECTION

11.1 At the time of initial approval of the product or firm, full testing as mentioned in clause 5.2.3, shall be carried out.

11.2 In case of acceptance testing, Inspecting Authority shall draw the sample as per clause 3.1, from the batch under consideration and the material shall be tested for the tests stipulated in Table-I.

11.2.1 Long duration tests need substantial amount of time. The testing facilities for these tests may not be available in each and every laboratory, therefore, Approving authority's certificate for long term tests as stipulated in Table-II & Supplier's test certificate/NABL accredited laboratory test certificate meeting the short term tests as stipulated in Table-I may be accepted by the Purchaser for the acceptance of the material. However if desired by the purchaser, long term tests may also be organized to be carried out at any IITs/NABL accredited laboratory.

तकनीकी विनिर्देशन
सिविल एवं संरचनात्मक कार्य

TECHNICAL SPECIFICATION
CIVIL & STRUCTURAL WORKS

टर्नकी पैकेज के लिए
सीमेंट एवं इस्पात की चिमनी

RCC AND STEEL CHIMNEYS FOR TURNKEY PACKAGE

NO.	DATE	REVISION	BY	CHECKED	CONVENOR	CHAIRMAN (S.B.)
1	27/03/98	REVISED & ISSUED AS STANDARD SPECIFICATION	SPC	SCS	SCJAIN	ASONI
0	22/12/89	ISSUED AS STANDARD SPECIFICATION	HCS ()	HCS ()	KCK ()	RCPC ()

CONTENTS

SECTION - I

SCOPE OF WORK

1.0 GENERAL

The scope of work under this contract shall include preparation of detailed design, drawings, supply and construction of all civil and structural/thermal lining/electrical work required for the successful and satisfactory completion of the contract.

2.0 DETAILED ENGINEERING

2.1 The Contractor shall design the structures and prepare all the required drawings needed for correct and accurate construction. The design shall be strictly in accordance with the "Design Specifications" given herein.

2.2 The Contractor shall submit a detailed schedule for release of drawings/ documents for review by EIL in the format given in Annexure-I within four weeks of date of award of the contract (LOI/TOI). Such a schedule shall be made in line with the overall time schedule given elsewhere. The Contractor shall strictly adhere to the reviewed/approved/agreed schedule.

2.3 The Contractor shall submit the design basis and General Arrangement (G.A.) of the chimney including the foundation alongwith required explanatory sketches/drawings and get the same reviewed by EIL before starting the final design and AFC drawings.

2.4 Construction of the chimney shall not be taken up at site till all the drawing are reviewed by EIL, and comments/suggestions given by EIL are incorporated.

2.5 The contractor shall not be allowed to revise any of his design/drawing/detailing unless the same is required after review of such documents by EIL. Such revisions shall be kept restricted to only those commented upon earlier. Similarly there shall be no addition of new details in the drawings unless called for by the earlier comments. All revisions shall be clearly pointed out and clouded for easy identification and/or review.

2.6 EIL reserves the right to review any/all or none of the designs and drawings. Review by EIL shall not relieve the Contractor of his responsibility for correct design and execution of the works.

2.7 The final design and AFC drawings shall strictly adhere to the reviewed design basis and general arrangement and shall incorporate all the comments/suggestions given by EIL without any extra cost to the Owner and any implication on time-schedule for completion of work.

2.8 The Contractor shall supply requisite number of prints (as mentioned elsewhere) of the design calculations and drawings for EIL's review/information/record. All the designs and drawings submitted by the Contractor shall be complete in all respects and thoroughly checked, approved, stamped "APPROVED FOR CONSTRUCTION" (AFC) and signed by the contractor's own responsible engineer (irrespective of the fact that the same are prepared in the contractor's own design office or by an approved agency) to ensure accuracy, correctness and completeness before submission to EIL.

Incomplete, unchecked, unsigned and unstamped documents/drawings and designs shall not be accepted for review/construction and shall be returned forthwith.

2.9 The design and drawings for the chimney shall be submitted by the Contractor in one lot so as to facilitate an overall systematic review.

2.10 All design and drawings shall be prepared in the Contractor's own design office, or in case such facility is not available with the contractor, by an established agency. The names of at least two agencies, who may be considered for entrusting with the work, including their acceptance letter if allotted with the job shall be submitted along with the offer for approval of EIL. If none of the agencies so named is approved, the Contractor shall submit a fresh list for approval.

Bio-data of the engineers who shall be directly involved in the design and preparation of AFC drawings shall be submitted along with the offer irrespective of the fact that detail engineering is being done by the Contractor himself or his appointed agency.

2.11 After the completion of erection and construction, the contractor shall submit to the Owner "As Built " drawings in requisite number of copies as specified elsewhere alongwith one set of reproducibles.

2.12 All fabrication/erection drawings and bar bending schedules shall be prepared by the Contractor and shall be directly Issued for construction to his work site. Six copies of such drawings shall, however, simultaneiously be submitted to the Engineer-in-Charge for review. Design calculations for all splices, joints and gusset plates shall be submitted to the Engineer-in-Charge whenever asked for. The Engineer-in-Charge at his discretion may review all or some or none of these designs & drawings.

Wherever such review is carried out the same shall be restricted to the following only:

a) structural layout, orientation, elevation of structural members.

b) section/size of members.

c) adequacy of few critical connections and joints for their required strength.

3.0 CONSTRUCTION

3.1 Construction of all civil & structural works including supply of all materials, labour, supervision, plant, tools and tackles etc. shall be carried out by the Contractor.

3.2 All materials and construction shall conform to the Material and Construction Specifications given in Section III of this document.

3.3 Materials of construction shall be selected in such a way so as to protect the structures & foundations against any harmful effect of chemicals, fumes etc. present in the plant or its vicinity or in the ground and/or subsoil water.

3.4 The Contractor shall be responsible for obtaining the statutory approval from local authorities such as Municipal Corporation, Development Authorities, Inspector of Factories and any other concerned authorities before starting the work.

ANNEXURE-I
[Cl.2.2 of Section-I]

NO	DATE	REVISION	BY	CHKD	APPD

SCHEDULE FOR RELEASE OF DRGS./ DOCUMENTS

CONTRACTOR:

PLANT :

UNIT :

S.NO.	DOC. NO.	TITLE	SCHEDULED DATE FOR SUBMISSION FOR REVIEW	
			PROPOSED	AGREED

SECTION - II

DESIGN SPECIFICATIONS

1.0 GENERAL

The design considerations given hereunder establish the minimum basic requirements for the design of RCC and structural steel chimneys. However, the chimney shall be designed for the satisfactory performance of the functions for which the same is to be constructed.

1.1 Whenever any reference to IS Codes is made, the same shall be taken as the latest revision (with all amendments issued there to) on the notified date of submission of tender.

1.2 Apart from the IS Codes mentioned in particular in the various clauses of this specification, all other relevant codes related to the specific job under consideration and/or referred to in the above mentioned codes shall be followed wherever applicable. Reference to some of the codes in the various clauses of this specification does not limit or restrict the scope of applicability of other relevant codes.

1.3 In case of any variation/contradiction between the provisions of IS Codes and the specifications given hereunder, the provisions given in these specifications shall be followed.

2.0 LOADING

2.1 General

The chimney shall be designed for all loads including the weight of chimney, accessories, temperature and wind or earthquake. Due consideration shall be given to loadings during the construction/erection phase and accounted for in the design.

2.2 Design Loads:

2.2.1 Dead Load

All permanent loads due to the weight of chimney shell, corbels and lining supported on them, platforms, ladders, flue ducts and other accessories.

2.2.2 Imposed Load

Imposed load on service platforms around chimney shall be taken as 300Kg/m^2 . Design live load during construction/erection shall be computed as per actual condition.

2.2.3 Wind Load

The wind loading shall conform to IS-875. Dynamic analysis shall be carried out as per IS-4998 and IS-6533 for RCC and steel chimney respectively and stability ensured under such condition. If two or more chimneys are spaced at less than 20 times the diameter (effective diameter i.e. diameter at 2/3rd height of the chimney) of bigger chimney or when the chimney is located close to other structure of comparable height, due consideration shall be taken into account for carrying out wind loading analysis due to aerodynamic interferences.

2.2.4 Earthquake Load

Earthquake forces acting on the chimney and analysis for the same shall be carried out as per IS-1893. The horizontal design seismic coefficient (α_h) shall be worked out by response spectra method as per IS1893 with an Improtance Factor of 2. Where seismo-tectonic studies are carried out, the design seismic coefficient (α_h) shall be based on the seismo-tectonic report.

2.2.5 Thermal Effect

Forces in both vertical and circumferential direction due to variation in temperature at internal and external face of chimney shall be considered. The stresses induced in concrete due to these forces shall not exceed, those given in IS-4998. The thickness of thermal lining shall be so designed that temperature on the inner face of chimney shell at any cross section never exceeds 80°C in case of concrete chimney and 200°C in case of steel chimney for steel as per IS-2062.

2.2.6 Local Loads

The effect of following local loads shall also be considered.

a) Local moment produced by thermal gradient at all thickenings.
b) Local moment produced by interior corbels.
c) Local moment due to platform.
d) Local moment produced by ovalling.
e) Local buckling of shell (For steel chimney).

3.0 LOAD COMBINATION

Chimney shall be designed for the most unfavourable load combination during construction, operation and shut down conditions. Various load combinations for calculation of stresses shall be as under.

3.1 RCC Chimney

a) Dead Load + Wind Load

b) Dead Load + Earthquake force.

c) Dead Load + Temperature effect.

d) Dead Load + Wind Load + Temperature effect.

e) Dead Load + Earthquake force + Temperature effect.

In combinations(a) and (b) above dead load considered shall be with or without the weight of lining whichever condition is more critical. In all other cases of load combinations, dead load shall include the weight of lining and imposed loads on all service platforms.

In all combinations, effect of local loads shall also be considered.

3.2 **Steel Chimney**

a) Dead load + Wind load

b) Deal load + Earthquake load

c) Dead load + Load due to lining + Imposed load on service platforms + Wind load.

d) Dead Load + Load due to lining + Imposed load on service platforms + Earthquake load.

3.3 The thickness of lining shall not be assumed to increase the section modulus of the shell nor to resist overturning due to lateral bending action or strutting action from wind/seismic forces for stability checking.

4.0 DESIGN AND DETAILING REQUIREMENTS FOR RCC CHIMNEY

4.1 The chimney shall be designed to resist stresses in concrete and reinforcing steel resulting from various load combinations. The permissible stresses for various load combination shall not exceed those given in IS-4998.

4.2 The minimum thickness of concrete shell for any chimney with an average internal diameter of 4m or less shall be 150 mm. When the average internal diameter exceeds 4m, the minimum thickness in mm shall be

$$150 + \frac{Dci - 4000}{100}.$$

Where Dci = average inside diameter of the Concrete shaft in mm.

4.3 Minimum grade of concrete shall be M-20. Grade of concrete in shaft and in foundation of chimney may be of different grades as per design but intermixing of grade of concrete in shaft shall not be permitted.

4.4 **Reinforcement**

4.4.1 The minimum total vertical reinforcement of deformed bars shall be 0.25 percent of plan area of concrete section under consideration. Where stress considerations demand and shell thickness exceeds 180mm, vertical reinforcements shall be provided on both outer and inner faces. The inner vertical reinforcement where provided shall be as required by the design subject to a minimum of 50% of the vertical reinforcement required on the outer face by design.

4.4.2 The minimum diameter of vertical bars shall be 12mm and maximum spacing of reinforcement shall not exceed 300mm where provided in a single layer. When two layers of reinforcement are provided, the maximum spacing of outer reinforcement shall not exceed 300mm and inner reinforcement shall not exceed 600mm.

4.4.3 The total circumferential reinforcement of deformed bars shall be not less than 0.2 percent of the concrete area in vertical section under consideration subject to a minimum of $4cm^2$ per metre height of the stack. If the vertical reinforcement is provided in two layers, the circumferential reinforcement shall also be provided in two layers and the minimum reinforcement on the inner face shall be 50% of the area of reinforcement required on the outer face by design.

4.4.4 The circumferential reinforcement for the top 2.25m of the chimney shell shall be 100 percent more than the amount required as circumferential steel from design consideration.

4.4.5 The circumferential reinforcement shall be placed on the outer side of the vertical reinforcement when provided in one layer and near the faces of the shell when provided in two layers.

4.4.6 The minimum diameter of circumferential bars shall be 10mm and maximum spacing of inside face reinforcement shall be 300mm and outside face reinforcement shall not be more than the shell thickness and in any event not more than 300mm.

4.4.7 In addition to the reinforcement determined by design, extra reinforcement shall be provided at the sides, bottom, top and corners of the openings. This extra reinforcement as provided below shall be placed near the outside surface of the chimney shell as close to the opening as proper spacing of bars will permit. Unless otherwise specified, all extra reinforcement shall extentd past the opening a sufficient distance to develop full strength in bond.

4.4.8 At each side of the opening, the additional vertical reinforcement on outside surface shall have a total area equal to established design reinforcement for one-half of the width of the opening.

4.4.9 At both top and bottom of each opening, additional reinforcement shall be placed having an area at least equal to one-half of the established designed circumferential reinforcement interrupted by the opening, but the area of this additional steel at the top as well as at the bottom shall be not less than that given by the following formula.

$$As\ (cm^2) = 0.09\ \frac{fcv\ t\ s}{fst}$$

Where fcv = computed vertical compressive stress in concrete due to dead load plus wind (or earthquake) at the outer fibre of the chimney shell at sill level of the opening; ($Kg./cm^2$).

fst = Permissible stress in steel in tension ($Kg./cm^2$)

t = concrete thickness of shell at opening (cm.)

s = width of opening (cm.)

One-half of this additional reinforcement shall extend completely around the circumference of the chimney, the other half shall extend beyond the opening a sufficient distance to develop the full strength in bond. This steel shall be placed as close to the opening as practicable, but within a height not exceeding twice the thickness.

4.4.10 Diagonal reinforcement with a total cross sectional area in square cms of not less than 1/5 of the shell thickness in cm shall be placed on each face at each corner of the openings. Such diagonal bars shall extend past their intersection points upto a distance sufficient to develop the full bond.

4.4.11 The clear concrete cover over the circumferential reinforcement shall be not less than 50mm.

4.5 **Openings**

4.5.1 When duct openings are provided at different levels, the minimum clear distance between top of lower opening to the bottom of upper opening shall not be less than the hight of the

bigger opening or 2m whichever is more. The clear circumferential disntance between two side openings at different levels shall not be less than 2m or the width of the bigger opening whichever is more.

4.5.2 When two duct openings are provided at the same level, the minimum clear circumferential distance between the two shall not be less than 2m or the width of the bigger opening whichever is more.

4.5.3 The plan area of the openings at a particular section shall not be more than one third the plan area of the concrete shell.

4.5.4 The maximum stresses in concrete and reinforcing bars at each horizontal section where openings are provided shall be checked for various combination of loads as per clause 3.0.

4.5.5 Where the segment between two openings is critical as related to the hiehgt of the openings, the segment must be investigated for beam and column action.

5.0 DESIGN AND DETAILING REQUIREMENTS FOR STEEL CHIMNEY

5.1 The design of chimney shell and other components of chimney in steel shall be done in accordance with the provisions of IS-6533. In case where IS-6533 is silent, provisions of IS-800 shall govern.

5.2 The minimum thickness of the chimney shell shall be the calculated thickness obtained from stress and deflection considerations plus the corrosion alloswance but shall not be less than 6mm nor less than 1/500 of the outside diameter of the chimney at the considered height. The corrosion allowancde shall be as per IS-6533 or specified in the tender drawings.

5.3 For load combinations involving earthquake the permissible stresses in chimney shell may be exceeded by $33^{1}/_{3}\%$ provided the steel thickness is not less than the minimum thickness specified. However, for the combination involving wind, no increase is permissible stresses shall be permitted.

5.4 Where large openings / apertures are cut in the shell plate, a structural analysis of the stresses shall be made and compensating material provided, as required, to ensure that the stresses specified in IS Code are not exceeded.

5.5 If the period of natural oscillation for the chimney computed as per IS-6533 exceeds 0.25 sec., the design wind loads shall take into consideration the dynamic effect due to pulsation of thrust caused by wind velocity in addition to the calculated static wind loads.

5.6 The stability of the structure as a whole or any part of it shall be investigated to satisfy the following relationship.

$$1.6\ (\sigma_w + \sigma_m) - 0.9\sigma_e < 1.8\ \sigma_a$$

Where σ_w = stress produced by wind load

σ_m = stress produced by any other load which may act to increase the combined stress.

σ_e = stress produced by dead load and any other load which acts at all times and will reduce the combined stress.

σ_a = allowable stress.

5.7 In the case of guyed or laterally supported chimneys, the stability of the structure and foundation as a whole or any part of it shall be investigated and weight or anchorage shall be provided so that, without exceeding the allowable material stresses and foundation bearing pressure, 0.9 times the least restoring moment including anchorage will not be less than the sum of 1.1 times the maximum overturning moment due to stress-increasing dead loads, less 0.9 times that due to stress-reducing loads, plus 1.4 times that due to wind and imposed loads, that is

$$1.4\ M_w + 1.1\ M_m - 0.9\ M_e < 0.9\ M_a$$

Where

M_w = overturning moment produced by the wind and imposed loads,

M_m = overturning moment produced by dead or other loads which may act to increase combined moment,

M_e = overturning moment produced by dead or other loads which act at all times to reduce combined moment, and

M_a = resisting moment produced by the foundation without exceeding the allowable material stress and the ground stress without exceeding the foundation bearing pressure.

5.8 In the case of self-supporting chimney, the stability of the structure as a whole shall be investigated and weight or anchorages shall be so proportioned that the least resisting moment shall be not less than the sum of 1.5 times the maximum overturning moment due to dead load and wind load/earthquake load.

5.9 The stability of the chimney shall be ensured at all the times by taking into account probable variations in dead load during construction, repair or other similar work.

5.10 Suitable stiffeners of 12mm minimum thickness shall be provided on either side of each bolt hole of base plate to take care of local bending.

6.0 DEFLECTION AND TOLERANCE

6.1 Permissible deflection at the top of chimney produced by wind load moment taking into account the dynamic factor shall not exceed the following limits.

R.C.C. Chimney : h/500

Steel Chimney : h/300

(Both self supported & guided)

Where

h = unsupported height of the chimney.

6.2 Permissible erection tolerances for chimney shall not exceed the limits specified below.

6.2.1 **R.C.C. Chimney**

6.2.1.1 The variation in the eccentricity of the axis of the chimney from vertical at any level shall not exceed 75mm or 1/600 of the height, whichever is lesser at that particular section.

6.2.1.2 Variation from design diameter

for diameter upto 6m:	$\pm$ 25mm
For diameter >6m:	$\pm$ 12.5mm per 3m diameter but in no case more than $\pm$ 75mm.
Variation in Wall thickness	- 10mm + 25mm.

6.2.2 **Steel Chimney**

The variation in the eccentricity of the axis of the chimney from the vertical at any level shall not exceed 25mm or 1/1000 of the height, whichever is lesser at that particular section.

7.0 THERMAL LINING

7.1 Adequate ceramic lining and insulation shall be proavided to limit temperature stresses in the chimney shell and protect the same from abrasive and corrosive action of chimney gases.

7.2 The lining shall be supported on reinforced concrete corbels cast integrally with concrete shell or supporting ring connected to steel chimney shell at about 8 to 10 metres interval. The corbels/supporting rings shall be designed to take the load of lining supported on them. These corbels/supporting rings shall be slotted vertically (gap of 100mm) for their full depth on approximately 900mm centares to reduce the effect of temperature stresses set up by the sudden change in shell thickness. The corbels shall be adequately reinforced and the effect of their eccentric loading considered in the design of the concrete and reinforcement in the chimney shell.

7.3 Where ventilated air gap has been provided in form of annular space between the chimney shell and lining, proper consideration shall be given to ensure air circulation in the gap. This shall be achieved by providing number of ventilation holes cast vertically in the corbels for air to move vertically and just below each corbel through the shell to atmosphere. To permit the cavity to be considered as ventilated, the total area of holes through the chimney shell and each corbel shall be atleast two-third of the area of the cavity. The holes in the chimney shell shall be distributed in more than one layer, if required, to minimise the reduction in shell area which may otherwise weaken the shell. Such ventilation holes through the shell shall be covered with a suitable G.I. wire mesh to prevent any dirt or tiny creatures entering the cavity.

7.4 Thickness of lining shall be checked at each corbel level such that temperataure on the inner face of shell is well within the limits.

7.5 Openings for flue duct and access door into the chimney lining shall be properly formed with arches or suitable supports to soffits. Thresh holds, heads and jambs shall be suitably insulated to prevent deterioration and over-heating.

7.6 At openings for flue duct and access door, the exposed portion of concrete shell, air gap and thermal lining shall be provided with castable refractory. The thickness of castable lining shall be decided as per temperature of flue gases inside chimney.

7.7 The top surface of the concrete bottom slab which is exposed to inside condition of RCC chimney shall be protected by providing suitable refractory lining. Gap between chimney shell and bottom slab shall be provided for expansion.

7.8 Provision shall be kept in ground floor slab, to take out blow down drain pipe outside chimney shell, for connection to plant disposal system.

7.9 The bricks for the ceramic lining shall be suitably designed for a thin brick joints. Shaped/standard bricks shall be used wherever required. Suitable metallic cage shall be provided around the outer periphery of the brick lining to hold the brick work in position.

7.10 At the corbel level, suitable sealing arrangement shall be provided between the two different sections of the lining. Suitable overlap shall be provided between the walls of successive corbels at corbel location.

7.11 Brick, castable, mortar and other accessories shall be selected to suit different temperature and flue gas conditions of chimney.

7.12 Castable lining shall be provided in case of steel chimney. Thickness, material quality, anchoring system etc. of castable linings shall be decided on the basis of operating temperature, flue gas condition.

8.0 FOUNDATION

8.1 For the design of chimney foundation reference shall be made to foundation design report.

8.2 The depth of the foundation shall be decided from the considerations of stability and net allowable bearing pressure of the soil. The minimum depth of foundation shall however be 2.0m below natural ground level or finished ground level whichever is lower. In case piles are used, the minimum depth of cut-off level of piles shall be minimum 2.0m below finished ground level/pile cap.

8.3 A minimum clear distance of 1000mm shall be maintained between top of foundation and finished grade level in order to lay the underground pipes and cables without any obstruction.

8.4 Each chimney shall be provided with an independent foundation. Where the foundation of an adjoining structure fouls with the chimney foundation, the contractor shall modify the design to clear the existing foundation.

8.5 The foundation shall be checked for stability against overturning and sliding. The minimum factors of safety shall be as follows:

Against overturning

With lining	=	2.0
Without lining	=	1.5

Against sliding = 1.5

50% of the weight of earth fill directly over the foundation shall be considered for the stability checks.

8.6 While computing the stability it shall be ensured that the resulting pressure and shear forces to be transferred to the supporting soil through foundation, will not cause failure of foundation.

8.7 If loose Soil Layer is encountered at founding level, the same shall be completely removed and excavation shall be done upto firm soil bed. The difference in levels shall be filled up with lean concrete of grade 1:4:8 (1:3:6 in case of rock).

8.8 The minimum thickness of lean concrete layer of grade 1:4:8 (1:3:6 for rock) shall be 75mm and extend 50mm beyond the foundation edge.

8.9 **Special requirements for steel chimney**

8.9.1 Minimum height of pedestal above finished ground level shall be not less than 300mm.

8.9.2 Grout shall be non-shrink and pre-mix type of minimum thickness 30mm with compressive (28 days) strength not less than 40N/mm^2.

8.9.3 The clear distance between a standard mild steel anchor bolt or anchor sleeve and the face of the foundation shall be not less than 100mm.

8.9.4 Minimum vertical reinforcement in pedestal shall be 0.15% of cross sectional area in plan. Minimum horizontal reinforcement in pedestal shall be of diameter 10mm at a spacing of 200mm c/c.

9.0 CHIMNEY ACCESSORIES

9.1 Inspection/Cleaning door

Suitable door for access near the base shall be provided for the purpose of inspection of the inside of the chimney and ease during construction. In case of lined chimneys, two such access doors shall be porovided i.e one on the concrete shell and the other on the lining facing each other. The door on the lining shall be omitted where the flue gas temperature in the region exceeds 200°C and this opening shall be filled with loose fire bricks. Minimum clear access opening shall be 600mm x 900mm and the sill of the door shall be 300mm above the finished grade/pavement level outside the chimney. The doors shall be hinged and shall be provided with a locking device. These doors shall be fabricated from mild steel plates and angle sections of thickness not less than 6mm and painted as per clause 4.2.3 - SECTION III of this specification. All construction and details shall be made in such a way as to ensure no entry of rainwater from outside or leakage of flue gases from inside.

9.2 Chimney Cap

In order to protect the top of the chimney from acid attack of flue gases, a sectional flanged grey cast iron cap of minimum 12mm thickness, over 18mm thick asbestos packing, shall be provided. Asbestos packing (3mm thick) shall cover the concrete shell, brick lining and the air space between them. It shall be designed to allow for circumferential and vertical expansion and contraction of the lining and the shell, deflection of the shell due to wind and seismic forces and the circumferential expansion of the cap. The cap shall slope towards the inside of the chimney at approximately 30° to the horizontal. All sections of the cap shall be bolted together and anchored in place with bronze bolts and bronze rag bolts respectively. The cast iron cap shall be lined with 3mm thick lead homogenously on all the faces. The

lead sheet shall be mechanically pressed on CI surface and free ends shall be joined by thermal stitching. Rivets shall be provided (not less than 30 Nos. Per metre square) by drilling holes through lead-lining and cast iron and filling them with molten lead.

9.3 Ladder

The chimney shall be provided with a mild steel ladder extending from bottom to top and fabricated in 4.5 to 5.0 metre sections and constructed as follows:

The ladder shall consist of 75x10mm stringers spaced at 450mm clear inside width with 20mm dia rungs. The rungs shall be spaced 300mm c/c and shall be 250mm away from the chimney outside surface. Each ladder section shall be bolted together with the next section. The ladder shall be provided with 75x10mm stays @ 3500mm c/c. Location of Ladders shall be made staggered among the platforms for the entire height of the chimney shell.

The stays shall be bolted/welded to the stringers and fixed to the chimney shell with 20mm dia M.S. anchor fastener 150mm long. The ladder shall be provided with a safety cage made up of mild steel flats of size 50x6 for both verticals and horizontal rings. The cage shall have a minimum diameter of 800mm and start from a height of 3000mm above ground.

9.4 Platforms

Both concrete and steel chimneys shall be provided with chequered plate platforms supported on structural steel sections around the outer shell for erection and service of warning lamps, earthing, inspection, sampling points etc. at intervals of about 15 to 20m. The platforms shall be at least 800mm wide and provided with tubular handrails of 1m height with a toe guard of 125x5mm. The top most platform shall be located 2.5m below the top of chimney.

10.0 ELECTRICAL WORK

10.1 Aviation Obstruction Lighting

10.1.1 The aviation obstruction lights shall be provided at every 30m height or part thereof. The lighting fixtures shall be erected on the platform railing equally spaced along the periphery and adequately secured to the railing against wind pressure/forces. The lights shall be red in colour having an intensity sufficient to be conspicuous considering the intensity of adjacent lights and general level of illumination against which these lights will be viewed.

10.1.2 The lighting fixtures shall be distributed at intervals of 120° in one horizontal plane. Each lighting fixture shall have two lamps.

10.1.3 The wiring of these lights shall be carried out by multicore 2.5mm^2 YFY cable. Wiring of alternate fixtures in one horizontal plane shall be from different circuits. The cable shall run exposed along the length of the chimney by the side of the ladder by fixing it with saddles/clamps. Suitable number of junction boxes shall be provided all along the chimney and power for obstruction lights shall be tapped from these junction boxes. Power supply shall be made available by the Owner at one point near the base of the chimney, bidder shall provide suitable junction box for receiving the same.

10.1.4 Lighting fixture shall be provided with an internal earth terminal.

10.1.5 Ttemporary aviation obstruction lights shall also be provided during construction stage at the top most point of the obstruction and shall be shifted up as construction progresses. These lights need to be installed only if the level of obstruction is greater than 30m above grade.

10.1.6 Lighting fixtures shall be suitable for 240V, 50HZ supply and the incoming terminal shall be suitable for 2.5mm^2 copper conductor.

10.2 **Lightning Protection**

10.2.1 Lightning protection system of chimney shall conform to the requirements of IS:2309.

10.2.2 Air termination for lightning protection shall comprise of vertical rods connected together by horizontal conductor along the perphery of the chimney.

10.2.3 The circumferential conductor shall be 40x5mm GI strip running along the periphery. The down conductor shall be either one or maximum two 40x5mm GI strips as per the requirement of IS:2309. In case two down conductors are used these shall run on diametrically opposite sides of the chimney. The down comers shall be fixed to the outside surface of chimney shell.

10.2.4 Each down conductor shall be terminated on to an earth electrode. The whole of the lightning protective system, including any ring earth, should have a combined resistance to earth not exceeding 10 ohms without taking account of any bonding.

10.2.5 During construction stage, temporary lightning protection shall be provided by connecting to the concrete reinforcement, two permanent electrical grounding conductors. After the top lift of the chimney shell has been completed, temporary air terminals, which may consist of reinforcing bars shall be installed at the top to serve, as a temporary protection until the lining etc. are completed and permanent lightning protection is installed.

SECTION - III

MATERIAL, CONSTRUCTION REQUIREMENTS & SPECIFICATIONS

1.0 GENERAL

1.1 These specifications establish and define the material and construction requirements for RCC & steel chimneys.

1.2 **Quality control requirement**

1.2.1 The detailed QA & QC arrangements for each activity along with Quality plan shall be submitted for review & approval by Engineer-in-Charge. The methodology of construction shall specifically include the controls for verticality of shell, equipment proposed and their calibration etc.

1.2.2 For all materials, all incidental charges such as carriage, octrol, loading, unloading, storing, safe custory, watch & ward, returning back surplus materials to godown of issue (where applicable) etc. shall be deemed to be incorporated within the lumpsum price quoted by the Contractor.

1.2.3 Providing and operating necessary measuring and testing devices and materials (including all consumables) are included in the Contractor's scope of work. No separate payment for testing shall be made but the lumpsum quoted price shall be deemed to include the cost of such tests which are required to ensure achievement of specified quality.

1.2.4 All materials shall be of standard quality manufactured by renowned concerns conforming to Indian Standards and shall have "ISI" mark as far as possible unless otherwise approved by the Engineer-in-Charge. The Contractor shall get samples of all materials approved by the Engineer-in-Charge prior to their bulk procurement and use. The Contractor shall furnish manufacturer's certificates, for the materials supplied by him when asked for. Further to that he shall get the materials tested from an approved test house, if asked for by the Engineer-in-Charge. The cost of all tests shall be borne by the contractor. Materials not conformig to specifications or considered defective by the Engineer-in-Charge shall not be used and shall be promptly removed from the site by the Contractor at his own expense.

1.2.5 Whenever any reference to IS Code is made, the same shall be taken as the latest revision (with all amendments issued thereto) on the notified date of submission of tender.

2.0 CONSTRUCTION REQUIREMENT FOR RCC CHIMNEY

2.1 **Earthwork in Excavation**

2.1.1 Excavation work shall be commenced and carried out as per programme of work front to be approved by the Engineer-in-Charge. Setting out and line out for the excavation shall be done by the contractor and excavation shall be started only after approval by the Engineer-in-Charge.

2.1.2 Excavation shall be carried out in all types of soils including clay, murrum, laterite, weathered/soft/hard rock etc.

2.1.3 All types of shoring and strutting wherever necessary shall be adopted to with-hold the face of earth or cutting in slopes as per site requirements, and as directed by the Engineer-in-Charge. Earth work in excavation includes pumping/bailing out water emanating collected from any source inside the foundation pit.

2.1.4 Excavated material shall not be deposited within 1.5M from the top edge of the excavation, or within a distance equal to the depths of excavation, whichever is higher.

2.1.5 If contractor excavates beyond the specified depth, the over excavated portion shall be filled back only with 1:4:8 cement cncrete and well compacted without any extra cost to the owner.

2.1.6 The surplus earth shall be removed within a lead of 1KM from work site and shall be deposited as directed by Engineer-in-Charge.

2.1.7 Loose or soft ground encountered in excavations at the required depth shall on Engineer-in-Charge's instructions be excavated to a firm bed and the difference made up to the required level by lean concrete (1:4:8) at no extra cost.

2.1.8 Any obstruction like buried pipe, cable etc. encountered during excavation of the foundation shall be reported to the Engineer-in-Charge. If required, the same shall be removed without any extra cost to the owner.

2.2 Backfilling in Foundations

2.2.1 The soil used for back filling shall be selected suitable soil (non expansive)and approved by Engineer-in-Charge. The soil shall be free from rubbish, grass, organic matter, stones, building waste, clods and hard lumps. Borrowed earth shall be used in back filling wherever the excavated soil is not found suitable without any extra cost to the owner. The expansive soil shall not be used in backfilling.

2.2.2 The filling shall commence only after approval of Engineer-in-Charge is obtained.

2.2.3 Filling shall be done in layers. Each layer shall be not more than 150mm thick when loose and shall be well rammed, with necessary watering, to obtain at least 95% of standard proctor density or 90% of modified proctor density as per relevent IS Code.

2.2.4 Filling shall extend upto the level of original ground surface or as per drawings or as directed by Engineer-in-Charge. The finished surface shall be properly trimmed and dressed. The adjoining area shall be cleaned and no heaps of surplus earth shall be left out.

2.2.5 Filling where provided between top of foundation slab to the plinth inside the chimney shell, shall be done with dry coarse medium sand compacted in layers of 150mm to 85% relative density as per relevent IS Code as approved by Engineer-in-Charge.

2.3 Plain and Reinforced Cement Concrete

2.3.1 Materials

2.3.1.1 Cement

Cement shall be ordinary portland cement conforming to IS-269 or blast furnace slag cement conforming to IS-455. **Pozzolana cement conforming to IS-1489 shall not be used for shell construction.**

2.3.1.2 Aggregate for Concrete

The fine and coarse aggregates shall conform to IS-383 and the requirement of size of aggregates shall conform to provisions of IS-456. The fine and coarse aggregates shall

consist of clean, hard, strong, sharp, durable, uncoated particles free from any mix of clay, dust, vegetable matter, mica, iron pyrites, shells soft or flaky and elongated particles, alkali, organic matter, salts, loam and other impurities. Sulphate content shall not exceed 1%. Total content of all deleterious matter shall not exceed 5%. Sand obtained from river bed subject to tidal effect shall not be allowed in works. All sand shall be washed before being brought to site.

2.3.1.3 **Water**

The quality of water shall conform to provision of IS:456. It shall be free from injurious amount of soils, acids, alkalies, organic matters or other harmful substances. Only natural water suitable for drinking shall be used.

2.3.1.4 **Reinforcing Steel**

The reinforcing bars shall be high strength deformed bars conforming to IS-1786 Grade Fe 415. All reinforcement bars shall be free from loose rust or scales, oil, grease or other harmful matter that will destroy or reduce the bond.

2.3.1.5 **Structural Steel**

Structural steel to be used for platforms, ladders, insert plates etc. shall conform to IS-2062 Grade-A.

2.3.1.6 **Admixture**

Admixtures shall be used in concrete only with the approval of the Engineer-in-Charge. Wherever used, the admixture shall conform to IS-9103. Admixtures containing calcium chloride shall not be used.

2.3.2 **Storage of Aggregates**

2.3.2.1 The contractor shall at all times maintain at the site of work such quantities of aggaregates as are considered by the Engineer-in-Charge to be sufficient to ensure continuity of work.

2.3.2.2 Each type and grade of aggregates shall be stored separately. The ground on which the aggregates are stored shall be firm and have sufficient slope to ensure adequate drainage of rain water.

2.3.2.3 Any aggregate delivered to site wet, shall be placed in storage for at least 24 hours to ensure adequate drainage before it is used for concreting.

2.3.2.4 Sand heaps shall be covered with bricks or such other materials to prevgent blowing off and to assist in good house keeping.

2.3.3 **Grades and Proportioning**

2.3.3.1 The concrete mix to be used for construction of superstructure and foundation of chimney shall be of minimum M-20 grade design mix concrete conforming to IS-456. The water cement ratio, coarse aggregate size, grading and the proportion for each mix shall be predetermined from the results of cube tests of trial mixes and got approved by the Engineer-in-Charge. The proportions determined thus shall be followed at site and shall in no way relieve the contractor of his responsibility as regards to the prescribed strength of mix. The mix proportions, however, shall be

revised if the results of the cube tests during the construction show consistently lower or higher strength than the prescribed strength of mix. No claim shall be entertained due to such changes in mix designs, as the contractor shall be responsible to produce the concrete of required grade.

2.3.3.2 From durability considerations the minimum cement content and the maximum water-cement ratio for concrete shall be as given in Table-1.

TABLE - I

MINIMUM CEMENT CONTENT AND MAXIMUM WATER CEMENT RATIO FOR DURABILITY

Exposure	Type of Cement	Plain Concrete		Reinforced Concrete	
		Minimum Cement Content (Kg./m³)	Maximum Water-Cement Ratio	Minimum Cement Content (Kg./m³)	Maximum Water-Cement Ratio
Normal	OPC*/PPC*/PSC*	220	0.6	300	0.55
Moderate	OPC*/PPC*/PSC*	250	0.6	350	0.50
Severe	SSC*/PSC*/SRC*	310	0.45	400	0.45

*OPC - Ordinary lowheat Portland Cement
*PPC - Portland Pozzolana Cement
*PSC - Portland Slag Cement
*SRC - Sulphate Resistant Cement
*SSC - Super Sulphated Cement

2.3.3.3 In proportioning concrete, the quantity of both cement and aggregates shall be determined by weight. Water shall be either measured by volume in calibrated tanks or weighed.

2.3.4 **Mixing**

2.3.4.1 Mixing shall be carried out in mechanical mixers. Water cement ratio shall be rigidly controlled during mixing. Mixers shall be fitted with automatic devices to discharge measured quantity of water directly to the mixing pan. The water shall not be admitted to the drum until all the cement and aggregate constituting the batch are thoroughly mixed. Mixing shall continue until the concrete is uniform in colour and for not less than 2 minutes after all the materials and water are in the drum.

2.3.5 **Concrete Placement**

2.3.5.1 The place where concrete is to be poured shall be clean and free from all loose dirt, wooden pieces, dust, standing water etc. The form work shall be tight and rigid with all holes and crevices stopped effectively, to prevent cement slurry from running out.

2.3.5.2 Method of placing shall be got approved by the Engineer-in-Charge. Segregation during carriage and placement shall be avoided. If during carriage concrete segregates, it shall be remixed before placement.

2.3.5.3 Concrete shall not be dropped from a height of over 1.5m. Concrete shall be placed continuously in horizontal layers not exceeding 1.5m deep.

2.3.5.4 All hardened concrete surface shall be cleaned of laitance and dirt and shall be moistened before placement of new concrete.

2.3.5.6 All precautions shall be taken for concreting in extreme weather in accordance with the relevant clauses of IS-456. Due protection shall be provided to prevent cement cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains and necessary arrangements to cover the freshly poured concrete shall be provided.

2.3.5.7 All concrete placement shall be co-ordinated with placement of conduits, inserts, embedded parts etc. executed either by same agency or separately.

2.3.6 **Concrete Vibration**

2.3.6.1 Concrete shall be compacted by means of vibrators of approved type under proper supervision as directed by the Engineer-in-Charge. The whole mass of concrete shall be well vibrated until a dense mass with jelly like appearance and consistency and water just appearing on the surface is obtained. Over vibration or vibration of very wet mixture shall be avoided. Care shall be taken to avoid segregation and formation of air bubbles.

2.3.7 **Concrete Curing**

2.3.7.1 Curing of concrete shall be as per IS-456. The concrete shall be kept constantly wet for the specified period of time to ensure complete hydration and hardening. Curing shall start after 8 hours of placement of concrete in normal weather and 4 hours in hot weather.

2.3.8 **Finishing**

2.3.8.1 After removal of the formwork, all blow-holes and honey combing observed shall be brought to the notice of the Engineer-in-Charge. These shall be rectified by necessary chipping and packing or grouting with concrete or cement mortar (1:3) as per direction of the Engineer-in-Charge.

2.3.9 **Tests for Concrete Strength**

2.3.9.1 Samples from fresh concrete shall be taken as per IS-1199 and cubes shall be made, cured and tested in accordance with IS-516. The contractor shall furnish the cube test results for 7 days as well as 28 days strength for approval.

2.3.9.2 The quality in-situ concret tests, if required, shall be done by the vendor by any of the following methods without claiming any extra cost to the owner:

a. Ultrasonic pulse velocity test.

b. Drilled core test.

2.3.9.3 Requirement of tests and the selection of type of tests shall be as per the direction of Engineer-in-Charge.

2.3.10 **Construction Joints**

2.3.10.1 In the chimney shell, no vertical construction joints shall be provided and horizontal construction joints shall be maintained at approximately uniform spacing throughout the height of the chimney.

2.3.11 **Form work and Centering**

2.3.11.1 For the construction of the chimney shell, hydraulically/pneumatically operated slip form shuttering shall be used. The jack rod used may be removable or permanent type. In case removable type jack rod is used, the holes left in the hardened conrete, after shifting of slip form, shall be grouted with cement mortar (1:1). Where permanent type jack rod is used, this shall not be considered as part of the main reinforcement.

2.3.11.2 The form for the chimney shell shall be of metal only.

2.3.11.3 Tying between inner and outer chimney shell forms shall not be permitted.

2.3.11.4 Jump form type of shuttering shall also be permitted for the construction of chimney shell.

2.4 **Structural steel work**

2.4.1 All fabrication and erection shall be done in accordance with the provisions of IS-800.

2.5 **Reinforcement Placement**

2.5.1 Circumferential reinforcement shall be placed around the exterior of, and secured to, the vertical bars. Particular attention shall be paid to stretching and securing the circumferential reinforcement so that it cannot bulge or be displaced during the placing and working of the concrete so as to result in less than the specified minimum concrete covering over this circumferential reinforcement.

2.5.2 Vertical reinforcement projecting above the forms for the chimney shell shall be staggered and shall be so supported as to prevent the breaking of the bond between the reinforcement and the freshly placed concrete.

2.6 **M.S. Metal Inserts**

2.6.1 All M.S. metal inserts shall be fabricated as per IS-800. These shall be securely placed in the concrete shell such that its position is not disturbed while concreting. Necessary adjustment of reinforcement and shuttering shall be done for the placement of metal inserts if situation so desires. Where so indicated, it shall be welded to the reinforcement.

3.0 CONSTRUCTION REQUIREMENTS FOR STEEL CHIMNEY

3.1 **Material**

3.2 **Structural Steel**

3.2.1 The structural steel to be used for steel chimney shall be as per IS-2062 Grade-A unless specified otherwise in tender drawings.

3.2.2 Welding electrodes shall be of a make approved by Engineer-in-Charge. All electrodes shall conform to IS-814 unless specified otherwise to suit the requirement of shell plate and welding procedure. Contractor shall conduct all tests at site, as directed by Engineer-in-

Charge to get his approval for use on Job. Manufacturer's batch certificates shall be submitted atleast 2 weeks prior to commencement of welding.

3.3 **Base Plate and Holding Down Bolts**

3.3.1 The material shall conform to the requirement of IS-2062 Grade-A and IS-432 Grade-I unless specified otherwise in tender drawings.

3.4 **Concrete work in Foundation**

3.4.1 This shall conform to provisions of clause No. 2.3.1.

3.5 **Receipt and Storing of Material**

3.5.1 All steel parts furnished by supplier shall be checked, sorted out, straightened, and arranged by grades and qualities in stores.

3.5.2 All sections shall be free from surface defects such as pitting, cracks, laminations, twists etc. Use of defective materials shall not be permitted and all such defective material shall be removed from the site immediately.

3.5.3 Welding electrodes shall be stored separately by qualities and lots inside a dry and enclosed room, in compliance with IS-9595 and as per instructions given by the Engineer-in-Charge. Electrodes shall be kept perfectly dry to ensure satisfactory operation and weld metal soundness.

3.6 **Fabrication and Erection**

3.6.1 All fabrication and erection shall be done in accordance with IS-800, IS-9595 and based on the fabrication drawings adhering strictly to work points and work lines on the same.

3.6.2 All connections shall be welded connections except for ladders and platforms unless specified otherwise. Welding shall be done as per IS-9595. Welding procedures shall be conducted and approved as per IS-7307. Approval of welders shall be as per IS-7310.

3.6.3 The vertical butt weld seam shall be staggered at about 120° between adjacent sections of chimney shell.

3.6.4 Any defective material used shall be replaced by the contractor at his own expense.

3.6.5 Any faulty fabrication pointed out at any stage of work shall be made good by the contractor at his own cost.

3.6.6 Radiography examination shall be carried out to a minimum aggregate weld length of 3 meters in a chimney. However, the weld length radiographed shall not be lower than 5% of total weld length of the chimney.

3.6.7 Atleast one spot of 300mm length shall be radiographed for each thickness produced.

3.6.8 If the random radiography of a weld in any joint reveals unacceptable defects, two further welds in the group represented by the weld shall be radiographed to the same extent. If these further welds show no unacceptable defects, the group of welds represented by the weld shall be accepted. However, the first defective weld shall be repaired. If one of the two further welds show unacceptable defects, each weld in the group shall be radiographed. Unacceptable welds shall be repaired and then radiographed.

3.6.9 The acceptance levels shall be in accordance with table-1 enclosed.

3.6.10 Radiography shall be carried out using x-ray or Gama ray as decided by the Engineer-in-Charge.

4.0 PAINTING

All painting work shall be carried out with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of the Engineer-in-Charge. The compatibility of the paint system shall suit the environment envisaged in and around the plant and confirmed by the paint manufacturer.

4.1 R.C.C. Chimney

4.1.1 Surface preparation

The concrete surface of the chimney shell shall be thoroughly cleaned by scraping all loose particles of sand, mortar dripping etc. with soft wire brush. If necessary acid etching with 10-15% HCL solution for about 15 minutes shall be carried out and surface shall be thoroughly washed with water to remove acid and loose particles. The surface shall be dried completely before application of paint.

4.1.2 Internal surface painting

Full height of the chimney shell shall be painted with one coat of approved sodium silicate solution of brushable consistancy.

4.1.3 External surface painting

The outside surface of the shell except for the top 20m shall be given two coats of cement paint of approved colour and shade so that the surface presents a smooth and uniform finish. Top 20m of the outer face of the chimney shell shall be painted with two coats of epoxy high build coating of 100 microns per coat (minimum). The outer most coat on top 20m shall have more than one colour (preferably white and orange) to give perfect contrast in horizontal alternate bands with a minimum of 5m width to serve as aviation warning signal during day time. The bands at extremities shall be of darker colour.

4.2 Steel Chimney

4.2.1 Surface preparation

The surface to be painted shall be cleaned by chipping, scraping hammering and wire brushing. On completion of cleaning the detached rust, mill scale and other deleterious material shall be removed by clean rag and/or washed by water or steam and thoroughly dried with compressed air jet if required before application of paint.

4.2.2 Internal surface painting

4.2.2.1 Unlined Chimney Shell

One coat of suitable priming paint to the interior surface shall be provided.

If required suitable protective treatment shall be used to withstand the corrosive, abrasive and thermal effects of the fluegases.

4.2.2.2 **Lined Chimney Shell**

If required one coat of a suitable priming paint shall be used followed by two coats of a finish paint or paints applied in accordance with the instructions of the manufacturer.

4.2.3 **External surface painting**

The outer surface shall be given two coats of epoxy zinc chromate primer followed by two coats of epoxy high build finish coating of approved quality and shade. Where aviation warning signals are required, top 20m of the outer face of the chimney shell shall be painted with two coats of above finish coat of more than one colour in horizontal alternate bands of minimum 5m width to give a perfect contrast. The bands at extremities shall be of darker colour.

4.3 **Structural Steel Members**

All structural steel works such as walkways, platforms, handrails, ladders etc. shall be given two coats of high build chlorinated rubber zinc phosphate primer followed by two coats of chlorinated rubber paint of approved quality.

5.0 ELECTRICAL WORK

All electrical work shall be as per Specifications/Standards attached with the Tender.

6.0 THERMAL LINING WORK

All thermal lining work shall be as per Specifications/Standards attached with the tender.

TABLE-1 : ACCEPTANCE LEVELS

DEFECT TYPE		PERMITTED MAXIMUM
PLANER DEFECTS	(a) CRACKS AND LAMELLAR TEARS	NOT PERMITTED
	(b) LACK OF ROOT FUSION LACK OF SIDE FUSION LACK OF INTER-RUN FUSION	NOT PERMITTED
	(c) LACK OF ROOT PENETRATION	NOT PERMITTED
CAVITIES	(a) ISOLATED PORES (OR INDIVIDUAL PORES IN A GROUP)	$\phi \leq$ 1/4 AND ϕ 3.0mm FOR t UP TO AND INCLUDING 50mm ϕ 4.5mm FOR t OVER 50mm UPTO & INCLUDING 75mm ϕ 6.0mm FOR t OVER 75mm
	(b) UNIFORMLY DISTRIBUTED OR LOCALIZED POROSITY	2% BY AREA *(AS SEEN IN A RADIOGRAPH) FOR t $\leq$ 50mm AND PRO-RATA FOR GREATER THICKNESSESS
	(c) LINEAR POROSITY	LINEAR POROSITY PARALLEL TO THE AXIS OF THE WELD MAY INDICATE LACK OF FUSION OR LACK OF PENETRATION AND IS THEREFORE NOT PERMITTED
	(d) WORMHOLES ISOLATED	l $\leq$ 6mm, w $\leq$ 1.5mm
	(e) WORMHOLES ALIGNED	AS LINEAR POROSITY
	(f) CRATER PIPES	AS WORMHOLES ISOLATED
	(g) SURFACE CAVITIES	NOT PERMITTED
SOLID INCLUSIONS	(a) SLAG INCLUSIONS (1) INDIVIDUAL AND PARALLEL TO WELD AXIS (2) LINEAR GROUP !	t $\leq$18mm t> 18mm $\leq$ 75mm t> 75mm l $\leq$T/2 $\leq$ 6mm l$\leq$ t/3 l$\leq$ 25mm w $\leq$1.5mm w$\leq$1.5mm w$\leq$1.5mm AGGREGATE LENGTH NOT TO EXCEED 8% OF LENGTH OF GROUP, WHICH IN TURN NOT TO EXCEED 12 t IN LENGTH AS ISOLATED PORES
	(3) INDIVIDUAL AND RANDOMLY ORIENTATED (4) NON-LINEAR GROUP	AS UNIFORMLY DISTRIBUTED OR LOCALIZED POROSITY
	(b) TUNGSTEN INCLUSIONS (1) ISOLATED (2) GROUPED	AS ISOLATED PORES AS UNIFORMLY DISTRIBUTED OR LOCALIZED POROSITY
	(c) COPPER INCLUSIONS	NOT PERMITTED
PROFILE DEFECTS	(a) UNDERCUT	SLIGHT INTERMITTENT UNDERCUT PERMITTED, DEPTH NOT TO EXCEED APPROXIMATELY 0.5mm
	(b) SHRINKAGE GROOVE AND ROOT CONCAVITY	AS FOR UNDERCUT, BUT DEPTH NOT TO EXCEED 1.5mm
	(c) EXCESS PENETRATION	h $\leq$3mm OCCASIONAL LOCAL SLIGHT EXCESS IS ALLOWABLE
	(d) REINFORCEMENT SHAPE	THE REINFORCEMENT IS TO BLEND SMOOTHLY WITH THE PARENT METAL; DRESSING IS NOT NORMALLY REQUIRED PROVIDED THE SHAPE DOES NOT INTERFERE WITH THE SPECIFIED NON DESTRUCTIVE TESTING TECHNIQUES
	(e) OVERLAP	NOT PERMITTED
	(f) LINEAR MISAUGNMENT	h $\leq$t/10, 3mm MAXIMUM

1. **ABBREVIATIONS**

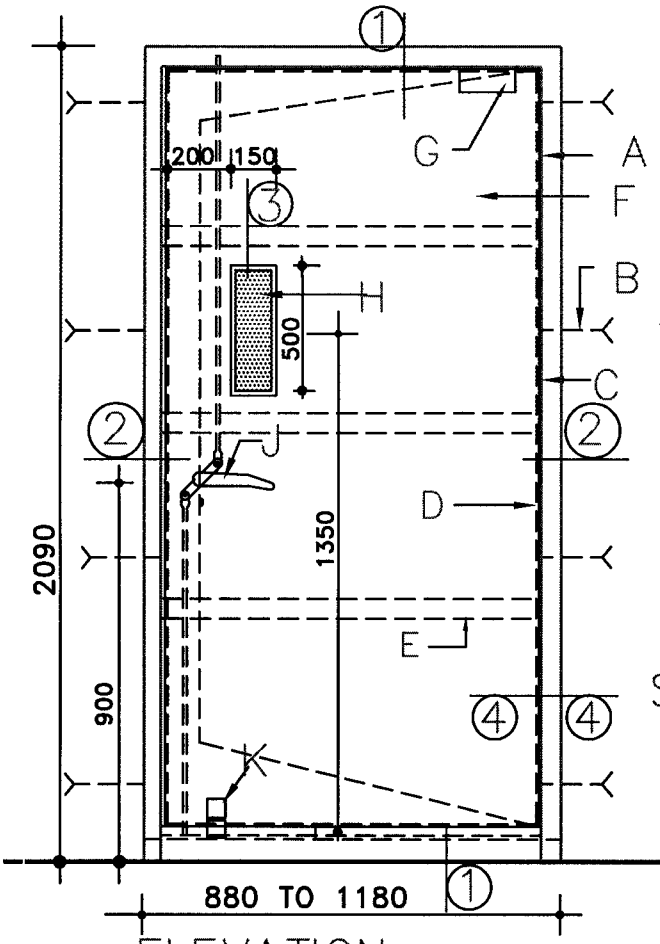
t	Parent metal thickness, in the case of dissimilar thicknesses t applies to the thinner component.
w	Width of defect
l	Length of defect
h	Height of defect
ϕ	Diameter of defect

2. **Notes:**

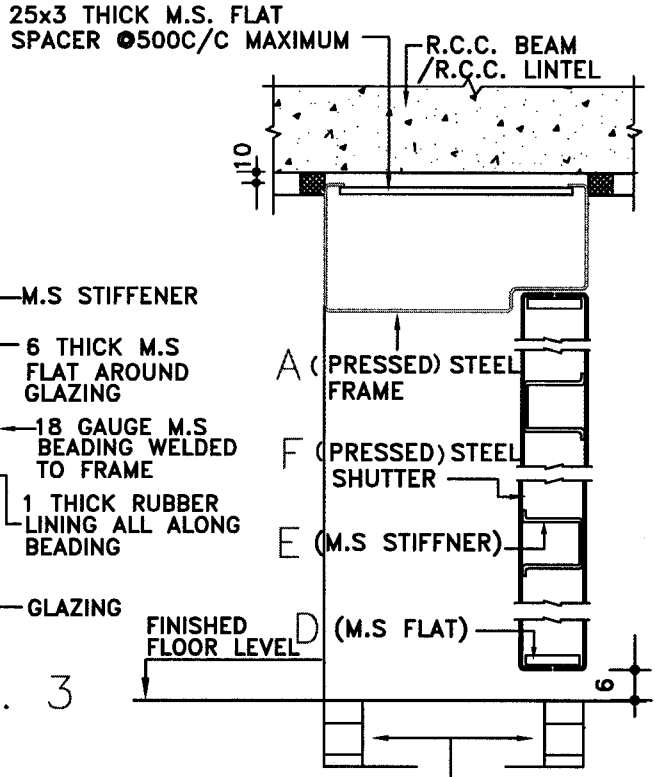
The significant dimension of a defect in terms of its effect on service performance is the height or through thickness dimension. If ultrasonic examination is employed, it is probable that defect indications of very minor cross section will be obtained. In interpreting the requirements of this table, such indications having a dimensions h of 1.5mm or less should be disregarded unless otherwise agreed between the contracting parties.

* Area is the product of length and width of an envelope enclosing the affected volume of weld metal measured on a plane substantially parallel to the weld face (i.e. as seen on a radiograph).

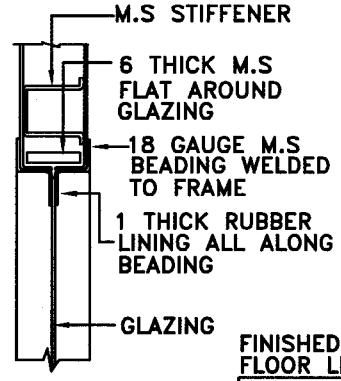
! Individual inclusions within the group should not exceed the sizes for isolated pores (or individual pores in a group). A linear group is defined as a number of inclusions in line and parallel to the weld axis where the spacing between their adjacent ends does not exceed 6 times the length of the longest inclusion within the group. With parallel groups, all inclusions count towards the aggregate.



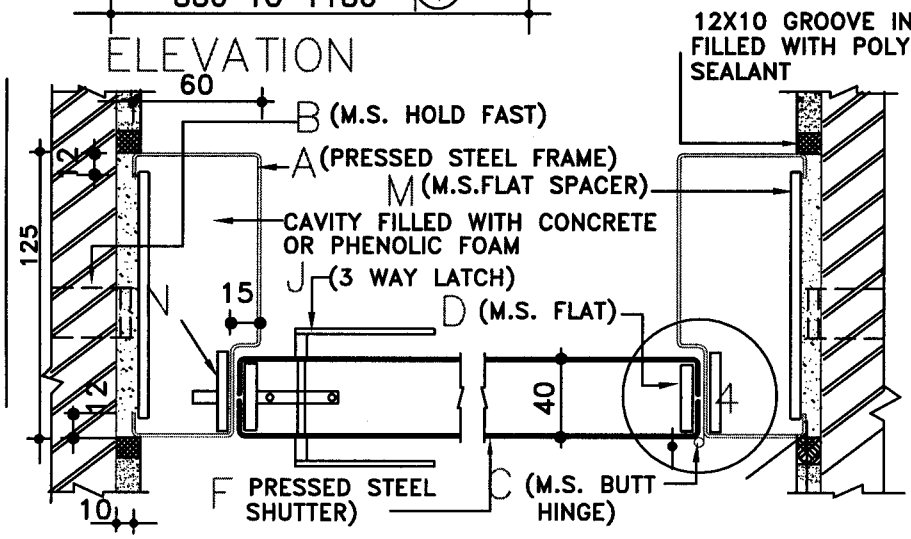
ELEVATION



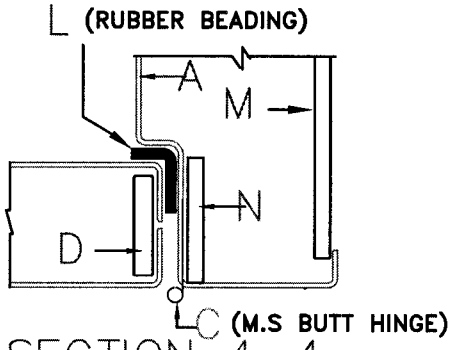
SECTION 1–1



SEC. 3



SECTIONAL PLAN 2–2



SECTION 4–4

NOTE:
1: REFER STANDARD NO. 7–75–0071 FOR DETAIL OF 3 WAY LATCH.

LEGEND :

A: 16 GAUGE PRESSED STEEL FRAME FINISHED WITH SYNTHETIC ENAMEL PAINT/ELECTROSTATIC. POWDER COATING OVER RED–OXIDE ZINC CHROMATE PRIMER AS PER TENDER ITEMS

B: M.S. HOLDFAST 300x25x6 THICK @ MAXIMUM 600 C/C WELDED TO FRAME SPACER (M).

C: 150 LONG M.S. BUTT HINGE @MAXIMUM 600 C/C SCREWED TO FRAME AND SHUTTER.

D: 3 THICK M.S. FLAT CONTINUOUS ALONG PERIMETER OF SHUTTER.

E: 35 WIDE 16 GAUGE M.S. HORIZONTAL STIFFNER @ 500 C/C MAXIMUM.

F: 18 GAUGE PRESSED STEEL SHUTTER (OVERALL 40 THK.)

G: OVER HEAD HYDRAULIC DOOR CLOSER (HEAVY DUTY)

H: VISION PANEL AS PER SPECIFICATION (OPTIONAL)

J: 3WAY SPRING LOADED LATCH AND LOCKING SYSTEM.

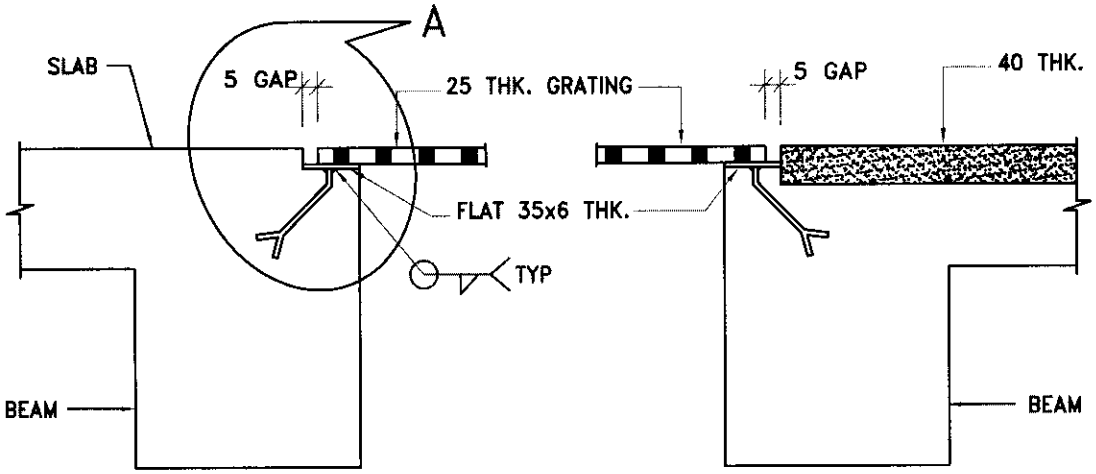
K: SPRING LOADED PRESSURE DIE CAST ZINC ALLOY DOOR STOPPER.

L: NEOPRENE RUBBER BEADING FIXED WITH NEOPRENE RUBBER ADHESIVE(DUNLOP S–758 OR EQUIVELENT) ALONG FRAME REBATE.

M: 50x5 THICK M.S. FLAT SPACER WELDED TO FRAME AT HOLD FAST LOCATION.

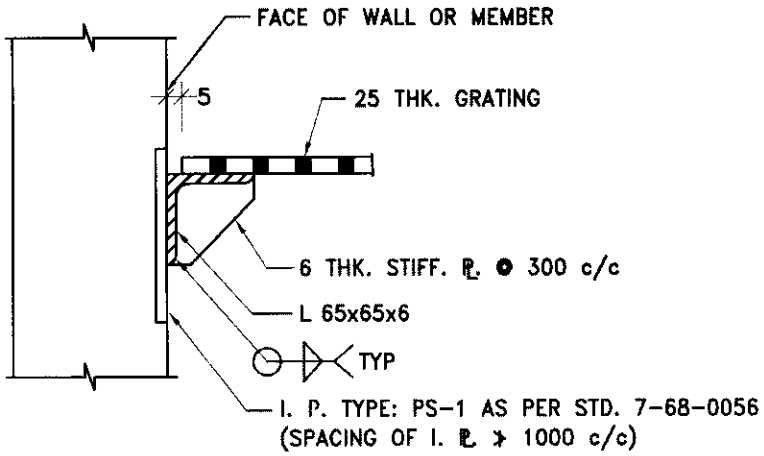
N: 40x150x3 THICK M.S PAD WELDED TO FRAME AT ALL HINGE & LOCK LOCATION.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	21.03.07	REVISED, ISSUED AS STANDARD	AMARJIT	JKB/SD	ARVIND KUMAR	V.CHATURVEDI

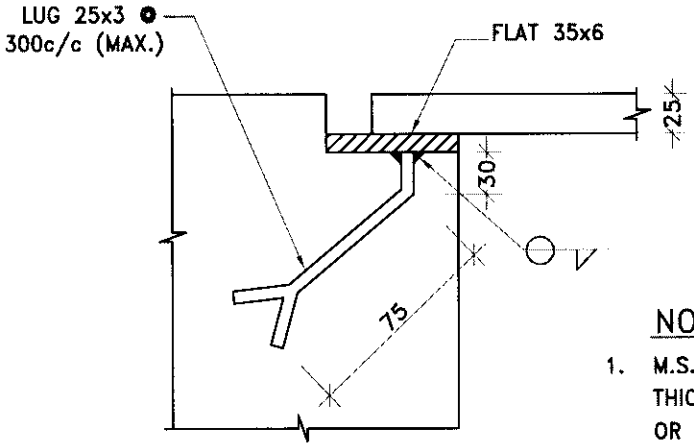


GRATING SUPPORT OVER BEAM WITHOUT FLOOR FINISH

GRATING SUPPORT OVER BEAM WITH FLOOR FINISH



GRATING SUPPORT ON WALL/COLUMN



DETAIL A

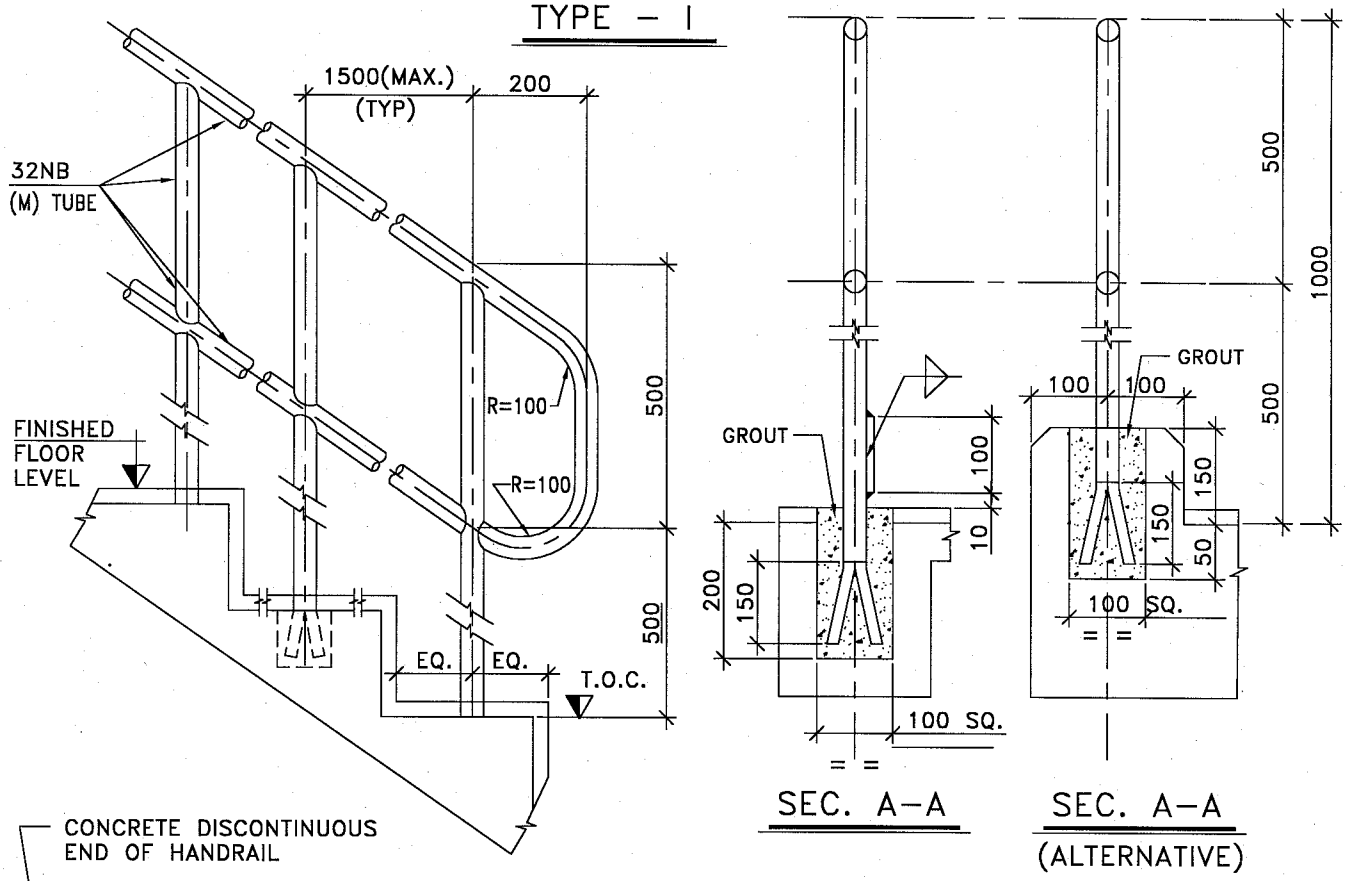
NOTES:

1. M.S. LUGS SHALL BE SUITABLY BENT IF CONCRETE THICKNESS IS LESS THAN THE LENGTH OF LUGS OR LUGS INTERFERE WITH R/F BARS.
2. ALL DIMENSIONS ARE IN mm.

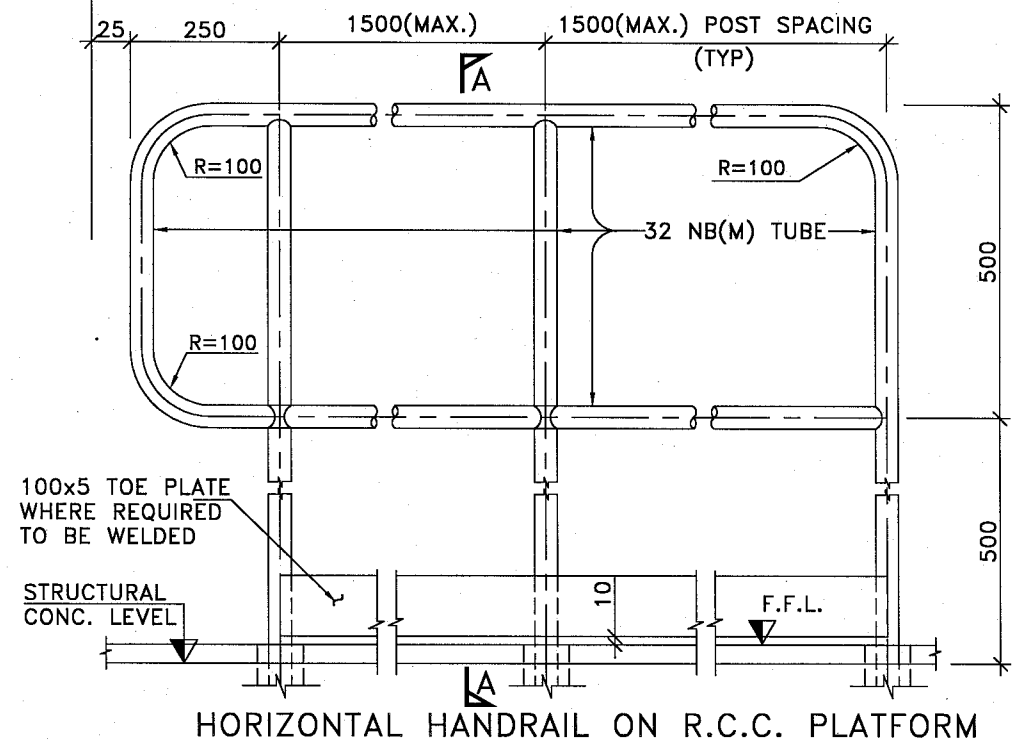
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
5	10.12.07	REAFFIRMED AND ISSUED AS STANDARD	VPS	P.K.MITTAL	VINAY KUMAR	V.CHATURVEDI
4	16.04.01	REAFFIRMED AND ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	SC JAIN	M IYENGAR

Approved by

TYPE – I



SLOPING HANDRAIL ON R.C.C. STAIR



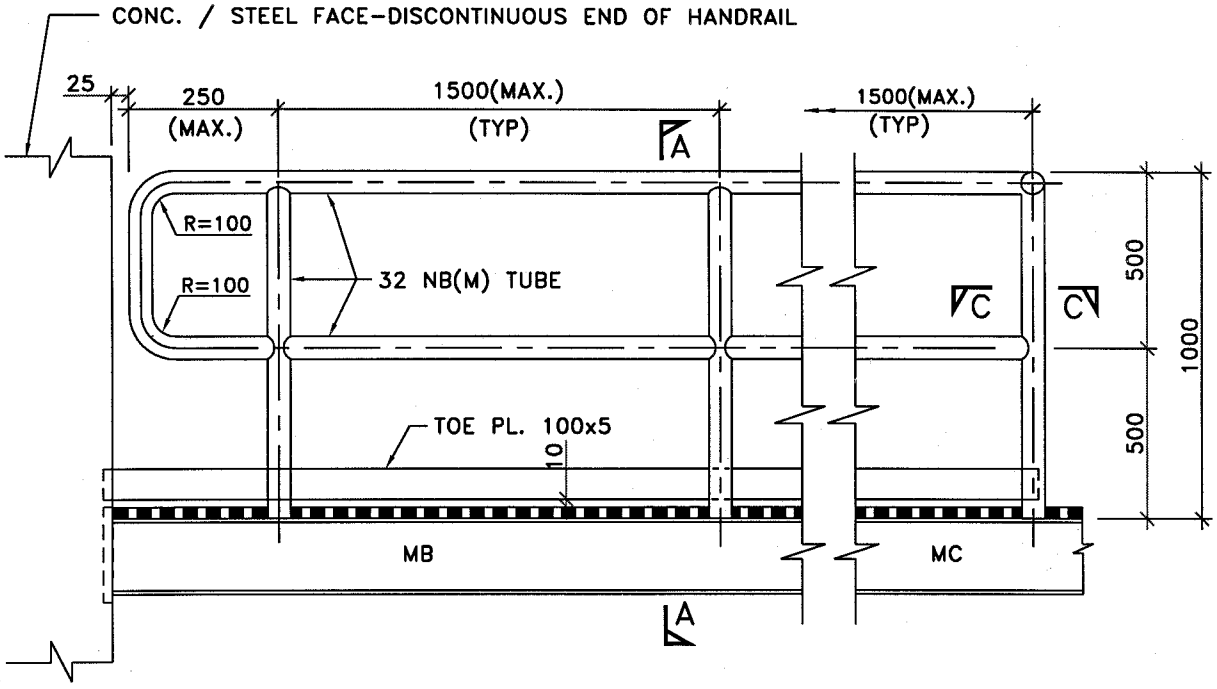
HORIZONTAL HANDRAIL ON R.C.C. PLATFORM

FOR NOTES REFER PAGE 4 OF 10 AND 7 OF 10

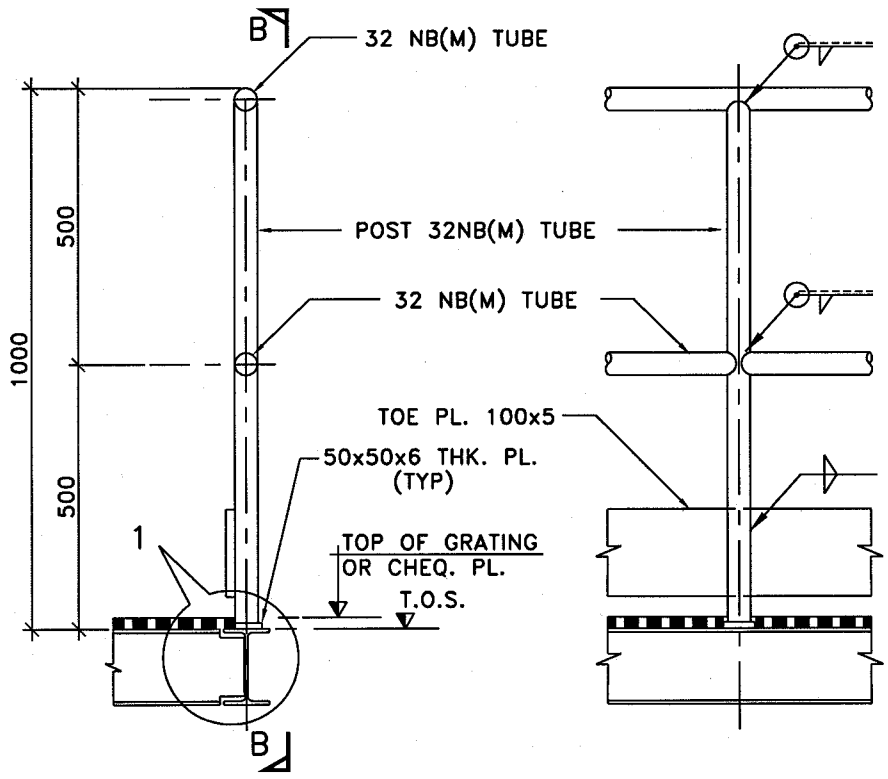
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI

Approved by

TYPE – II

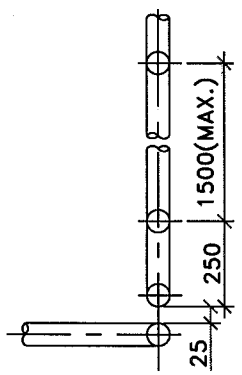


HORIZONTAL HANDRAIL ON STEEL PLATFORM



SECTION A–A

VIEW B–B



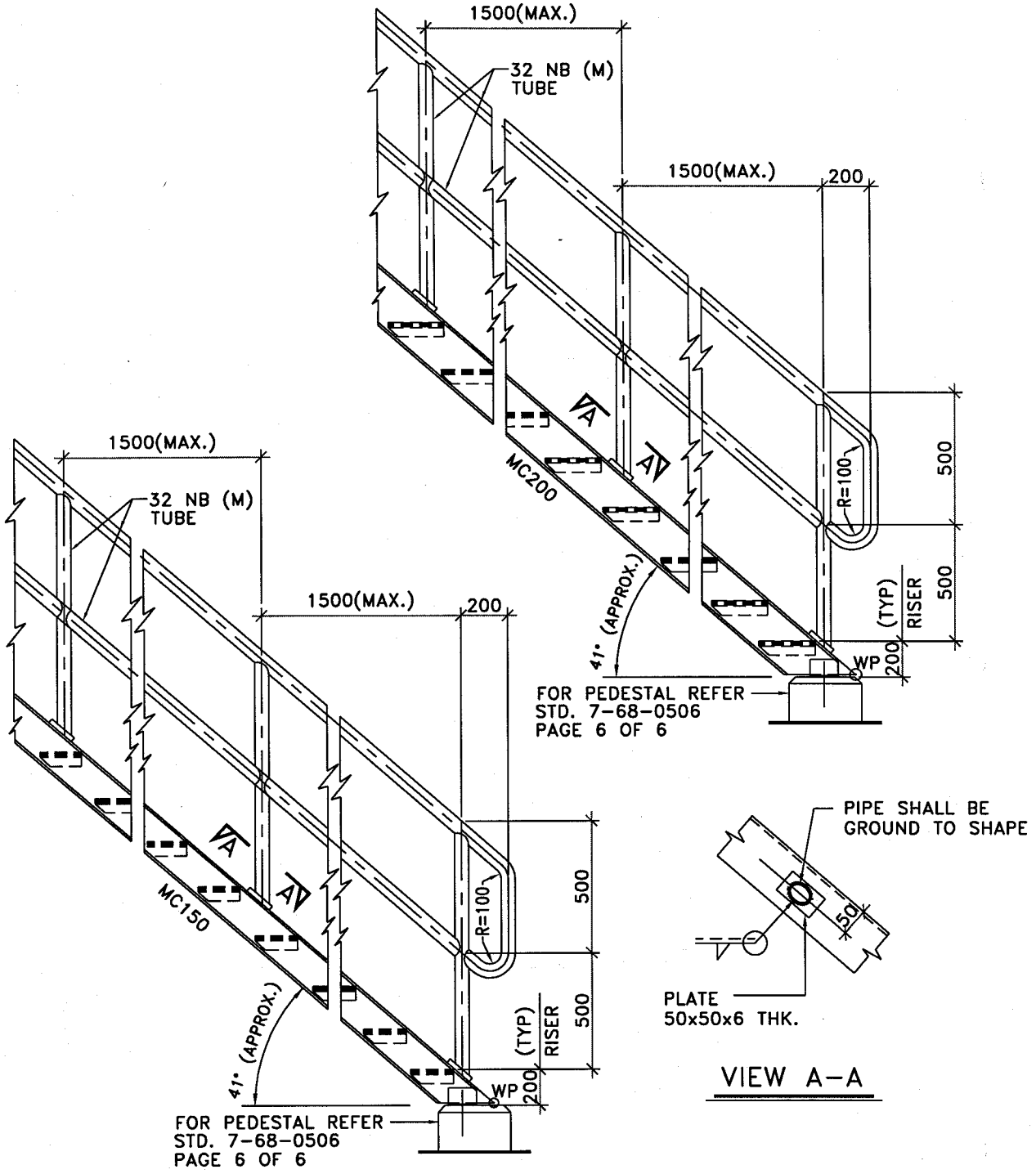
VIEW C–C
(AT CORNER)

(FOR DETAIL (1) REFER PAGE 10 OF 10)

FOR NOTES REFER PAGE 4 OF 10 AND 7 OF 10

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI

TYPE – II



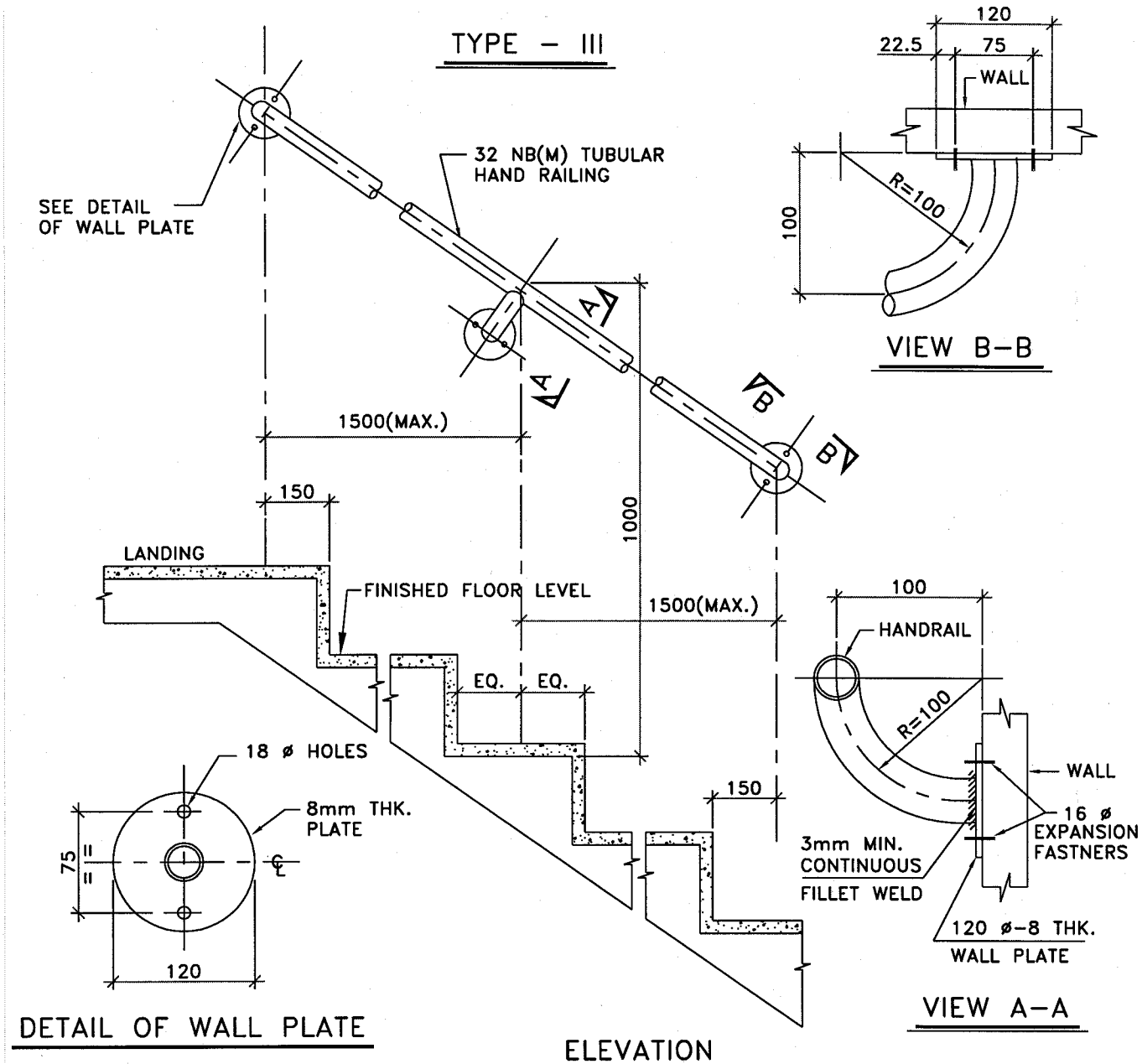
VIEW A–A

TYPICAL SLOPING HANDRAIL ON STEEL STAIR

WHEREVER HIGHER SIZE OF STRINGER BEAMS ARE REQUIRED AS PER DESIGN SIMILAR G.A. BE FOLLOWED FOR THE SAME.

FOR NOTES REFER PAGE 4 OF 10 AND 7 OF 10

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI



DETAIL OF WALL PLATE

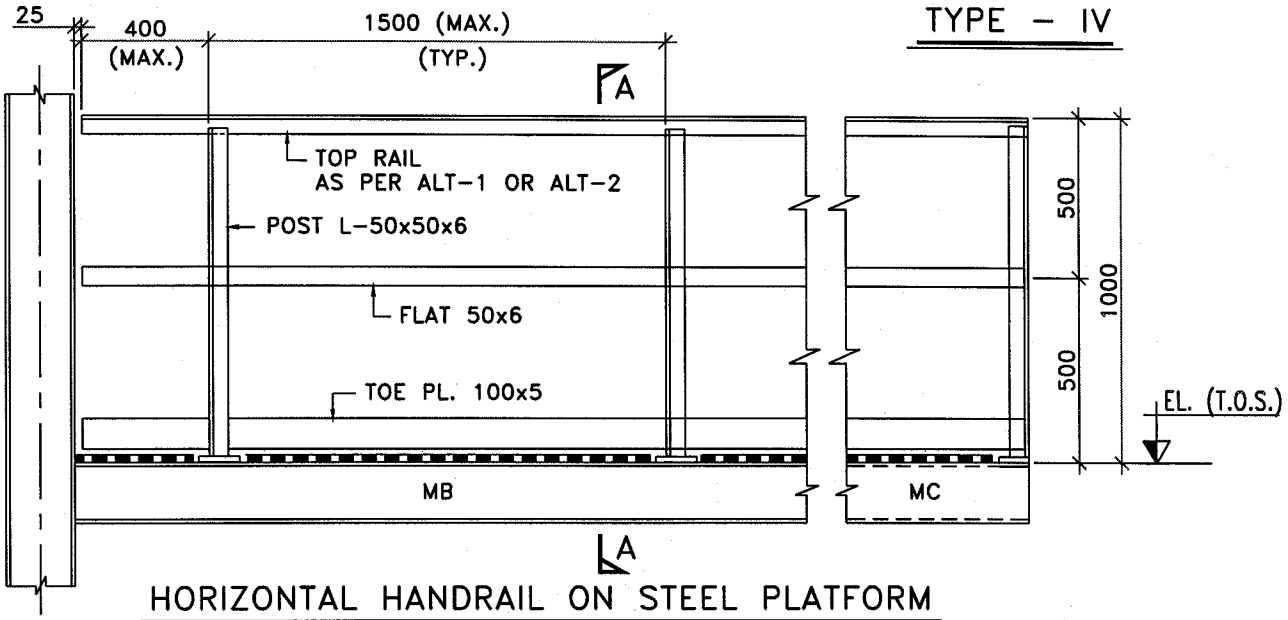
ELEVATION

HANDRAIL FIXED TO WALL DIRECT

NOTES:–

1. ALL HANDRAILS AND UPRIGHT SHALL BE AS PER RESPECTIVE TYPE.
2. ALL FILLET WELDS OF 3mm (MINIMUM) THICKNESS SHALL BE CONTINUOUS UNLESS NOTED OTHERWISE.
3. JOINTS IN HANDRAILS SHALL BE PROVIDED AT SUITABLE LOCATIONS, WELDED AND GROUND FLUSH.
4. FOR ADDITIONAL TYPE OF UPRIGHT FIXING DETAILS REFER EIL STD. 7–68–0061.
5. ALL M.S. TUBES AND FITTINGS SHALL CONFORM TO IS:1239.
6. BOTTOM 150mm OF ALL UPRIGHT MEMBER EMBEDED IN CONCRETE SHALL BE CUT AND ENDS SPLAYED OUT.
7. FABRICATION OF TOP RAIL, INTERMEDIATE FLAT AND TOE PLATE SHALL ONLY BE STARTING AFTER TAKING ACTUAL DIMENSIONS AT SITE.
8. FOR FURTHER NOTES REFER PAGE 7 OF 10.

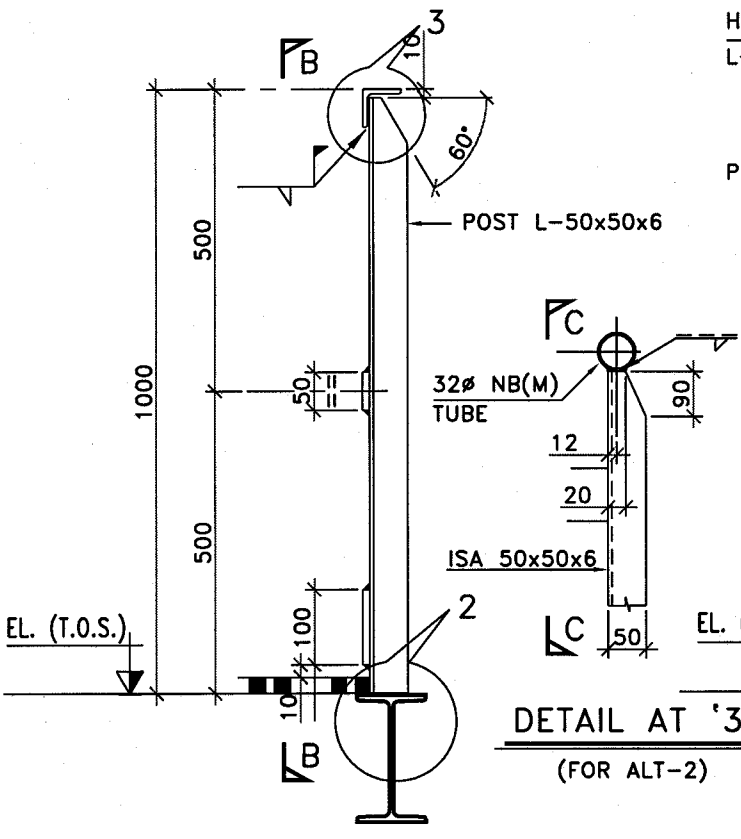
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI



TYPE – IV

HORIZONTAL HANDRAIL ON STEEL PLATFORM

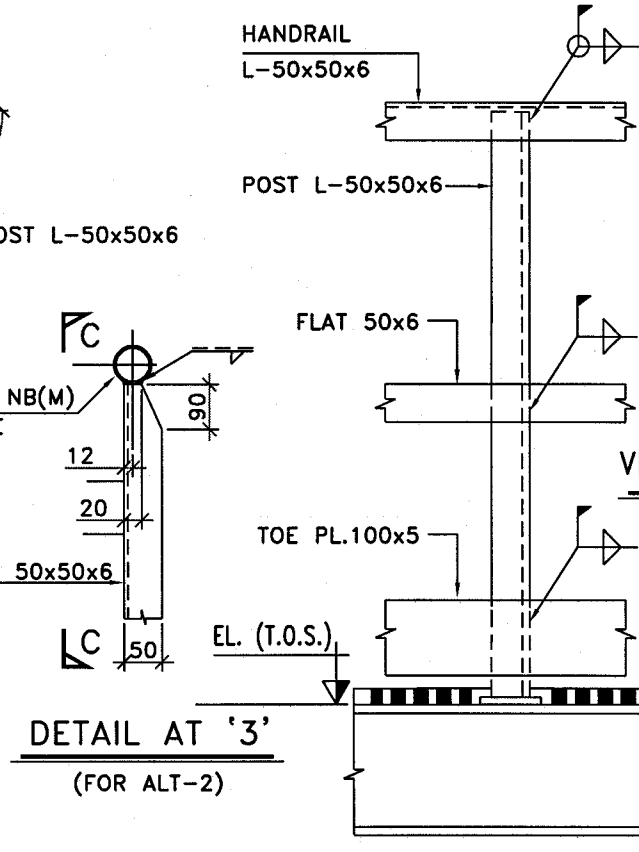
(ALT.–1 TOP RAIL OF L–50x50x6; ALT.–2 TOP RAIL OF 32NB(M) TUBE)



SECTION A–A

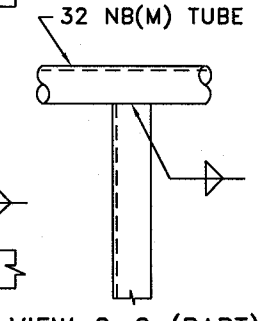
(FOR ALT–1)

(FOR DETAIL–2 REFER PAGE 10 OF 10)



VIEW B–B

(FOR ALT–1)



VIEW C–C (PART)

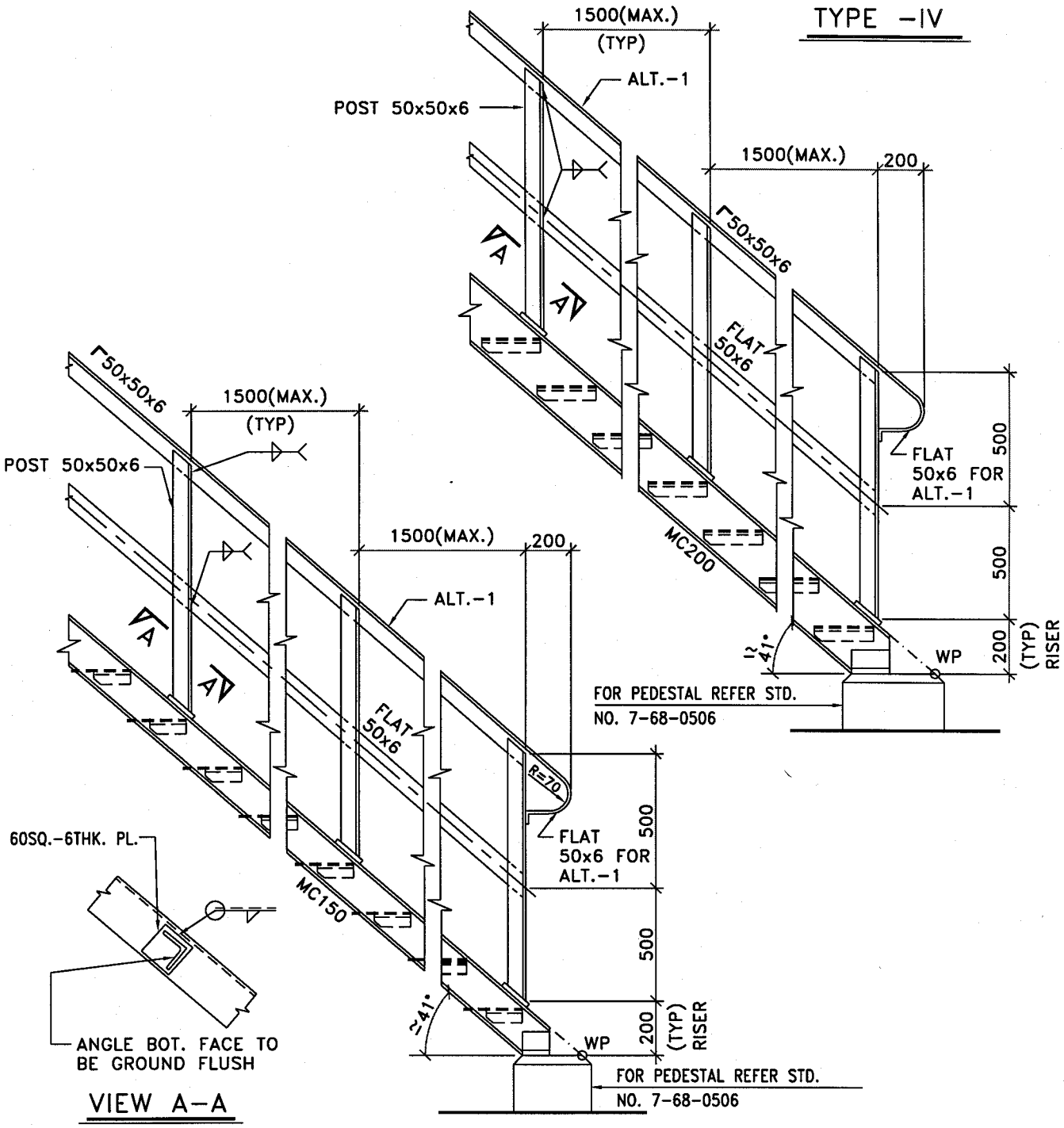
(FOR ALT–2)

DETAIL AT '3'

(FOR ALT–2)

FOR NOTES REFER PAGE 4 OF 10 AND 7 OF 10

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI



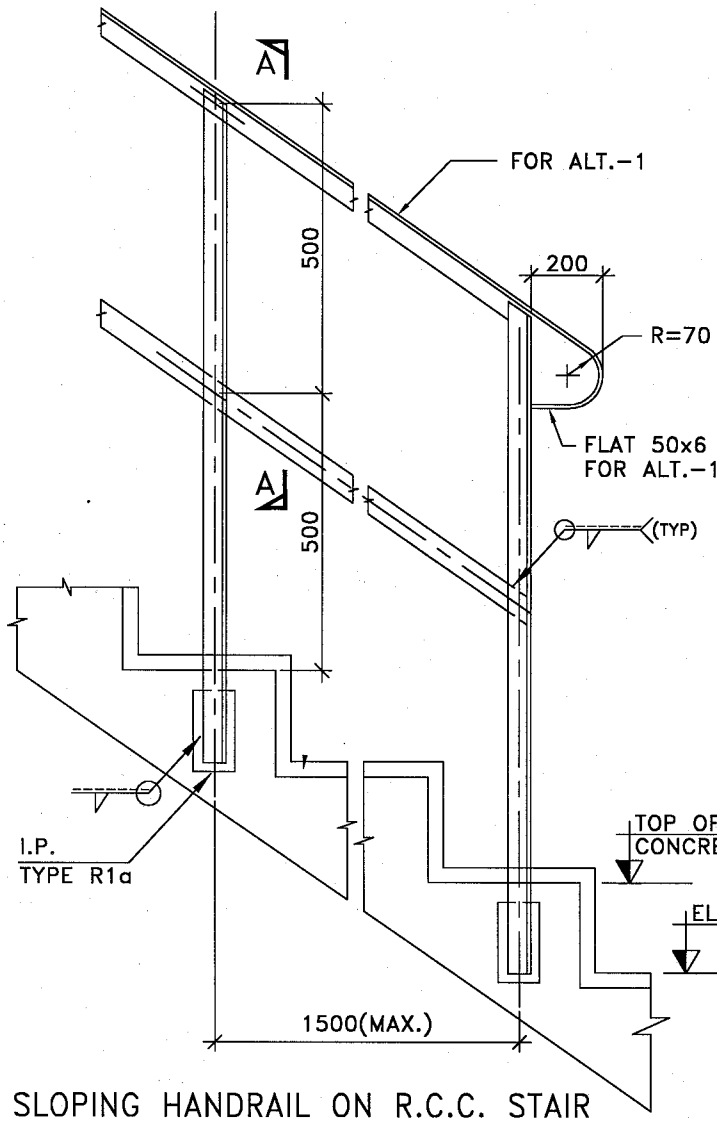
SLOPING HANDRAIL ON STEEL STAIR

(FOR ALT.–2 REFER DETAIL GIVEN ON SHEET 3 OF 10)

WHEREVER HIGHER SIZE OF STRINGER BEAMS ARE REQUIRED AS PER DESIGN SIMILAR G.A. SHALL BE FOLLOWED FOR THE SAME.

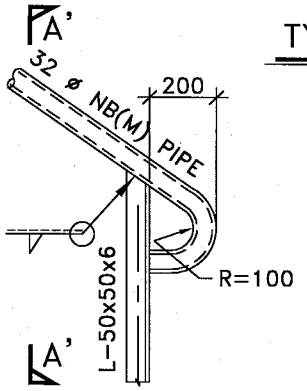
FOR NOTES REFER PAGE 4 OF 10 AND 7 OF 10

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI

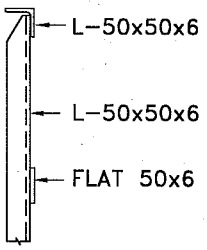


SLOPING HANDRAIL ON R.C.C. STAIR

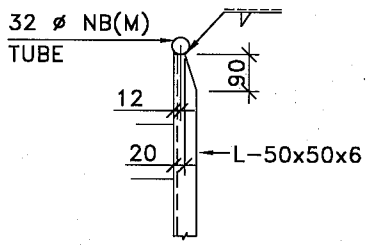
TYPE - V



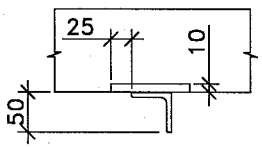
FOR ALT.-2



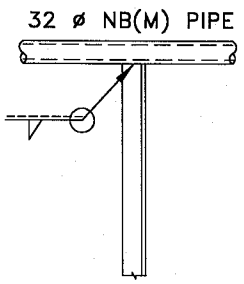
SEC. A-A
(FOR ALTERNATE-1)



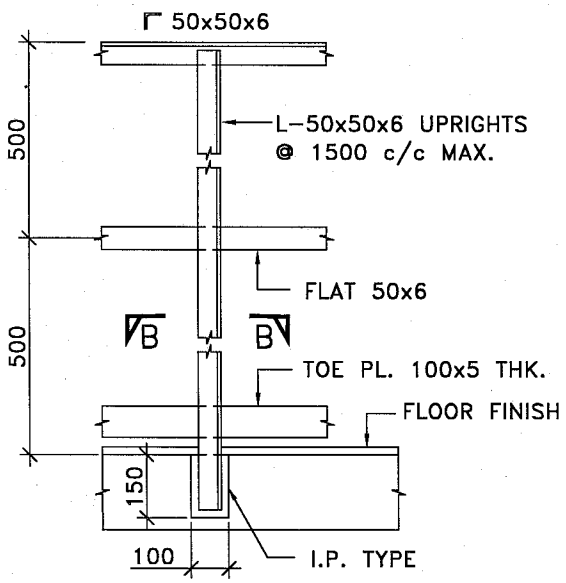
SEC. A'-A'
(FOR ALTERNATE-2)



SEC. B-B



FOR ALT.-2

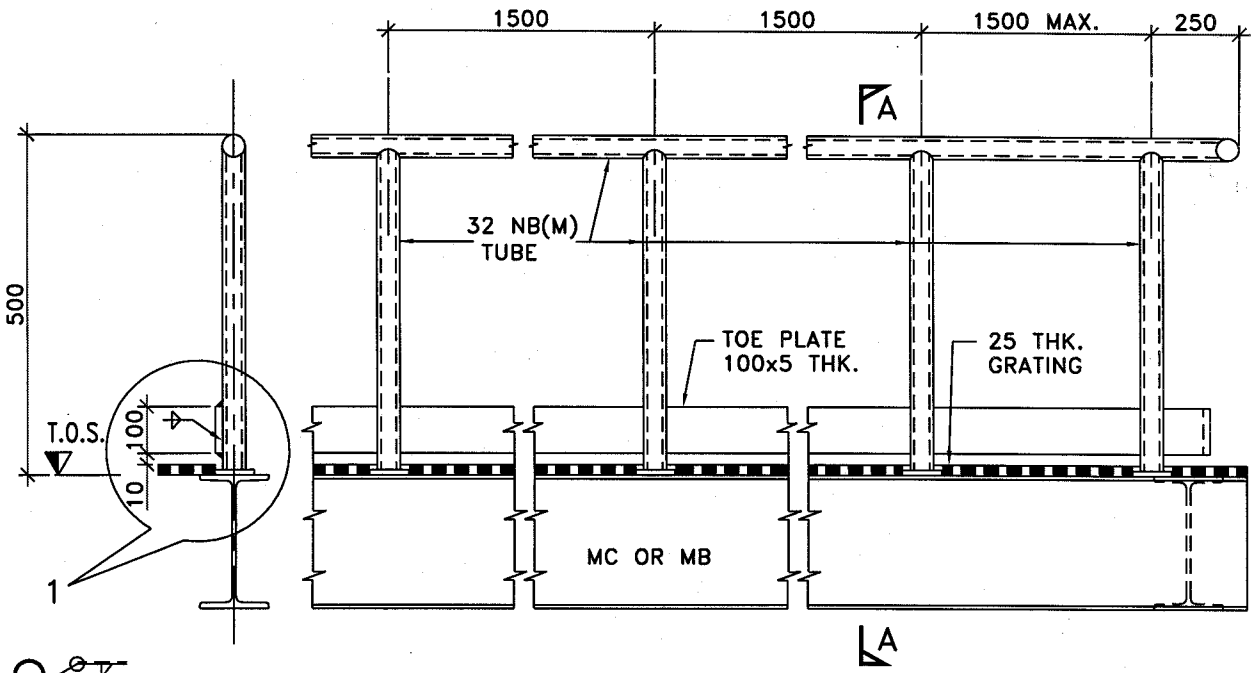


HORIZONTAL HANDRAIL ON LANDING
(FOR ALTERNATE-1)

NOTES:- (CONTD. FROM PAGE 4 OF 10)

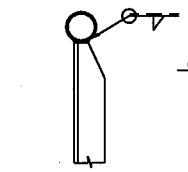
9. ADJUSTMENT IN SPACING OF VERTICAL POST SHALL BE DONE AT EITHER END OF PLATFORM.
10. FOR INSERT PLATE REFER EIL STD. 7-68-0056.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI

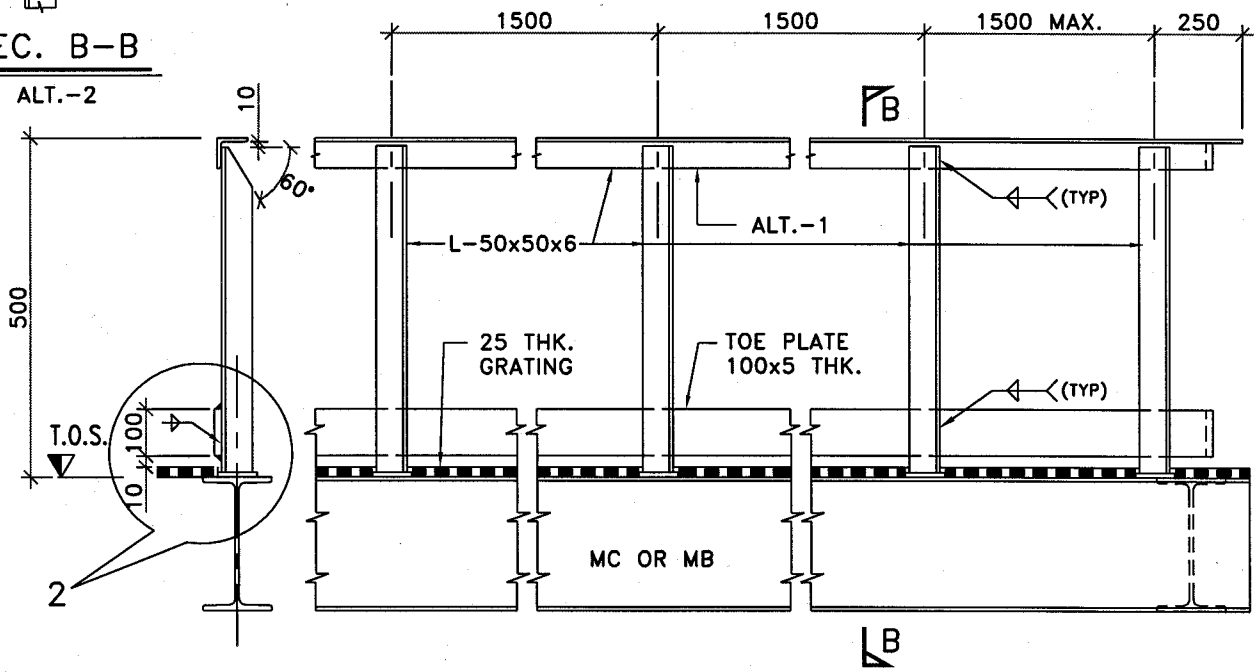


SEC. A–A

HANDRAIL TYPE VI ON HORIZONTAL PLATFORM (STEEL)



SEC. B–B
ALT.–2



SEC. B–B
ALT.–1

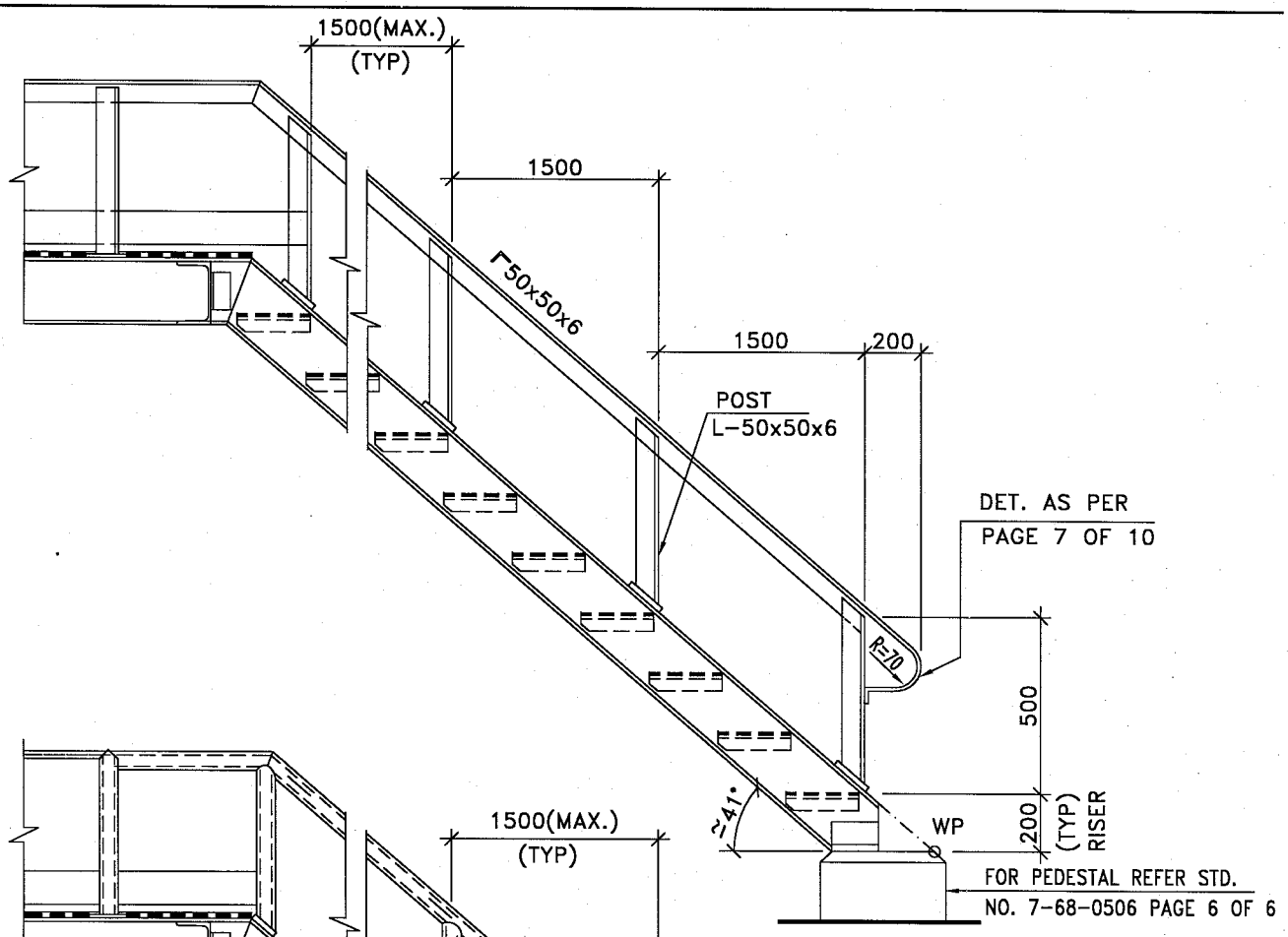
HANDRAIL TYPE VII ON HORIZONTAL PLATFORM (STEEL)

HANDRAIL TYPE VI & VII SHALL BE USED OVER PIPE CROSS OVER AND LOW LEVEL PLATFORMS SUCH AS FOR VALVE OPERATION ETC. AS MENTIONED IN STD. 7–68–0562 & 0563.

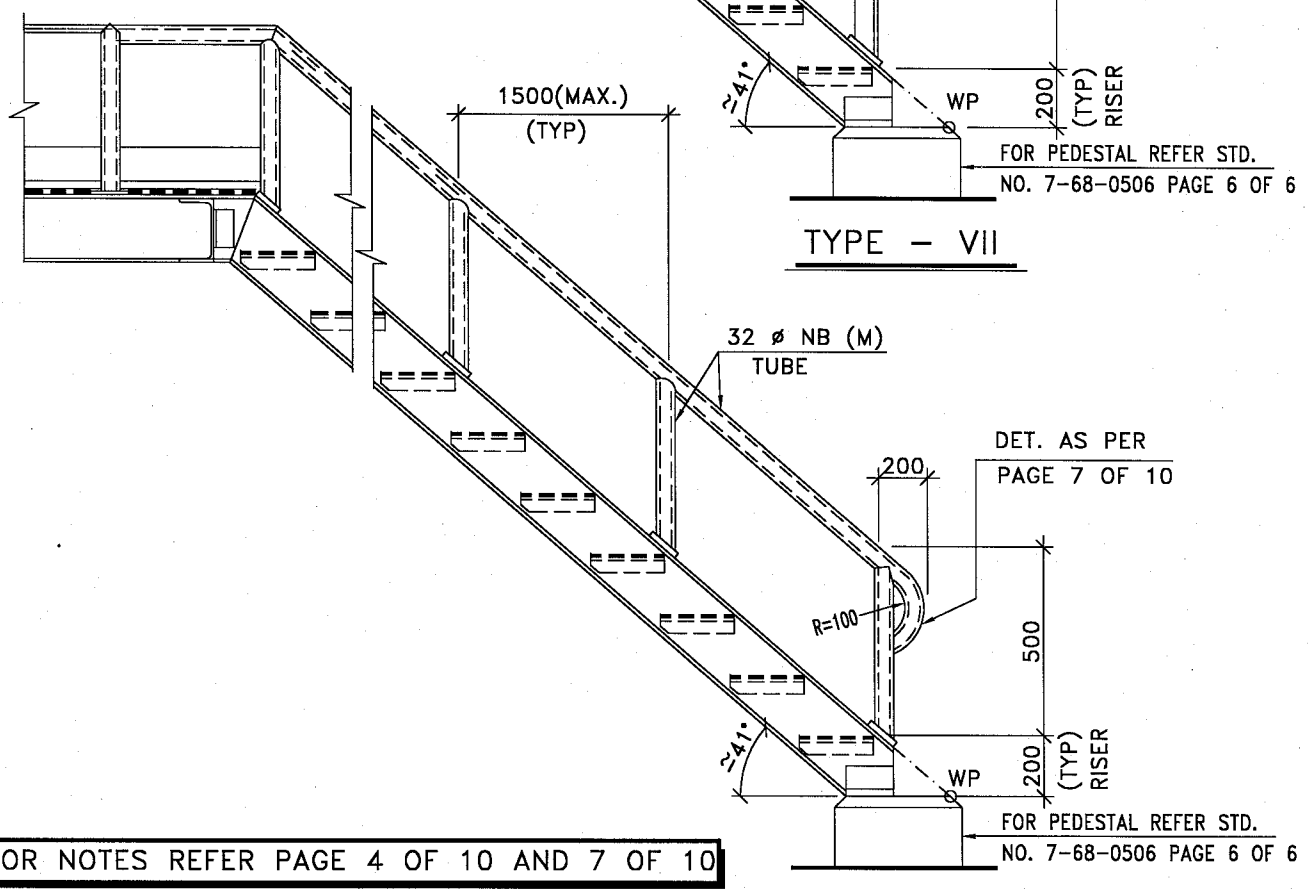
FOR DETAILS (1) AND (2) REFER PAGE 10 OF 10.

FOR NOTES REFER PAGE 4 OF 10 AND 7 OF 10

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI



TYPE – VII

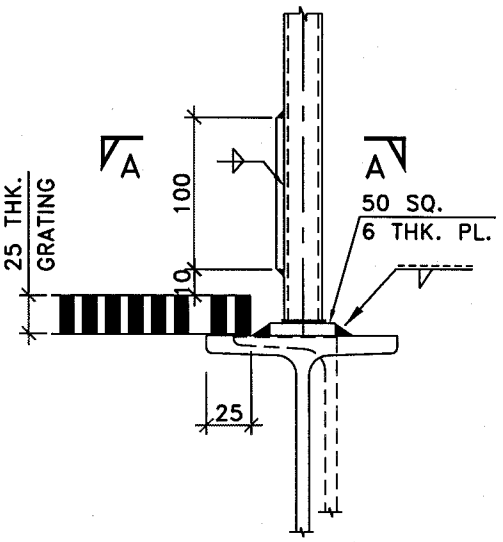


FOR NOTES REFER PAGE 4 OF 10 AND 7 OF 10

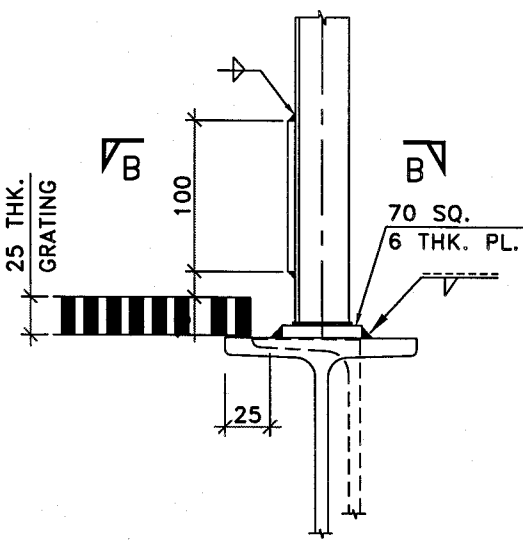
TYPE – VI

TYP. SLOPING HALF HANDRAIL ON STEEL STAIR

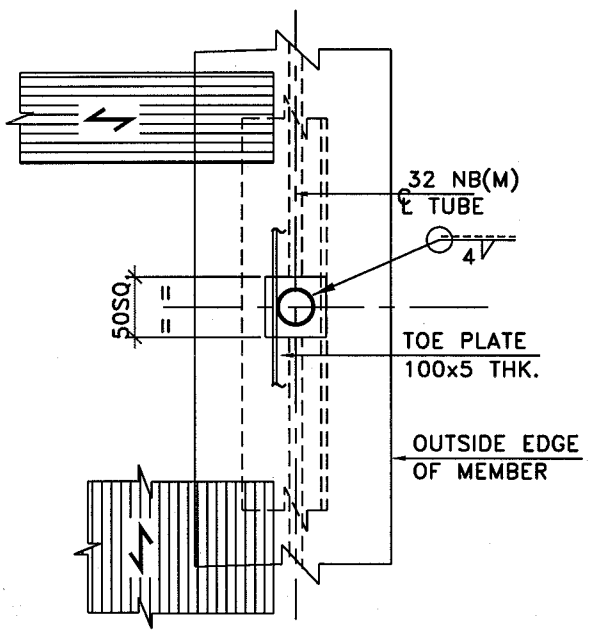
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI



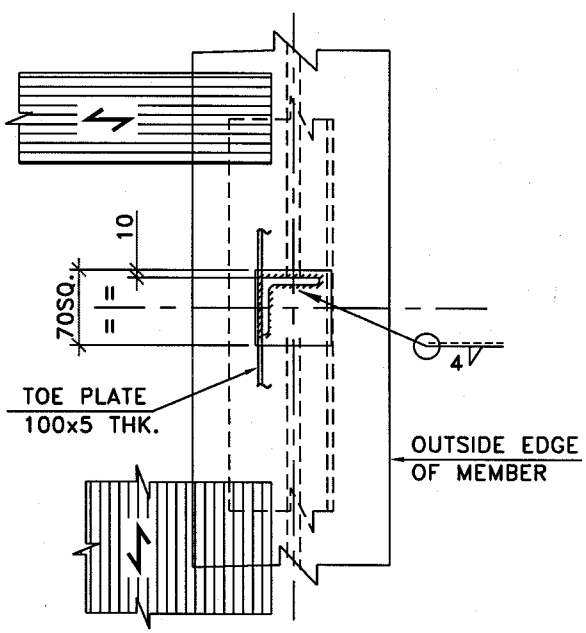
DETAIL – (1)



DETAIL – (2)



VIEW A–A



VIEW B–B

TYPICAL CONNECTION DETAILS

(FOR TYPE I, II, III, IV, V, VI, AND VII)

NOTE : CHEQUERED PLATES / GRATINGS SHALL BE SUITABLY NOTCHED TO ACCOMMODATE THE TUBE IN CASE OF BEAM MC100 OR MC125.

FOR NOTES REFER PAGE 4 OF 10 AND 7 OF 10

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	15.06.2004	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	RP MEHROTRA	ARVIND KUMAR	SK GARYALI
4	12.10.1998	REAFFIRMED & ISSUED AS STANDARD	SK SAGAR	R SOOD	SC JAIN	A SONI

JOB SPECIFICATION FOR ANTI FUNGAL PAINT SYSTEM FOR CONCRETE STRUCTURES

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	25-06-2009	ISSUED AS JOB SPECIFICATION	AS	Dr.DNW	RC

CONTENTS

1.0 GENERAL

This Job specifications covers the minimum requirement of surface preparation, protective coating system, application ,mixing, thinning and list of recommended coating materials manufacturers for antifungal paint system for exposed surfaces of all concrete structures in plant area, pedestals for equipment foundations , concrete supports of pipe racks and cooling towers etc.

2.0 SURFACE PREPARATION

Surfaces to be painted should be free from chalking. All dust, grease and loose paint ,looser powder particles , fungus/algae needs to be completely removed. Remove entirely the previous growth of fungus and algae if any by vigorous wire brushing and cleaning with water. The exterior surfaces should not be affected by any water seepage or by constant dampness. No painting shall be done in rainy season. Newly plastered surfaces shall be allowed to cure at least 2 months before painting.

3.0 COATING SYSTEM

1 Priming coat of water based 100% Acrylic exterior emulsion primer with light fast pigments and resistant to fungus and algae growth, alkali and UV degradation @ 50µ +

2 coats of finish coat with water based 100% acrylic exterior emulsion paint with light fast pigments and resistant to fungus and algae growth , alkali and UV degradation @ 50 µ = 2×50 = 100 µ

Total DFT = 150 µ minimum.
Note : DFT can be checked on a carbon steel panel of 1 ft × 1 ft , applied simultaneously.

4.0 APPLICATION , MIXING AND THINNING

The manufacturers recommendations given in the printed literature shall be followed .

6.0 LIST OF RECOMMENDED COATING MANUFACTURERS:

1. Asian Paints (I) Ltd., Mumbai
2. Berger paints Ltd., Kolkata
3. Kansai Nerolac Paints Ltd., Mumbai (including Ameron, USA Products).
4. Chugoku Marine Paints Pvt. Ltd., Mumbai
5. Shalimar Paints Ltd., Kolkata
6. Sigma Kalon Marine and Protective Coatings(India) Pvt Ltd, Mumbai.
7. CDC Carboline Ltd., Chennai
8. Premier products Ltd., Mumbai
9. Coromandel Paints & Chemicals Ltd., Visakhapatnam
10. Anupam Enterprises, Kolkata
11. Grand Polycoats, Vadodata
12. Bombay Paints Ltd., Mumbai
13. Akzo Nobel Coatings and Sealants Pvt. Ltd., Bangalore
14. Cipy Polyurethanes Pvt. Ltd., Pune
15. Gunjan Paints Ltd., Ahmedabad
16. Advance Paints Ltd., Mumbai
17. VCM Polyurethane Paints (for polyurethane paints only)

18. Jotun Paints India Pvt Ltd
19. Paladin Paints and Chemicals , Mumbai
20. Chembond Chemicals Pvt Ltd , Navi Mumbai
21. Aashish Coating Technologies Pvt. Ltd, Vadodara/Mumbai

JOB SPECIFICATION
FOR
SHOP & FIELD PAINTING

SMMS DEPARTMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	15-06-2009	ISSUED JOB SPECIFICATION	AS	DR.DNW	RC

Abbreviations:

AS	:	Alloy Steel
CS	:	Carbon Steel
LTCS	:	Low Temperature Carbon Steel
MS	:	Mild Steel
SS	:	Stainless Steel
GI	:	Galvanized Iron
DFT	:	Dry Film Thickness
WFT	:	Wet Film Thickness
DM	:	De-mineralized
ID	:	Internal Diameter
OD	:	Outside Diameter
NB	:	Nominal Bore
RCC	:	Reinforced Cement Concrete
IRN	:	Inspection Release Note

CONTENTS

1.0 GENERAL

1.1 These technical specifications shall be applicable for the work covered by the contract, and without prejudice to the provisions of various codes of practice, standard specifications etc. It is understood that contractor shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-In-Charge.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the contractor.

Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

2.0 SCOPE

2.1 Scope of work covered in the specification shall include, without being limited to the following.

2.1.1 This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services, MS Chimney without Refractory lining and Flare lines etc. The items listed in the heading of tables of paint systems is indicative only, however, the contractor is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

2.2 Extent of Work

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting:

a. All uninsulated C.S. & A.S. equipment like columns, vessels, drums, storage tanks(both external & internal surfaces), heat exchangers, pumps, compressors, electrical panels and motors etc.

b. All uninsulated carbon and low alloy piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.

c. All items contained in a package unit as necessary.

d. All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.

e. Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining.

f. Identification colour bands on all piping as required including insulated aluminium clad, galvanised, SS and nonferrous piping.

g. Identification lettering/ numbering on all painted surfaces of equipment/piping insulated aluminium clad, galvanized, SS and non-ferrous piping

h. Marking / identification signs on painted surfaces of equipment/piping including hazardous service.

i. Supply of all primers, paints and all other materials required for painting (other than Owner supplied materials)

j. Over insulation surface of equipments and pipes wherever required.

k. Painting under insulation for carbon steel, alloy steel and stainless steel as specified.

l. Painting of pre-erection/fabrication and Shop primer.

m. Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection as required.

n. All CS Piping, equipments, storage tanks and internal surfaces of RCC tanks in **ETP plant.**

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the owner, the same shall be painted as per the relevant specifications:

a. Uninsulated austenitic stainless steel.

b. Plastic and/or plastic coated materials

c. Non-ferrous materials like aluminum.

2.3 **Documents**

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for execution of work.

a. Bill of quantities for piping, equipment, machinery and structures etc.

b. Piping Line List.

c. Painting specifications including special civil defence requirements.

2.4 Unless otherwise instructed, final painting on pre-erection/ shop primed pipes and equipments shall be painted in the field, only after the mechanical completion, testing on systems are completed as well as after completion of steam purging wherever required.

2.5 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to EIL for deviation permit.

3.0 REFERENCE CODES & STANDARDS

3.1 Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered by this contract.

IS-5	:	Colour coding.
RAL DUTCH	:	International Standard for colour shade (Dutch Standard)
IS-101	:	Methods of test for ready mixed paints and enamels.
IS-2379	:	Indian Standard for Pipe line identification-colour code.
ASTM-Vol 6.01 & 6.03:		American standard test methods for Paints and Coatings.
ASA A 13.1-1981:		Scheme for identification of piping systems: American National Standards Institution.

3.2 **Surface Preparation Standards**

The latest editions of any of the following standards shall be followed for surface preparation:

3.2.1 ISO 8501-1 / SIS-05 59 00: ISO standard for Preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-In-Charge.

3.2.2 Steel Structures Painting Council, U.S.A. (Surface Preparation Specifications (SSPC-SP).

3.2.3 National Association of Corrosion Engineers, U.S.A., (NACE).

3.2.4 Various International Standards equivalent to Swedish Standard for surface preparations are given in Table-I.

3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of above standards and codes at site.

3.4 The paint manufacturer's instructions shall be followed as far as practicable at all times for best results. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparation prior to painting shall be followed as per Table 8.0 to 16.0 of this standard shall be followed.

c. Mixing and thinning.

d. Application of paints and recommended limit on time intervals in between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipments, scaffolding materials, shot & grit blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity. The manufacturer's test certificates / data sheets for all the above items shall be reviewed by Engineer-in-charge at site before start of work.

4.2 Mechanical mixer shall be used for paint mixing operations in case of two pack systems except that the Engineer-In-Charge may allow the hand mixing of small quantities at his discretion in case of specific requirement for touch up work only.

5.0 SURFACE PREPARATION, SHOP PRIMER COATING APPLICATION & REPAIR AND DOCUMENTATION

5.1 General

5.1.1 In order to achieve the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by Engineer-In-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

a. Manual or hand tool cleaning.

b. Mechanical or power tool cleaning.

c. Blast cleaning.

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification The minimum acceptable standard in case of manual or hand tool cleaning shall be St. 2 or equivalent, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent, in case of blast cleaning it shall be Sa 2-1/2 as per Swedish Standard SIS-055900(latest edition) or SSPC-SP or ISO 8501-01.Blast cleaning shall be Sa 3 as per Swedish Standard in case of highly corrosive environment.

Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%. Incase of internal coating of storage tanks, De-humidifiers shall be used to control the humidity levels during

rainy season, if painting is to be carried out during the no rain days in case of exigency of project schedule with prior permission of Engineer-in-charge of OWNER/EIL

5.1.4 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray if recommended by the paint manufacturer on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.5 The external surface of R.C.C. chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush. Acid etching with 10-15% HCL solution for about 15 minutes shall be carried and surface must be thoroughly washed with water to remove acid & loose particles and then dried completely before application of paint.

5.2 **Procedure of Surface Preparation** :

5.2.1 Air Blast Cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives like copper slag, $A1_2O_3$ particles, chilled cast iron or malleable iron and steel at pressure of 7kg/cm^2 at a appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size with appropriate size of G42 grade (maximum) and S250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak or specified profile in case of steel and malleable iron . The combination of steel grits and shots shall be normally in the ratio of 3 : 1. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to ¾". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster. Primer/first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50 microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

5.2.2 Mechanical or Power Tool Cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire- brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and /or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

5.2.3 Manual or hand tool cleaning

Manual or hand tool cleaning is used only where safety problems limit the application of other surface preparation procedure and hence does not appear in the tables of paint systems.

Hand tool cleaning normally consists of the following:

a. Hand de-scaling and/or hammering

b. Hand scraping

c. Hand wire brushing

Rust, mill scale spatters, old coatings and other foreign matter, shall be removed by hammering, scrapping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose material shall be removed from the surface by clean rags and the surface shall be bushed, swept, dusted and blow off with compressed air/steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 Non-Compatible shop coat primer

The paint system followed for Shop coating of structures/equipments etc., shall be mentioned in IRN. The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc Rich epoxy, inorganic zinc silicate etc. as shop coat, the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in-Charge.

5.4 Shop coated (coated with Primer & finishing coat) equipment should not be repainted unless paint is damaged. Repair shall be carried out as per Table 7.2 of paint systems depending upon compatibility of paint.

5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before application of selected paint system for particular environment.

5.6 For Package units/equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

5.7 **Coating Procedure and Application**

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than $5^{o}F$ above dew point when the relative humidity is greater than 85% or when the temperature is below $40^{o}F$ and when the ambient/substrate temp is below the paint manufacturer's recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20KM per hour.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter coat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Air spray application shall be in accordance with the following:

a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.

c. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

d. The pressure on the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for changes in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or less by over spray

e. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film.

Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted.

f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited

uniformly. During application, the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

g. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.

h. Areas inaccessible to the spray gun shall be painted by brush; if not accessible by brush, daubers or sheepskins shall be used.

i. All nameplates, manufacturer's identification tags, machined surfaces, instrument glass, finished flange faces, control valve items and similar items shall be masked to prohibit coating deposition. If these surfaces are coated, the component shall be cleaned and resorted to its original condition.

j. Edges of structural shapes and irregular coated surfaces shall be coated first and an extra pass made later.

k. If spray gun shows choking, immediately de-choking procedure shall be followed.

5.7.7 Airless spray application shall be in accordance with the following procedure: as per stesl structure paint Manual Vol.1 & Vol.2 by SSPC, USA, Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is sued to operate a pump to produce pressures of 1000 to 6000 psi. paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in automization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consist of in built strainer. Usually very small quantity of thinning is required before spray. In case of high build epoxy coating (two pack). 30:1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally fluid hoses should not be less than 3/8" ID and not longer than 50 ft to obtain optimum results.

In case of gun choking, de-choking steps shall be followed immediately.

5.7.8 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint.

b. Round or oval brushes are most suitable for rivets, bolts, irregular surface, and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

c. Paint shall be applied into all corners.

d. Any runs or sags shall be brushed out.

e. There shall be a minimum of brush marks left in the applied paint.

f. Surfaces not accessible to brushes shall be painted by spray, doubers, or sheepkin.

5.7.9 Manual application by sling (where 6 O' clock position of pipe is not approachable)

A canvas strip (alternatively a tinplate strip) about 450 mm wide and 1.5m long is hold under the pipe by two men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is obtained all round the bottom. This work shall be done very carefully and by experienced personnel. There shall not be any formation of "Whiskers" and holes in the coating. The coating film shall be inspected by mirror.

5.7.10 For each coat the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Drying of coated surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or maxing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause checking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

5.8.3 No drier shall be added to a paint on the job unless specifically called for in the manufacturer's specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

5.9 Repair of damaged paint surface

5.9.1 Where paint has been damaged in handling and in transportation, the repair of damaged coating of pre-erection / fabrication and Shop primer shall be done as given below and as per the Table 7.2 of this specification.

5.9.2 Repair of damaged inorganic zinc silicate primer after erection / welding in the design temperature of -90^{o}C to 550^{o}C.

Surface Preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface over the intact adjacent surface surrounding the damaged area by emery paper.

Primer coating: One coat of F-9 shall be applied wherever damaged was observed on pre-erection pre fabrication / shop primer of inorganic zinc silicate coating (F-9). F-9 shall not be applied if damaged area is not more than 5x5 cm.

5.10 Paint Application

5.10.1 Shop priming/pre-erection priming with F9 or F12 shall be done only on blasted surface (SSPC-SP-10)

5.10.2 Shop priming/ pre-erection priming with F9 or F12 shall be done only with airless spray.

5.10.3 For large flat surface field painting shall be done by airless spray otherwise brush can be used.

5.10.4 Assessment of painting requirement

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

- Identify the environment from area classification details and chose the appropriate table.

- Identify the design temperature from the technical documents

- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.

- Identify the shop priming requirement from Table 7.1 based on compatibility of the above paint system.

- Identify the need of repair of shop primer and execute as per Table 7.2.

5.11 Documentation

5.11.1 A written quality plan with procedure for qualification trials and for the actual work.

5.11.2 Daily progress report with details of weather conditions, particular of applications, no of coats and type of materials applied, anomalies, progress of work versus program.

5.11.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

5.11.4 Particulars of surface preparation and paint application during trials and during the work.

5.11.5 Details of non-compliance, rejects and repairs.

5.11.6 Type of testing equipments and calibration.

5.11.7 Code and batch numbers of paint materials used.

TABLE-1 (FOR CLAUSE 5.0)

SURFACE PREPARATION STANDARDS

SL. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)			REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
1	Manual or hand tool cleaning Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen	ST.2	SSPC-SP-2	--	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting.
2	Mechanical or power tool cleaning Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	ST.3	SSPC-SP-3	--	
3	Dry abrasive Blast cleaning There are four common grades of blast cleaning				
3.1	White metal Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	SA 3	SSPC-SP-5	NACE#1	Where extremely clean surface can be expected for prolong life of paint system.
3.2	Near white metal Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is	SA 2½	SSPC-SP-10	NACE#2	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based

SL. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)			REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
	free of all visible residues with desired surface profile.				and inorganic zinc silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
3.3	Commercial Blast Blast cleaning until at least two-third of each element of surface area is free of all visible residues with desired surface profile.	SA 2	SSPC-SP-6	NO.3	For steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint systems.
3.4	Brush-off Blast Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so important	SA 1	SSPC-SP-7	NO.4	

6.0 PAINT MATERIALS

Paint manufacturers shall furnish the characteristics of all paints materials on original printed literature, alongwith the test certificate for all specified characteristics given in this specification. All the paint materials shall be of first quality and conform to the following general characteristics as per the tables 6.1, 6.2, 6.3 and 6.4.

PAINT MATERIALS

TABLE No. 6.1 PRIMERS

Sl. No.	DESCRIPTION	P-2	P-4	P-6	P-7
1	Technical name	Chlorinated rubber Zinc Phosphate primer.	Etch primer/wash primer	Epoxy zinc phosphate primer	ZINGA synthetic zinc primer
2	Type and composition	Single pack, air drying chlorinated rubber based medium plasticised with unsaponifiable plasticizer, pigmented with zinc phosphate.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack Synthetic Resin based zinc primer containing 96% of electrolytic zinc dust of 99.995% purity.
3	Volume Solids (minimum)	40%.	7-8%	40%	37%
4	DFT (Dry Film thickness) per coat (minimum)	30-40µ	8-10µ	40-50µ	40-50µ
5	Theoritical covering capacity in M^2/coat/ litre (minimum)	8-10	8-10	8-10	4m^2/kg
6	Weight per litre in kgs/litre (minimum)	1.3	1.2	1.4	2.67 kg at 15°C
7	Touch dry at 30°C (minimum)	30 minutes	2 hrs.	After 30 min.	10 minutes
8	Hard dry at 30°C (maximum.)	24 hrs.	24 hrs.	24 hrs.	24 hrs.
9	Overcoating interval	Min.: 8 hrs	Min: 4-6 hrs.	Min.:8hrs.	Min.:4 hrs
10	Pot life at 30°C for two component paints (minimum)	Not Applicable	Not applicable	6 - 8 hrs.	Unlimited
11	Temperature (Resistance (minimum)	60 °C	NA	80°C	100°C.

PAINT MATERIALS

TABLE No. 6.2 FINISH PAINTS

Sl. No	DESCRIPTION	F-2	F-3	F-6A/B	F-7
1	Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build finish paint.	High build coaltar epoxy coating.
2	Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint.	Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.	F6A: Two-pack polyamine cured epoxy resin medium suitably pigmented. F6B: polyamide cured epoxy resin medium suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
3	Volume Solids (minimum.)	40%.	40%	62%	65%
4	DFT (Dry Film thickness) per coat (minimum)	30-40µ	30-40µ	100-125µ	100-125µ
5	Theoritical covering capacity in M^2/coat/litre (minimum)	10-13	8-10	5-6	5.2-6.5
6	Weight per liter in kgs/litre(minimum)	1.3	1.2	1.4	1.5
7	Touch dry at 30°C	1 hr.	30 minutes.	3 hrs.	4 hrs.
8	Hard dry at 30°C (max) Full cure at 30°C (for immersion/ high temperature service)	16 hrs 5 days	8 hrs NA	16 hrs 5 days	48 hrs. 5 days
9	Over-coating interval at 30 °C	Min.: 12 hrs.	Min.: Overnight	Min.: Overnight Max.: 5 days	Min.: 24 hrs Max.: 5 days.
10	Pot life (approx.) at 30°C for two component paints (minimum)	6-8 hrs.	Not applicable	4-6 hrs	4-6 hrs.
11	Temperature Resistance (minimum)	80 °C	60 °C	80°C	125°C.

PAINT MATERIALS

TABLE No. 6.3 FINISH PAINTS

Sl. No	DESCRIPTION	F-8	F-9	F-11	F-12
1	Technical name	Self priming type surface tolerant high build epoxy coating (complete rust control coating).	Inorganic zinc silicate coating	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250°C dry temp.	Heat resistant silicone Aluminium paint suitable upto 500°C dry temp.
2	Type & composition	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	A two pack air drying self curing solvent based inorganic zinc silicate coating with minimum 80% zinc content on dry film. The final cure of the dry film shall pass the MEK rub test.	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250°C.	Single pack silicone resin based medium with Aluminium flakes.
3	Volume Solids (minimum)	72%.	60%	25%	20%
4	DFT (Dry Film thickness) per coat (minimum)	100-125µ	65-75µ	20-25µ	20-25µ
5	Theoritical covering capacity in M^2/coat/ litre (minimum)	6.0-7.2	8-9	10-12	8-10
6	Weight per liter in kgs/litre (minimum)	1.4	2.3	1.2	1.1
7	Touch dry at 30°C (maximum)	3 hrs.	30 minutes.	3 hrs.	30 minutes.
8	Hard dry at 30°C (maximum) Full cure 30°C (for immersion /high temperature service)	24 hrs 5days	24 hrs NA	24 hrs NA	24 hrs NA
9	Over-coating interval	Min.: 10 hrs	Min.: 12 hrs.at 20°C & 50% RH	Min.: 24 hrs	Min.: 24 hrs
10	Pot life at 30°C for two component paints (minimum.)	90 minutes.	4-6 hrs.	Not applicable	Not applicable
11	Temperature Resistance (min)	80 °C	400 °C	250°C	500°C.

PAINT MATERIALS
TABLE No. 6.4 FINISH PAINTS

Sl. No	DESCRIPTION	F-14	F-15	F-16	F-17
1	Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardner system (primer + intermediate coat + finish paint)	Ambient temperature curing Poly Siloxane coating/High build cold applied inorganic copolymer based aluminium coating suitable for under insulation coating of CS and SS piping for high temperature service.	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system
2	Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation of CS/SS piping	Amercoat 738 from Ameron Products, USA/ Berger 938 from Berger Paints Ltd., or Intertherm 751 CSA from Akzo Nobel coating. Note: 6	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system
3	Volume Solids (minimum)	70%	65%	60%	98-100 %
4	DFT (Dry Film thickness) per coat (minimum)	125 µm	75-100 µm	75-100 µm	125- 150 µm
5	Theoritical covering capacity in M^2/coat/ litre (minimum)	5.5	6.5- 8.5	6.0- 8.0	6.5 - 8
6	Weight per liter in kgs/litre (mix paint) (minimum)	1.5	1.7	1.3	1.7
7	Touch dry at 30°C (maximum)	4 hrs	2 hrs	1 hr	2 hrs
8	Hard dry at 30°C (maximum) Full cure 30°C (for immersion /high temp. service)	24 hrs 168 hrs (7 days)	24 hrs 168 hrs (7 days)	16 hrs -	24 hrs 168 hrs (7 days)
9	Over-coating interval	Min. 6 hrs Max.5 days	Min. 36 hrs Max.21 days	Min.16 hrs Max. Not applicable	Min. 16 hrs Max.21 days
10	Pot life at 30°C for two component	4 hrs	1.5 hrs	1 hr	1 hr

	paints (minimum.)				
11	Temperature Resistance (min)	-45°C to 125°C under insulation	-45°C to 150°C under insulation (Note: 5)	Up to 400 deg. C for CS & SS surfaces under insulation	-45°C to 150°C for immersion service

NOTES (for tables 6.1 to 6.4):

1. Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the losses during application, min specified DFT should be maintained.

2. All primers and finish coats should be cold cured and air drying unless otherwise specified.

3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. In case of conflict between this specification and manufacturer's recommendation, the same shall be clarified through SMMS.

4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

5. F-15: Two-component Epoxy phenolic coating cured with Polyamine adduct hardner system (primer + intermediate coat + finish paint) suitable upto 225ºC (Intertherm 228 from M/s Akzo Nobel Coatings & Sealants, Bangalore). For all other companies, the temperature resistance shall be a maximum of 150ºC.

6. F-16: Ambient temperature curing epoxy poly siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating.

   'Amercoat 738' from Ameron Products USA/Kansai Nerolac Paints Ltd. Mumbai, suitable upto 400ºC for CS surfaces and 600ºC for SS surfaces.

   'Berger 938' from Berger Paints Ltd Kolkata, suitable upto 400ºC for CS & SS surfaces.

   'Intertherm 751' from Akzo Nobel Coatings and Sealants Pvt Ltd, Bangalore, Inorganic co-polymer cold applied Aluminium spray coating suitable upto 400ºC of CS & SS surfaces.

6.5 List of recommended Manufactures

The paints shall conform to the specifications given above and best quality in their products range of manufacturers listed in Annexure-I.

7.0 PAINT SYSTEMS

The paint system should be selected based on the areas classified inside the plant as given below. The Geographical corrosive and highly corrosive conditions of a plant located in Coastal and Marine area , Highly Corrosive conditions inside a plant and Industrial Corrosive Environment are taken care in the specifications in total.

ENVIRONMENT/AREA CLASSFICATION

- **Corrosive Environment-Offsite areas** (excluding Cooling Tower area, DM-plant)
- **Corrosive Environment-Unit areas**
- **Highly Corrosive Environment-Unit & Offsite areas** of a plant with corrosive fumes like HCl, H_2SO_4, Water impingement, Salty water, , Chloride and water mist, Cooling Tower areas, DM Plant area.

Notes:

1. Painting systems (Primers, Finish Paints etc) based upon Area classification/ Environments (Corrosive / Highly Corrosive) / Applications are tabulated in Tables 8.0 to 16.0.

2. Primers & Finish paints covered in Tables 8.0 to 16.0 are listed in Table 7.1.

3. Repair of Pre-Erection/Pre-Fabrication & Shop priming after erection/ welding shall be done as per Table 7.2.

TABLE 7.1: LIST OF PRIMERS & FINISH COATS COVERED IN TABLE NOS. 8.0 - 16.0

PRIMERS	
P-2	Chlorinated rubber zinc Phosphate Primer
P-4	Etch Primer/Wash Primer
P-6	Two component Epoxy Zinc Phosphate Primer cured with polyamine hardner
P-7	Single pack, synthetic resin based `ZINGA' zinc primer containing 96% of electrolytic zinc dust in dry film.
FINISH COATS/PAINTS	
F-2	Two component Acrylic – Polyurethane finish paint
F-3	Chlorinated Rubber finish paint
F-6A	High Build Epoxy finish coating cured with **polyamine** hardner
F-6B	High Build Epoxy finish coating cured with **polyamide** hardner
F-7	High build Coal Tar epoxy coating cured with **polyamine** hardner
F-8	Self priming surface Tolerant High Build epoxy coating. cured with **polyamine** hardner
F-9	Two component Inorganic Zinc Silicate coating
F-11	Heat resistant synthetic medium based Aluminium paint
F-12	Two component Heat resistant Silicone Aluminium paint.
F-14	Specially formulated coaltar epoxy coating. cured with **polyamine** hardner
F-15	Two component Epoxy phenolic coating cured with Polyamine adduct hardner system
F-16	Engineered Epoxy poly Siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating
F-17	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system

TABLE 7.2 REPAIR OF PRE-ERECTION/PRE-FABRICATION & SHOP PRIMING AFTER ERECTION/WELDING for all insulated and un-insulated CS, LTCS & low allow steel items in all environments. (refer clauses 5.4, 5.5 & 5.9)

Sl. No.	Design Temp. in ^{o}C	Surface Preparation	Paint System	Total DFT in Microns (min.)	Remarks
7.1	-40 to 150 for structures, hand rails and Gratings only	SSPC-SP-3	1 coat of F-9 or 2 coats of P-7 @ 40µ DFT/coat	65-75 (F-9) or 80 (P-7)	For few isolated damaged areas of more than 5x5 CM
7.2	-90 to 400	SSPC-SP-3	1 coat of F-9	65-75	-DO-
7.3	401 to 550	SSPC-SP-3	1 coat of F-12	20	-DO-

NOTES:

1 The application and repair of pre-erection/pre-fabrication & Shop Priming given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread on large areas, the Engineer-in-Charge may decide to advise re-blasting and priming again if required.

2 The pre-fabrication primer P-7, 'ZINGA' primer is recommended as alternative repair primer to F-9 for Structures, Hand Rails and Gratings only. F-9 shall be used for all other areas.

TABLE 8.0 **PAINT SYSTEM FOR CORROSIVE ENVIRONMENT-OFFSITE AREAS (excluding Cooling Tower area & DM Plant area)** for external surfaces of Un-insulated Structures, Piping, Equipments, Pumps, Vessels etc (Note-1); (For Carbon Steel, LTCS & Low Alloy Steel)

Sl. No.	Design Temperature in °C	Surface Preparation & Pre-erection/Shop Primer	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
8.1	-90 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	None	65-75	No over-coating to be done on F-9 as it will lead to mud cracking. F-3 paint shall contain pure chlorinated rubber, not modified. F-12 shall be ambient temperature curing type **Flare lines shall be painted as per Table 9.0.**
8.2	-14 to 60	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-2 @ 40µ DFT/ coat	2 coats of F-3 @ 40µ DFT/coat ; (2x40=80)	185	
8.3	61 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-6 @ 40µ DFT/ coat	1 coat of F-6B @ 100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat; (100+40=140)	245	
8.4	81 to 250	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	3 coats of F-11 @ 20µ DFT/coat; (3x20=60)	125	
8.5	251 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat (2x20=40) or 1 coat of F-16 @ 50 µ DFT/coat.	105-115 or 115-125	
8.6	401 to 550	SSPC-SP-10; 1coat of F-12 @ 20µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat (2x20=40)	60	

NOTES

1 The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2 For external surfaces of MS chimney with/without refractory lining and for internal surfaces of MS chimney without refractory lining 8.3, 8.4 & 8.5 shall be followed.

3 For external surfaces of RCC chimney: 2 coats of F-6 @ 100µ DFT/coat to obtain 2x100=200µ DFT shall be applied after making surface preparation as per guidelines in 5.1.5.

4 If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table 7.2

5 In case of Paint systems as per Sl Nos 8.5 and 8.6, the colour bands shall be applied over the Aluminum paint as per the Colour coding requirement for specific service of piping given in Clause 18.0.

TABLE 9.0 PAINT SYSTEM FOR CORROSIVE ENVIRONMENT-UNIT AREAS
for external surfaces of Un-insulated Structures, Piping, Equipments, Columns, Towers, Vessels, Pumps, Compressors, Blowers etc(Note1); (For Carbon Steel, LTCS & Low Alloy Steel)

Sl. No.	Design Temperature in °C	Surface Preparation & Pre-erection/Shop Primer	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
9.1	-90 to -15	SSPC-SP-10; 1coat of F-9 @65-75µDFT/coat	None	None	65-75	No over-coating to be done on F-9 as it will lead to mud cracking.
9.2	-14 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-6 @ 40µ DFT/ coat	1 coat of F-6A @ 100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat; (100+40=140)	245-255	
9.3	81 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat (2x20=40) or 1 coat of F-16 @50 µ DFT/coat.	105-115 or 115-125	F-12 shall be ambient temperature curing type
9.4	401 to 550	SSPC-SP-10; 1coat of F-12 @ 20µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat (2x20=40)	60	

NOTES:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table 7.2.

3. In case of paint systems as per Sl Nos 9.3 and 9.4, the colour bands shall be applied over the Aluminum paint as per the Colour coding requirement for specific service of piping given in clause 18.0.

TABLE 10.0 PAINT SYSTEM FOR HIGHLY CORROSIVE ENVIRONMENT- UNIT & OFFSITE AREAS OF THE PLANT with corrosive fumes like HCL, H2SO4, Water Impingement, Salty Water, Chloride & Water Mist, DM Plant Area, Cooling Tower Area for external surfaces of Un-insulated Structures, Piping, Equipments, Towers, Columns, Vessels, Pumps, Compressors, Blowers etc(Note-1); (For Carbon Steel, LTCS & Low Alloy Steel)

Sl. No.	Design Temperature in ^{o}C	Surface Preparation & Pre-erection/Shop Primer	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
10.1	-90 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	None	65-75	No over-coating to be done on F-9 as it will lead to mud cracking. F-12 shall be ambient temperature curing type
10.2	-14 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-6 @ 40µ DFT/ coat	2 coat of F-6A @ 100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat; (2x100+40=240)	345-355	
10.3	81 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat 2x20=40 or 1 coat of F-16 @ 50µ DFT/coat.	105-115 or 115-125	
10.4	401 to 550	SSPC-SP-10; 1coat of F-12 @ 20µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat; (2x20=40)	60	

NOTES:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table 7.2.

3. In case of paint systems as per Sl Nos 10.3 and 10.4, the colour bands shall be applied over the Aluminum paint as per the Colour coding requirement for specific service of piping given in clause 18.0.

TABLE 11.0 PAINT SYSTEM FOR CARBON STEEL AND LOW ALLOY STEEL STORAGE TANKS (EXTERNAL)
All areas (Units & Offsites)

Sl. No.	Design Temperature in °C	Surface Preparation	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
11.1	All external surfaces of shell, internal surfaces of shell above maximum liquid level exposed to atmosphere, wind girders, appurtenances, roof tops of all above ground tank including top side of floating roof of open tank as well as covered floating roof tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments for crude oil, LDO, HSD, ATF, Kerosene, Gasolene, motor spirit, DM water, firewater, raw water, potable water, acids, alkalis, solvents and chemicals etc.					
11.1.1	-14 to 80	SSPC-SP-10;	1coat of F-9 @ 65-75µ DFT/coat + 1coat of P-6 @ 40µ DFT/ coat ; (65/75+40=105/115)	2 coats of F-6A @ 100µ DFT /coat + 1 coat of F-2 @ 40µ DFT/ coat; (2x100+40=240)	345-355	F-6 should be suitable for occasional water immersion
11.1.2	81 TO 150	SSPC-SP-10;	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat ; (80+80=160)	1 coat of F-15 finish coat @80µ DFT/ coat + 1coat of F-2 @ 40µ DFT/ coat; (80+40=120)	280	
11.1.3	151TO 500	SSPC-SP-10;	1 coat of F-9 @ 65-75µ DFT/ coat	2 coats of F-12 @ 20µ DFT/coat; (2x20=40) or 1 coat of F-16 @ 50µ DFT/coat	105-115 OR 115-125	F-12 shall be ambient temperature curing type
11.2	External surfaces of bottom plate (soil side) for all storage tanks.					
11.2.1	-14 TO 80	SSPC-SP-10;	1 coat of F-9 @ 65-75µ DFT/ coat	3 coats of F-7@ 100µ DFT/coat (3x100=300)	365-375	F-7 should be suitable for immersion service of the products given
11.2.2	81 TO 150	SSPC-SP-10;	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat ; (80+80=160)	1 coat of F-15 finish coat @ 80µ DFT/ coat	240	

NOTES

1. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table 7.2

TABLE 12.0 PAINT SYSTEMS FOR CARBON STEEL AND LOW ALLOY STEEL STORAGE TANKS (INTERNAL)
All Areas (Units & Offsites)

Sl. No.	Design Temperature in °C	Surface Preparation	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
12.1	Underside of floating roof, internal surface of cone roof, bottom plate, bottom course up to 1meter height, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel, ladders, supports for storing crude oil, LDO, HSD and Gas Oil (Excluding white oil products)					
12.1.1	-14 to 80	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat + 1coat of P-6 @ 40µ DFT/ coat ; (65/75+40=105/115)	2 Coats of F-6A @ 100µ DFT/coat; (2x100=200)	305-315	Note-2
12.2	Inside of bare shell of floating roof tanks and cone roof tanks for items mentioned in 12.1					
12.2.1	-14 TO 80	SSPC-SP-10	1coat of Phosphating treatment with phosphating chemical @ 10 M²/Litre of coverage	1coat of Phosphating treatment with phosphating chemical @ 10 M²/Litre of coverage	2 coats	DFT need not be measured reconciliation of Chemical used shall be done (Note : 4)
12.3	Floating / Cone roof tanks for petroleum products such as ATF, Gasoline, Naptha, Kerosene, Motor spirit, inside of bottom plate, bottom course upto 4 meters height inside shell, underside of floating roof and shell above maximum liquid level, oil side surfaces of deck plates, oil side surfaces of pontoons, support structures and ladders etc.					
12.3.1	-14 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/coat	3 coats of F-6A @ 100µ DFT/ coat; (3x100=300)	365-375	Note-2
12.4	Inside of Bare shell of floating/cone roof tanks for products mentioned in 12.3.					
12.4.1	-14 to 80	SSPC-SP-10	1 Coat of F-9 @ 65-75µ DFT/Coat	None	65-75	
12.5	Internal protection of fixed roof type storage tanks for potable water: Inside of shell, under side of roof and roof structure inside surface, bottom plate and structural steel works, ladders, walkways, platforms etc.					
12.5.1	-14 to 80	SSPC-SP-10	2 Coats of P-6 @ 40µ DFT/coat; (2x40=80)	2 Coats of F-6B @ 100µ DFT/ Coat; (2x100=200)	280	Note-2
12.6	D.M. (De-mineralized water) and hydrochloric acid (HCL): Internal shell, bottom plate & all accessories					
12.6.1	-14 to 60	SSPC-SP-10	None	Natural Rubber lining as per SMMS specifications 6-06-204	4.5MM	For DM tanks **without** steam blanketing
12.6.2	61 to150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat; (80+80=160)	240	For DM tanks **with** steam blanketing
12.7	EG(Ethylene Glycol) tanks (internal shell, bottom plate roof and all accessories)					

12.7.1	All	SSPC-SP-10	None	3 coats of vinyl chloride co-polymer Amercoat 23 @ 75µ /Coat ; (3x75=225)	225	
12.8	Inside pontoon and inside of double deck of all floating roofs.					
12.8.1	-14 to 80	SSPC-SP-3	1 coat of F-8 @ 100µ DFT/coat	1 coat of F-8 @ 100µ DFT/coat	200	
12.9	Internal surfaces of wet slop, amine, sour water , water draw off storage tanks					
12.9.1	-14 TO 80	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat; (80+80=160)	240	
12.10	Underside of floating roof, internal surface of cone roof, bottom plate, bottom course up to 4meter height, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel, ladders, supports for storing Vacuum Residue, Fuel oil , dry slop and other high temperature hydrocarbon liquids.					
12.10.1	81 TO 150	SSPC-SP-10	1 coat of F-17 primer @ 125µ DFT/ coat	1 coat of F-17 intermediate coat @ 125µ DFT/coat + 1 coat of F-17 finish coat @125µ DFT/ coat; (125+125=250)	375	Note:3
12.11	Inside of Bare shell of floating/cone roof tanks for products mentioned in 12.10					
12.11.1	81 TO 150	SSPC-SP-10	1 coat of F-17 primer @ 125µ DFT/ coat	None	125	

NOTES

1. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table 7.2.

2. F-6A/F6B should be suitable for immersion service of the products given.

3. This system can be used where maximum operating temperature is below 150^{o}**C** and design temperature is upto 200^{o}C. Cases of operating temperature > 150^{o}**C are not covered in this spec, such cases shall be covered in the job specifications.**

4. The phosphating chemical shall be applied on blast cleaned surface inside the shell of carbon steel storage tanks at the time of erection. Incase, any corrosion is observed at the time of commissioning, 2 coats of the phosphating chemical shall be applied at the discretion of Engineer-in-charge.

TABLE 13.0 COATING SYSTEM FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND UNDERGROUND TANKS IN ALL AREAS

Sl. No.	Design Temperature in °C	Surface Preparation	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
13.1	Underground carbon steel plant piping (Yard/ Over the Ditch Corrosion protection Coating)					
13.1.1	25 to 65	SSPC-SP-10	1 coat of synthetic fast drying primer 25 @µ DFT/ coat	1 layer of coaltar tape coating @ 2mm +1 coat of synthetic fast drying primer 25 @µ DFT/ coat +1 layer of coal tar tape coating @ 2mm /layer as per EIL Standard Spec.No 6-79-0011	4 mm	
13.2	Carbon steel plant piping (underground).					
13.2.1	66 to 150	SSPC-SP-10	1 coat of F-17 primer @ 125µ DFT/ coat	1 coat of F-17 intermediate coat @ 125µ DFT/coat + 1 coat of F-17 finish coat @125µ DFT/ coat; (125+125=250)	375	
13.2.2	151 to 400	SSPC-SP-10	1 coat of F-16 primer @ 125µ DFT/ coat	1 coat of F-16 finish coat @125µ DFT/ coat	250	
13.3	External side of un-insulated underground storage tanks:					
13.3.1	-40 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	3 coats of F-7 @ 100µ DFT/coat (3x100=300)	365-375	
13.3.2	81 to 150	SSPC-SP-10	1 coat of F-17 primer @ 125µ DFT/ coat	1 coat of F-17 intermediate coat @ 125µ DFT/coat + 1 coat of F-17 finish coat @125µ DFT/ coat; (125+125=250)	375	
13.3.2	151 to 400	SSPC-SP-10	1 coat of F-16 primer @ 125µ DFT/ coat	1 coat of F-16 finish coat @125µ DFT/ coat	250	

TABLE 14.0 PAINTING UNDER INSULATION (ALL ENVIRONMENTS)

All areas (Units & Offsites) for insulated Piping, Storage Tanks, Stacks & Equipments etc (Note-1); (For Carbon Steel, LTCS, Low Alloy Steel & Stainless Steel)

Sl. No.	Design Temperature in °C	Surface Preparation & Pre-erection/Shop Primer	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
14.1	Insulated carbon steel, LTCS and low allow steel Piping, Storage Tanks, Equipment etc					
14.1.1	-45 to 125	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	2 coats of F-14 @ 125µ DFT/coat; (2x125=250) or 3 coats of F-15 @ 80µ DFT/coat ; (3x80=240)	315-325 or 305-315	No over-coating to be done on F-9 as it will lead to mud cracking.
14.1.2	126-400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	3 coats of F-12 @ 20µ DFT/coat; (3x20=60) or 1 coat F-16 @ 60 µ DFT/coat	125 – 135	F-12 shall be ambient temperature curing type
14.2	Insulated stainless steel including Alloy-20 piping (Note:2)					
14.2.1	Below 0°C to all minus temperature	Aluminium sheeting with aluminium foil and "Chloride free mineral sealant coating barium chromate" shall be applied.				If the piping & equipments are already erected than surface shall be prepared by cleaning with emery paper and wash/flush with chloride free DM water followed by wiping with organic solvent
14.2.2	0 to 125	SSPC-SP-10 (15-25µ surface profile) 1 coat of F-14 @ 125µ DFT/coat	None	1 coats of F-14 @ 125µ DFT/coat;	250	
	0 to 125 (alternate)	SSPC-SP-10 (15-25µ surface profile) 1 coat of F-15@ 80µ DFT/coat	None	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat; (80+80=160)	240	
14.2.3	121 to 400	SSPC-SP-10; 1 coat of F-16@ 125 µ DFT/coat	None	1 coat of F-16@ 125 µ DFT/coat	250	
14.2.4	401 to 600	SSPC-SP-10; 1 coat of Amercoat 738 @ 125µ DFT/coat	None	1 coat of Amercoat 738 @ 125µ DFT/coat	250	Only Amercoat 738 is suitable for the temperature of 600 deg.C and cyclic temperature.
14.2.5	Cyclic service (-)196 to 480 excepting (-)45 to 120	SSPC-SP-10 1 coat of Amercoat 738 @ 125µ DFT/coat	None	1 coat of Amercoat 738 @ 125µ DFT/coat	250	
14.3	No painting is required for insulated monel, incoloy and nickel lines.					

NOTES

1. Refer Notes 1 & 4 of Table 8.0.

2. The blast cleaning abrasives for SS and Alloy steel surfaces shall be SS grits/shots or Aluminium oxide grits/shots.
3. For SS surfaces with cyclic temperature of -45 to125 deg.C, both 14.2.1 & 14.2.2 are applicable.

TABLE 15.0 INTERNAL PROTECTION OF CARBON STEEL COOLERS / CONDENSERS

Water boxes, channels, partition plates, end covers and tube sheets etc.

Sl. No.	Design Temperature in °C	Surface Preparation & Pre-erection/Shop Primer	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
15.1	Upto 65	SSPC-SP-10; 1 coat of P-6 @ 40µ DFT/coat	None	2 coats of F-7 @ 125µ DFT/coat; (2x125=250)	290	For CS surfaces
15.2	Upto 65	SSPC-SP-3; 1 coat of P-4 @8-10µ DFT/ coat+ 1coat of P-6 @ 40µ DFT/coat.	None	2 coats of F-7 @ 125µ DFT/coat; (2x125=250)	300	(Non ferrous and brass tube sheets)

TABLE 16.0 PAINTING SYSTEM FOR GI TOWERS/NON-FERROUS TUBE SHEET

Sl. No.	Design Temperature in °C	Surface Preparation & Pre-erection/Shop Primer	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
16.1	Upto 65	SSPS-SP-3	1 coat of P-4 @8-10µ DFT/ coat + 1 coat of P-6 @ 40µ DFT/coat	2 coats of F-2 @ 40µ DFT/coat; (2x40=80)	130	Shade as per defence requirements
16.2	Upto 65	SSPS-SP-3	1 coat of P-4 @ 8µ DFT/coat.+ 1 coat of P-6 @ 40µ DFT/coat.	2 coats of F-7 @ 125µ DFT/coat; (2x125=250)	300	(Non ferrous and brass tube sheets)

17.0 STORAGE

17.1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE – NO NAKED LIGHT – HIGHLY INFLAMABLE" shall be clearly displayed outside. Manufacturer's recommendation shall be followed for storage of paint materials.

18.0 PIPING COLOUR CODE:

The following colour coding system has been made based on international standards like ASME/ ANSI, BS and Indian Standard.

18.1 IDENTIFICATION

The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated lines ground colour shall be provided as per specified length and interval to identify the basic nature of service and secondary colour bands to be painted on these specified length to identify the particular service. Above colour code is applicable for both unit and offsite pipelines.

18.1.1 The following ground colour designation for identification of basic classification of various important services shall be followed:

Post Office Red	-	Fire protection materials
Off White/Aluminium	-	Steam (all pressures)
Canary Yellow	-	Chemicals and dangerous materials
Dark Admiralty Grey	-	Crude oil, lube oil
Orange	-	Volatile petroleum products (motor spirit and lighter)
Oxide red	-	Non-volatile petroleum products (kerosene and heavier, including waxy distillates and diesel, gas oil)
Black	-	Residual oils, still bottoms, slop oils and asphalts, fuel oil
Sky blue	-	Water (all purities and temperatures)
Sea green	-	Air and its components and Freon

18.1.2 Secondary colours: The narrow bands presenting the secondary colour which identifies the specific service, may be applied by painting or preferably by use of adhesive plastic tapes of the specific colour.

18.2 COLOUR BANDS AND IDENTIFICATION LETTERING

18.2.1 The following specifications of colour bands shall be followed for identifying the piping contents, size and location of bands & letters. The bandwidth and size of letters in legends will depend to some extent upon the pipe diameter. Either white or black letters are selected to provide maximum contrast to the band colour. Bands usually are 50 mm wide and regardless of band width, are spaced 25 mm apart when two bands are employed

Table 1.0: Colour bands and size of lettering for piping:

Outside diameter of pipe or covering in mm	Width of colour bands in mm	Size of legend letters in mm
19 to 32	200	13
38 to 51	200	19
64 to 150	300	32
200 to 250	600	64
Over 250	800	89

In addition, ground colour as per specified length should be provided on insulated piping for easy identification of nature of fluid, on which the colour bands should be painted for identification of each service. The length of the ground colour should be 3 times the width of normal band or 2 meters, whichever is suitable depending on the length of the pipe.

Size of letters stenciled/ written for equipment shall be as given below:

Column and vessel : 150 mm (Height)
Pump, compressor and other machinery : 50 mm (Height)

In addition, the contents of the pipe and/or direction of flow may be further indicated by arrows and legend. If a hazard is involved it must be identified clearly by legend.

18.2.2 Colour bands: The location and size of bands, as recommended, when used, shall be applied to the pipe:

- On both sides of the valves, tees and other fittings of importance.
- Where the pipe enters and emerges from walls and where it emerges from road & walkway overpasses, unit battery limits.
- At uniform intervals along long sections of the pipe.
- Adjacent to tanks, vessels, and pumps.

18.2.3 For piping, writing of name of service and direction of flow for all the lines shall be done at following locations:

18.2.4 The letters will be in black on pipes painted with light shade colours and white on pipes painted with dark shade colours to give good contrast.

18.2.5 Only writing of service name shall be done on stainless steel lines. Precautions should be taken while painting by using low chloride content painting to avoid any damage to the stainless steel pipes. It is preferable to use adhesive plastic tapes to protect stainless steel pipes.

18.2.6 Colour band specification:

a) Unit Area: Bands at intervals of 6.0 meters.
Offsite Area: Bands at intervals of 10.0 meters.

b) Each pipe segment will have minimum one band indication, irrespective of length.

c) The bands shall also be displayed near walkways, both sides of culverts, tanks dykes, tanks, vessels, suction and discharge of pumps/ compressors, unit battery limit, near valves of line, etc.

18.3 For alloy steel/ stainless steel pipes and fittings in stores/ fabrication yard, color band (Minimum ½" wide) should be applied along the complete length of pipe, bends/ tees, side-curved surface (on thickness) of flanges as well as valves as per the metallurgy.

18.4 In case of camouflaging requirements of civil defence or any other location requirements, the same shall be followed accordingly.

18.5 The specification for application of the complete Piping identification colour code, including base and bands colours, are presented in the following table confirming to RAL colour shades of Dutch Standard:

RECOMMENDED RAL COLOUR CODE FOR PAINTING OF PIPING AND EQUIPMENT

SR. No.	SERVICE	RECOMMNDED COLOR FOR PAINT SYSTEM	RAL COLOR CODE	
			BASE COLOR	BAND COLOR
		HYDROCARBON LINES (UNINSULATED)		
1	CRUDE SOUR	Dark Admiralty grey with 1 orange band	7012	2011
2	CRUDE SWEET	Dark Admiralty grey with 1 red band	7012	3001
3	LUBE OILS	Dark Admiralty grey with 1 green band	7012	6010
4	FLARE LINES	Heat Resistant Aluminium	9006	
	LPG	Orange with 1 oxide red band	2011	3009
6	PROPYLENE	Orange with 2 blue bands	2011	5013
7	NAPTHA	Orange with 1 green band	2011	6010
8	M.S.	Orange with 1 dark admiralty grey band	2011	7012
9	AV.GASOLINE (96 RON)	Orange with 1 band each of green, white and red bands	2011 / 6010	9010 / 3001
	GASOLINE (regular, leaded)	Orange with 1 black band	2011	9005

11	GASOLINE (premium, leaded)	Orange with 1 blue band	2011	5013
12	GASOLINE (white)	Orange with 1 white band	2011	9010
13	GASOLINE (Aviation 100/130)	Orange with 1 red band	2011	3001
14	GASOLINE (Aviation 115/145)	Orange with 1 purple band	2011	4006
	N-PENTANE	Orange with 2 blue bands	2011	5013
16	DIESEL OIL (White)	Oxide red with 1 white band	3009	9010
17	DIESEL OIL (Black)	Oxide red with 1 yellow band	3009	1023
18	KEROSENE	Oxide red with 1 green band	3009	6010
19	HY.KEROSENE	Oxide red with 2 green bands	3009	6010
	DISUFIDE OIL (EX-MEROX)	Oxide red with 1 black band	3009	9005
21	M.T.O	Oxide red with 3 green bands	3009	6010
22	DHPPA	Oxide red with 2 white bands	3009	9010
23	FLUSHING OIL	Oxide red with 2 black bands	3009	9005
24	LAB FS	Oxide red with 2 dark admiralty grey bands	3009	7012
	LAB RS	Oxide red with 3 dark admiralty grey bands	3009	7012
26	LAB (Off. Spec)	Oxide red with 1 light grey band	3009	7035
27	N-PARAFFIN	Oxide red with 1-blue band	3009	5013
28	HEAVY ALKYLATE	Oxide red with red band	3009	3001

29	BLOW DOWN, VAPOR LINE	Off white / Aluminum with 1-Brown band	9006	8004
30	BLOWDOWN	Off white / Aluminum with 2 brown bands	9006	8004
31	A.T.F.	Leaf brown with 1 white band	8003	9010
32	TOULENE	Leaf brown with 1 yellow band	8003	1023
33	BENZENE	Leaf brown with 1 green band	8003	6010
34	LAB PRODUCT	Leaf brown with 1 blue band	8003	5013
35	FUEL OIL	Black with 1 yellow band	9005	1023
36	FULE OIL (Aromatic rich)	Black with 2 yellow bands	9005	1023
37	ASPHALT	Black with 1 white band	9005	9010

38	SLOP AND WASTE OILS	Black with 1 orange band	9005	2011
39	SLOP AROMATICS	Black with 2 orange bands	9005	2011
CHEMICAL LINES				
40	TRI-SODIUM PHOSPHATE	Canary yellow with 1 violet band	1012	5000
41	CAUSTIC SODA	Canary yellow with 1 black band	1012	9005
42	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010
43	AMMONIA	Canary yellow with 1 blue band	1012	5013
44	CORROSION INHIBITOR	Canary yellow with 1 Aluminum band	1012	9006

45	HEXAMETA PHOSPHATE	Canary yellow with 2 black bands	1012	9005
46	ACID LINES	Golden Yellow with 1 red band	1004	3001
47	RICH AMINE	Canary yellow with 2 blue bands	1012	5013
48	LEAN AMINE	Canary yellow with 3 blue bands	1012	5013
49	SOLVENT	Canary yellow with 1 green band	1012	6010
50	LCS	Canary yellow with 1 smoke grey	1012	7031
	WATER LINES			
51	RAW WATER	Sky blue with 1 black band	5015	9005
52	INDUSTRIAL WATER	Sky blue with 2 signal red band	5015	3001
53	TREATED WATER	Sky blue with 1 oxide red band	5015	3009
54	DRINKING WATER	Sky blue with 1 green band	5015	6010
55	COOLING WATER	Sky blue with 1 light brown band	5015	1011
56	SERVICE WATER	Sky blue with 1 signal red brown	5015	3001
57	TEMPERED WATER	Sky blue with 2 green bands	5015	6010
58	DM WATER	Sky blue with 1 aluminum band	5015	9006
59	DM WATER ABOVE 150°F	Sky blue with 2 black bands	5015	9005
60	SOUR WATER	Sky blue with 2 pearl white bands	5015	1013
61	STRIPPED WATER	Sky blue with 2 blue bands	5015	5013
62	ETP TREATED WATER	Sky blue with 2 oxide red bands	5015	3009
	FIRE PROTECTION SYSTEM (ABOVE GROUND)			
63	FIRE WATER FOAM & EXTINGUISHERS	Post office red	3002	
	AIR & OTHER GAS LINES (UNINSULATED)			
64	SERVICE AIR	Yellow green with 1 signal red band	6018	3001
65	INSTRUMENT AIR	Yellow green with 1 black band	6018	9005
66	NITROGEN	Yellow green with 1 orange band	6018	2011
67	FREON	Yellow green with 1 yellow band	6018	1023
68	CHLORINE	Canary yellow with 1 oxide band	1012	3009
69	SO_2	Canary yellow with 2 white bands	1012	9010
70	H_2S	Orange with 2 red oxide bands	2011	3009
71	GAS (Fuel)	Orange with 1 aluminum band	2011	9006
72	GAS (Sour)	Orange with 2 aluminum bands	2011	9006
73	GAS (Sweet)	Orange with 2 signal red band	2011	3001
74	HYDROGEN	Orange with 1 light green band	2011	6021

STEAM AND CONDENSATE LINES (UNINSULATED)				
75	HP STEAM	Off white / Aluminum with 1 yellow band	9006	1023
76	MP STEAM	Off white / Aluminum with 1 red band	9006	3001
77	MLP STEAM	Off white / Aluminum with 1 orange band	9006	2011
78	LP STEAM	Off white / Aluminum with 1 light green band	9006	6021
79	CONDENSATE	Sky blue with 1 white band	5015	9010
80	CONDENSATE ABOVE 150°F	Sky blue with 3 oxide red band	5015	3009
81	BFW	Sky blue with 2 red bands	5015	3001
Note: For all insulated steam lines, the colour coding shall be follow as given for un-insulated lines with the specified length of color bands.				
INSULATED HYDROCARBON PIPING				
82	IFO SUPPLY	1Black ground colour with 1 yellow band in centre	9005	1023
83	IFO RETURN	Black ground colour with 1 green band in centre	9005	6010
84	HPS	Black ground colour with 1 red band in centre	9005	3001
85	BITUMEN	Black ground colour with 2 red bands in centre	9005	3001
86	CLO	Black ground colour with 1 brown band in centre	9005	8004
87	VB TAR	Black ground colour with 2 brown bands in centre	9005	8004
88	VR AM (BITUMEN / VBU FEED)	1 Black ground colour with 1 blue band in centre	9005	5013
89	VR BH	1 Black ground colour with 2 blue bands in centre	9005	5013
90	VAC. SLOP	1 Black ground colour with 1 white band in centre	9005	9010
91	SLOP	1 Black ground colour with 1 orange band in centre	9005	2011
92	CRUDE SWEET	1 Dark admiralty grey ground colour with 1 red band in centre	7012	3001
93	CRUDE OUR	1 Dark admiralty grey ground colour with 1 orange band in centre	7012	2011
94	VGO / HCU	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
95	OHCU BOTOM / FCCU FEED	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011

UNINSULATED EQUIPMENTS, TANKS AND STRUCTURES			
96	HEATER STRUCTURE	Steel grey	7011
97	HEATER CASING	Heat resistant aluminium	9006
98	VESSELS & COLUMNS	Aluminium	9006
99	HYDROGEN BULLETS	Pink	3014
100	LPG VESSELS	Oxide red	3009
101	SO_2 VESSEL	Canary yellow	1012
102	HEAT EXCHANGER	Heat resistant aluminium	9006
103	FO TANK AND HOT TANKS	Black	9005
104	ALL OTHER TANKS	Aluminum / Off white	9006
105	CAUSTIC / AMINE / ACID TANKS	Golden yellow	1004
106	SOUR WATER	Sky Blue	5015
107	OUTER SURFACE IN BOILER HOUSE	Heat resistant aluminum	9006
108	COMPRESSORS AND BLOWERS	Dark admiralty grey	7012
109	PUMPS	Navy blue	5014
110	Electrical Equipment – Indore	Pebbel grey	7032
111	Electrical Equipment - Outdoor	Blue grey	7031
112	HAND RAILING	Fluorescent yellow	1026
113	STAIRCASE, LADDER AND WALKWAYS	Black	9005
114	LOAD LIFTING EQUIPMENT AND MONORAILS ETC	Leaf brown	8003
115	GENERAL STRUCTURE	Dark grey	7031
116	LOCAL PANEL FACE	Opaline green	6026
117	PANEL REAR SURFACE, FRAME WORK & MOUNTING PLATES	Pale cream	9001
118	MONORAIL	Signal red	3001
PIPES AND FITTINGS OF ALLOY STEEL AND SS MATERIAL IN STORE			
119	IBR	Signal red	3001
120	9Cr-1Mo	Verdigris green	6021
121	5Cr-0.5Mo	Satin blue	5012
1 22	$2_{1/4}$Cr-1 Mo	Aircraft yellow	1026
123	$1_{1/4}$Cr-½ Mo	Traffic Yellow	1023
124	SS-304	Dark blue grey	5008
125	SS-316	Dark violet	4005
126	SS-321	Navy blue	5014
SAFETY COLOUR SCHEMES			

127	DANGEROUS OBSTRUCTION	Black and alert orange band	9005	2008
128	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Alert orange	2008	

RAL COLOR CODING FOR PETROCHEMICAL COMPLEX

Sr. No.	SERVICE	RECOMMENDED COLOR FOR PAINT SYSTEM	RAL COLOR CODE	
			BASE COLOR	BAND COLOR
	REFINERY PRODUCTS			
1	NATURAL GAS	Orange with 3 Oxide red bands	2011	3009
2	PROPANE	Orange with 3 Blue band	2011	5013
3	METHANE	Orange with 1 Brown band	2011	8004
4	CYCLOHEXANE	Orange with 1 Pearl night blue band	2011	5026
5	n-HEXANE	Orange with 1 Pearl green bend	2011	6035
6	ETHANE	Orange with 4 Blue bands	2011	5013
7	BLENDED FUEL OIL	Black with 3 Yellow bands	9005	1023
8	ETHYLENE OXIDE	Orange with 3 Green bands	2011	6010
9	POLYMER PELLETS & SLURRY	Brown beige with 1 white bands	1011	9010
10	HDPE PELLETS	Brown beige with 2 white bands	1011	9010
11	WAX	Oxide Red with 1 Pastel Green Band	3009	6019
12	GLYCOL	Canary yellow with 1 Pearl gentian blue	1012	5025
13	BUTADIENE < 15%	Orange with 1 band Pastel Green band	2011	6019
14	BUTADIENE 5 -95%	Orange with 2 Pastel Green bands	2011	6019
15	BUTADIENE > 95%	Orange with 3 Pastel Green bands	2011	6019
16	ALDEHYDE SOLUTION	Sky blue with 1 orange band	5015	2011
17	OCTENE-1	Orange with 1 Blue, 1 Black and 1 Blue band	2011 5013	9005 5013
18	ETHYLENE	Orange with 2 Blue bands + 1 Black band	2011	5013 9005
19	PROPYLENE	Orange with 2 Oxford blue bands	2011	5013
20	BUTENE -1	Orange with 2 Red band	2011	3001
21	HEXANE	Orange with 2 White bands	2011	9010
22	MEG	Canary yellow with 1 Blue lilac band	1012	4005
23	DEG	Canary yellow with 2 Blue lilac band	1012	4005

24	TEG	Canary yellow with 3 Blue lilac band	1012	4005
25	POLYGLYCOL	Canary yellow with 3 Green band	1012	6010
26	GLYCOL / WATER SOLUTION	Canary yellow with 1 Sky blue band	1023	5015
27	DTA	Canary yellow with 2 Green band	1012	6010
28	OXYGEN	Yellow green with 1 Blue band	6018	5013
29	CYCLE GAS SYSTEM	Oxide red with 2 Purple band	3009	4006
	CHEMICALS			
29	ISOPRENYL ALUMINUM	Canary yellow with 1 copper brown bands	1012	8004
30	MAGNESIUM ETHYLATE	Canary yellow with 2 copper brown bands	1012	8004
31	TITANIUM TETRA CHLORIDE	Canary yellow with 1 chocolate brown band	1012	8017
32	SULPHURIC ACID	Golden Yellow with 3 red bands	1004	3001
33	CALCIUM HYDROXIDE	Canary yellow with 3 black bands	1012	9005
34	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010
35	FERRIC CHLORIDE	Canary Yellow with 3 red oxide bands	1012	3009
36	SODIUM BI SULFIDE	Canary yellow with 3 white bands	1012	9010

37	CHLORINE DIOXIDE	Canary yellow with 1 orange band	1012	2011
38	HYDRAZINE	Canary yellow with 3 blue bands	1012	5013
39	CARBON DIOXIDE	Orange with 4 Aluminum bands	2011	9006
40	CARBON MONOXIDE	Orange with 3 Aluminum bands	2011	9006
41	TEAL	Dark admiralty grey with 2 white bands	7012	9010
42	LIQUID PEROXIDE	Canary yellow with 1 red and 1 blue band	1023 3001	5013
43	CATALYST LINE	Canary yellow with 2 Red band	1023	3001
44	CO-CATALYST LINE	Canary yellow with 3 Red band	1023	3001
45	EO / WATER SOLUTION	Sky blue with 3 Green bands	5015	6010

46	BCWS / BCSWR	Sky blue with 1 Brown Biege band	5015	1011
	WATER			
47	CYCLE WATER- LEAN	Sky blue with 2 blue lilac bands	5015	4005
48	CYCLE WATER- RICH	Sky blue with 3 blue lilac bands	5015	4005
49	JACKET WATER	Sky blue with 3 black bands	5015	9005
50	JACKET WATER-BIOCIDE	Sky blue with 2 aluminum bands	5015	9006
51	JACKET WATER-CORROSION INHIBITOR	Sky blue with 3 aluminum bands	5015	9006
52	CHLORINATED WATER	Sky blue with 1 green band	5015	6010

53	BACK FLUSH WATER	Sky blue with 3 signal red bands	5015	3001
54	CUTTING WATER	Sky blue with 1 orange band	5015	2011
55	REFRIGERATED WATER	Sky blue with 2 violet blue bands	5015	5000
56	WASTE WATER	Sky blue with 2 Signal red bands	5015	3001
	INTERMEDIATES			
57	MOTHER LIQUOR SOLUTION	Orange with 3 pebble grey bands	2011	7032
58	ADDITIVES SOLUTION	Pearl green with 2 white band	6035	9010
59	DEACTIVATORS	Pearl green with 2 orange band	6035	2011
60	OFF GAS	Pearl green with 2 yellow band	6035	1023
61	OFF GAS PLUS POLYMER	Pearl green with 2 Aluminum bands	6035	9006
62	RA SOLUTION	Pearl green with 2 oxide red bands	6035	3009
63	DONOR	Pearl green with 2 black bands	6035	9005
	STEAM			
64	VHP	Offwhite / Aluminium with 2 yellow band	9006	1023
65	MHP STEAM (20 KG / CM_2 G)	Off white / Aluminium with 3 yellow bands	9006	1023
66	OTHER PROCESS LINES e.g. PROCESS STEAM, PROCESS CONDENSATE, PROCESS VENTS.	Light grey with 1Trafffic yellow band	7035	1023
67	DECOKING AIR	Yellow Green with 1 Terrabrown band	6018	8028
68	RPG	Orange with 1 Yellow Green band	2011	6018
69	C6-C8 CUT	Orange with 1 terrabrown band	2011	8028
70	C4 MIX	Orange with 1 peral black berry band	2011	4012
71	C9+ CUT / FLUX OIL	Orange with 2 grey Beige band	2011	1019
72	C4 PURGE / C4 MIX	Orange with 2 peral black berry	2011	4012
73	C9 CUT	Orange with 1 grey beige	2011	1019
74	C7-C8 CUT	Orange with 2 terra Brown band	2011	8028
75	C3	Orange with 1 Sky blue band	2011	5015
76	PP RECYCLE	Orange with 1 water blue	2011	5021
77	PLANT AIR	Yellow green with 1 peral light grey	6018	9022
78	AROMATIC	Black with 1 water blue	9005	5021
79	LIGHT DISTILLATION	Orange with 1 Solman pink band	2011	3022
80	C9+	Orange with 3 grey beige	2011	1019
81	OWS-OIL WATER SEWER	Sky blue with 1 band of salmon orange	5015	2012
82	CRWS-CONTAMINATED RAIN WATER SEWER	Sky blue with 2 bands of salmon orange	5015	2012
83	CRYOGENIC TANK	Orange	2011	

	(RCC)		

19.0 IDENTIFICATION OF VESSELS, PIPING ETC.

19.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stencilled on all the pipe lines of more than one location as directed by Engineer-In-Charge, Size of letter printed shall be as below :

Column & Vessels	-	150mm (high)
Pump, compressor & other machinery	-	50mm (high)
Piping	-	40-150 mm

19.2 **Identification of storage tanks:**

The storage tanks shall be marked as detailed in the drawing.

20.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS

20.1 Following items shall be painted for camouflaging if required by the client.

a. All Columns
b. All tanks in Offsites
c. Large Vessels
d. Spheres

20.2 Two coats of selected finishing paint as per defence requirement shall be applied in a particular pattern as per 20.3 and as per the instructions of Engineer-In-Charge.

20.3 **Method of Camouflaging**

20.3.1 Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matt finish).

Dark Green	Light Green	Dark Medium Brown
5:	3:	2

20.3.2 The patches should be asymmetrical and irregular.

20.3.3 The patches should be inclined at 30º to 60º to the horizontal.

20.3.3 The patches should be continuous where two surfaces meet at an angle.

20.3.4 The patches should not coincide with corners.

20.3.5 Slits and holes shall be painted in dark shades.

20.3.6 Width of patches should be 1 to 2 meters.

21.0 INSPECTION AND TESTING

21.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable.

21.2 Engineer-In-Charge at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch-wise test of wet paints for physical & chemical analysis as per clause 24.4 of relevant ASTM test method. All costs there shall be borne by the contractor.

The contractor shall produce test reports from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right to test wet samples of paint at random for quality of same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

21.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

(a) Surface preparation
(b) Primer application
(c) Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e.g. Red oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (D F T)) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra coat should have prior approval of Engineer-in-charge.

21.4 **Primer Application**

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge.

21.5 The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-In-Charge before application of successive coats.

21.6 The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting. Holiday detectors and pinhole detector and protector whenever required for checking in case of immersion conditions.

21.7 Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on M.S.test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elkometer'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

21.8 At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations. The contractor is responsible to arrange the same.

21.9 Final inspection shall include measurement of paint dry film thickness, Adhesion, Holiday detection check of finish and workmanship. The thickness should be measured at as many points/ locations as decided by Engineer-In-Charge and shall be within + 10% of the dry film thickness, specified in the specifications.

21.10 The contractor shall arrange for spot checking of paint materials for Sp.gr., glow time (ford cup) and spreading rate.

22.0 GUARANTEE

22.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

23.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR/SUB-CONTRACTOR

Painting contractor who is awarded any job for EIL, Projects under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor mush have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The contractor supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

24.0 PROCEDURE FOR APPROVAL OF NEW COATING MATERIALS AND MANUFACTURERS

Following procedure is recommended to be followed for approval of new manufacturers.

24.1 The manufacturer should arrange testing of the coating materials as per the list of tests given in para 24.4 below from one of the reputed Government laboratories.

24.2 Samples of coating materials should be submitted to the Govt. laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory. The sampling shall be certified and sealed by a certifying agency.

24.3 All test panels should be prepared by Govt. testing agency coloured photographs of test panels should be taken before and after the test and should be enclosed alongwith test report.

Sample batch no. and manufacturer's test certificate should be enclosed alongwith the report. Test report must contain details of observation and rusting if any, as per the testing code. Suggested Government laboratories are:

IICT, Hyderabad
HBTI, Kanpur
DMSRDE, Kanpur
IIT, Mumbai
BIS Laboratories
UICT, Matunga, Mumbai
RITES, Kolkata
PDIL, Sindri
NTH, Kolkata

24.4 Manufacturers should intimate the company, details of sample submitted for testing, name of Govt. testing agency, date, contact personnel of the govt. testing agency. At the end of the test the manufacturer should submit the test reports to the company for approval. The manufacturer(s) shall be qualified based on the results of these tests and other assessment and the company's decision in this regard shall be final and binding on the manufacturer.

Test required for evaluation of acceptance of coating materials for onshore application.

Test	ASTM Test Method
Density	D 1475
Dipping properties	D 823
Film characteristics	
Drying time	D 1640
Flexibility	D 1737/D 522
Hardness	D 3363
Adhesion	D 2197
Abrasion resistance	D 968/ D 1044
DFT/coat	AS PER SSPC GUIDELINES
Storage Stability	D 1849
Resistance to	
Humidity for 2000 hrs.	D 2247
Salt spray 2000 hrs	B 117
Accelerated Weathering	D 822
% Zn in Dry film for Inorganic Zinc Silicate primer	G 53

24.5 Coating systems for panel test shall be decided after discussion with EIL.

24.6 Clause No. 24.0 is for approval prior to award of the contract. In case any agency proposes for any fresh approval after award of work, the same shall have no time implications upon the contract.

ANNEXURE-I

LIST OF RECOMMENDED MANUFACTURERS

Indian Vendors

1. Asian Paints (I) Ltd., Mumbai
2. Berger paints Ltd., Kolkata
3. Kansai Nerolac Paints Ltd., Mumbai (including Ameron, USA Products).
4. Chugoku Marine Paints Pvt. Ltd., Mumbai
5. Shalimar Paints Ltd., Kolkata
6. Sigma Kalon Marine and Protective Coatings(India) Pvt Ltd, Mumbai.
7. CDC Carboline Ltd., Chennai
8. Premier products Ltd., Mumbai
9. Coromandel Paints & Chemicals Ltd., Visakhapatnam
10. Anupam Enterprises, Kolkata
11. Grand Polycoats, Vadodata
12. Bombay Paints Ltd., Mumbai
13. Akzo Nobel Coatings and Sealants Pvt. Ltd., Bangalore
14. Cipy Polyurethanes Pvt. Ltd., Pune
15. Gunjan Paints Ltd., Ahmedabad
16. Advance Paints Ltd., Mumbai
17. VCM Polyurethane Paints (for polyurethane paints only)
18. Jotun Paints India Pvt Ltd, Chennai(Singapore)
19. Paladin Paints and Chemicals , Mumbai
20. Chembond Chemicals Pvt Ltd , Navi Mumbai
21. Aashish Coating Technologies Pvt. Ltd, Vadodara/Mumbai

Foreign Vendors

1. Sigma Kalon Protective Coatings, Singapore
2. Ameron, USA
3. Kansai Paints, Japan
4. Hempel Paints, USA
5. Valspar Corporation, USA
6. Akzo Nobel/International Coatings, UK
7. Jotun Paints, Singapore

The following are approved for specific materials only.

1.0 Mark-chem Incorporated, Mumbai (for phosphating chemicals only).

2.0 ChemTreat India Ltd.(for Phosphating Chemical and glass flake filled coatings of M/s Atlas Chemicals Corporation, USA).

3.0 Carolina equipment and supply Co., USA.

4.0 Zinga Metall(Rozenstraat 4-Industrial Zone)-9810 EKE-Belgium, Indian Agent-Newkem, Mumbai-14 (for cold spray zinc coating)

ANNEXURE-II
LIST OF RECOMMENDED MANUFACTURERS' PRODUCTS

Sl. No	Manufacturers Name	P2 Chlorinated Rubber Zinc Ph Primer	P4 Etch Primer/ Wash Primer	P6 Epoxy Zinc Ph. Primer	F9 Inorganic Zinc Silicate Primer/ Coating
1	ASIAN PAINTS (I) LTD.	ASIOCHLOR HB.ZN.PH.PRIMER RO PC 168	APCONYL WP636 (PC335)	APCODUR HB.ZP. PC433	APCOSIL 605
2	BERGER PAINTS LTD.	LINOSOL HIGH BUILD ZP PRIMER	BISON WASH PRIMER	EPILUX 610 HB PRIMER	ZINC ANODE 304 MZS
3	AMERON PRODUCTS	-	AMERCOAT 178	AMERCOAT 71/ 385P	DIMETCOTE-9FT
4	CHEMBOND CHEMICALS	KEMCHLOR 201	KEMGALVA GRIP A1	KEMOXY 301	KEMGUARD 501
5	SHALIMAR PAINTS LTD	CHLOROKOTE ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ETCH PRIMER	EPIGUARD ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ZILIKATE
6	SIGMA KALON INDIA PVT LTD,	SIGMA NUCOL UNICOAT 7321	SIGMA ETCH PRIMER (7185)	SIGMA COVER 256 (7412)	SIGMAZINC- 158
7	CDC CARBOLINE LTD.	-	-	CARBOLINE 893	CARBOZINC 11
8	PREMIER PRODUCTS LTD.	-	-	P-15/3A U-16/92	U17/92 ETHYL SILICATE INORGANIC ZINC
9	CORAMANDEL PAINTS & CHEMICALS LTD.	COROCLORE CR HB.ZN.PH PRIMER	CPC WASH PRIMER	COROPEX EPOXY ZN.PH. HIGH BILD PRIMER	CPC INORGANIC ZINC SILICATE PRIMER
10	ANUPAM ENTERPRISES	ANUCHLOR ZP PRIMER	ANUPRIME-291	ANUPAM ANLICOR A-EZP-500	ANUZINC 2001 TP
11	GRAND POLYCOATS	GP CHLOROPRIME 601	GP PRIME 401	-	GP PRIME 402
12	BOMBAY PAINTS LTD.	PENTA CHLOR HB PRIMER 8632	PENTOLITE WASH PRIMER 8520	PENTADUR PRIMER 8530	ZINC-O-SIL 75
13	HEMPEL MARINE PAINTS	HEMPA TEX HIGHBUILD 4633	-	HEMPEL'S SHOP PRIMER E1530	GALVASOL 1570
14	AASHISH COATING TECH-NOLOGIES				
15	AKZO NOBEL PAINTS	-	-	INTERGARD 251	INTERZINC 12/22
16	PALADIN PAINTS	VEGCHLOR HB PRIMER 1143	VEGWASH PRIMER 1181	VEGPOX 1241ZP	THERMOSIL1362 ZINC
17	VCM POLYURETHANE PAINTS				
18	JOTUN PAINTS		JOTA ETCH TWO PACK WASH PRIMER	EPOXY CQ SPECIAL ZINC PHOSPHATE PRIMER	RESIST-86
19	KCC PRODUCTS (KOREA)				EZ 180(N)
20.	CHUGOKU MARINE	-	-	CAMIDECK	GALBONS HB

	PAINTS PVT. LTD.			PRIMER	
21.	KANSAI NEROLAC PAINTS LTD.	NEROLAC HB CR ZINC PHOSPHATE PRIMER	NEROLAC ETCH PRIMER	NEROLAC EPOXY ZINC PHOSPHATE PRIMER	NEROSIL 118

LIST OF RECOMMENDED MANUFACTURERS PRODUCTS (Cont. …)

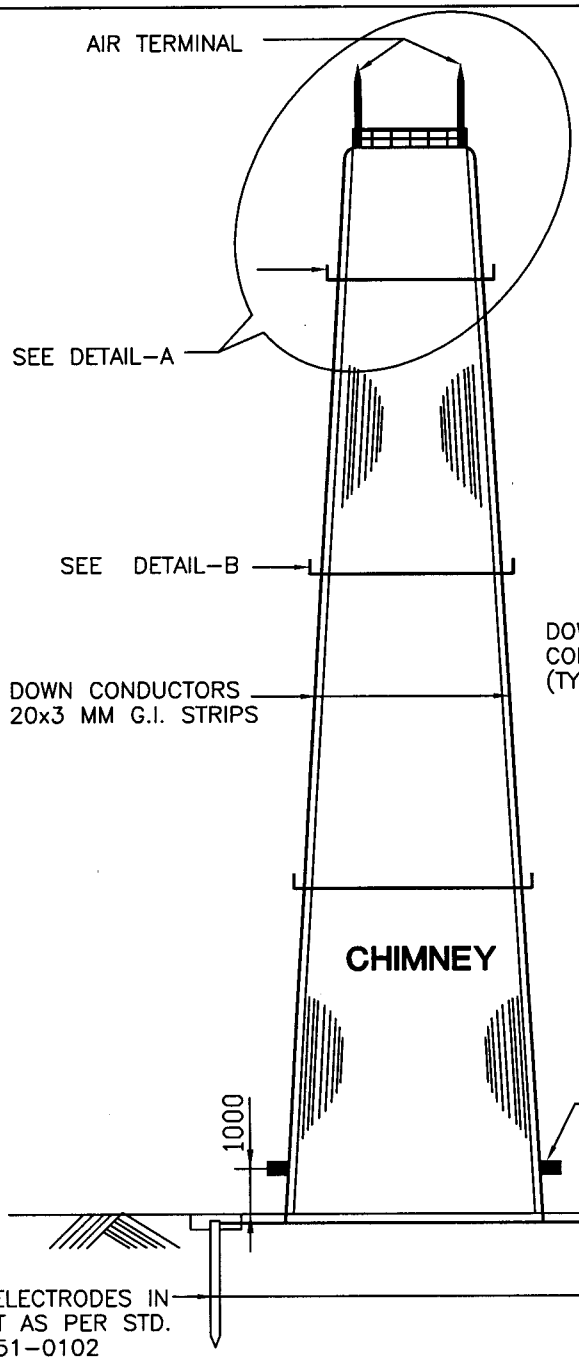
Sl. No	Manufacturers Name	F2 Acrylic-Polyurethane Finish Paint	F3 Chlorinated Rubber Finish Paint	F6A/B High Build Epoxy Finish Paint	F7 High Build Coal Tar Epoxy Coating
1	ASIAN PAINTS (I) LTD.	APCOTHANE CF676 (PC 1109)	ASIOCHLOR CF 621 (PC 319)	APCODUR HB COATING PC 1262	APCODUR CF 651/655(PC 131/471)
2	BERGER PAINTS LTD.	BERGER ACRYLIC PU FINISH	LINOSOL CHLORINATED RUBBER HB COATING	EPLIUX 04 AND 78 HB EPOXY COATING	EPILUX 555
3	AMERON	AMERCOAT 450GL	AMERCOAT 515	AMERCOAT 383 HS	AMERCOAT 78HB
4	CHEMBOND CHEMCIALS	KEMTHANE 411	KEMCHLOR 211	KEMOXY 324	KEMOXY 314
5	SHALIMAR PAINTS LTD	SHALITHANE FINISH	CHLORKOTE HB FINISH	EPIGARD TL FINISH POLYAMINE/ POLYAMIDE	BIPIGARD CTE ZL BLACK HB COAL TAR EPOXY COATING
6	SIGMA COATINGS.	SIGMADUR GLOSS (7528)	SIGMA NUCOL FINISH 7308	SIGMA GUARD 720	SIGMACOVER 300 (7472)
7	CDC CARBOLINE LTD.	CARBOLINE 132	-	CARBOLINE 191	CARBO-MASTIC-14
8	PREMIER PRODUCTS LTD.	U3/92 POLYURETHANE	CR-71, CR FINISH PAINT	42B/4A HIGH BUILD EPOXY	350/3A, COAL TAR EPOXY COATING
9	CORAMANDEL PAINTS & CHEMICALS LTD.	COROTHANE SUPER PU FINISH	COROCLORE CR FINISHING	COROPEX EPOXY HB COATING	COROPEX EPOXY COAL TAR COATING
10	ANUPAM ENTERPRISES	ANUTHANE ENAMEL	ANUCHLOR HB ENAMEL	DURACOAT-6000	COROGUARD
11	GRAND POLYCOATS	GP BOND 141	GP CHLOROGAURD 631	GP GUARD HP234	POLYGUARD CE
12	BOMBAY PAINTS LTD.	PENTATHANE FP 4510	PENTACHLOR FB 4635	PENTADUR HB 5540/5520	PENTADUR COALTAR EPOXY 8518/6518
13.	HEMPEL MARINE PAINTS	-	HEMPATEX HIBUILD 4633	HEMPADUR HIGH BUILD 5520	HEMPADUR 1510
14.	AASHISH COATING TECH	GA 1110 PU-UB		GA701 HB	
15	AKZO NOBEL COAITNGS	INTERTHANE 990	-	INTERGARD 966 / 410	INTERTUF 262 (TAR FREE TYPE)
16	PALADIN PAINTS	VEGTHANE (ALIPHATIC)	VEGCHLOR FP3140	VEGEPOX 3245/3562	VEGEPOX 4265
17	VCM POLYURETHANE PAINTS	PIPCOTHANE ALIPHATIC POLYURETHANE FINISH PAINT			
18	JOTUN PAINTS	HARDTOP XP		PENGUARD HB	JOTAGUARD 85
19	KCC PRODUCTS (KOREA)			KOEPOX TOPCOAT HB ET 5740	EH 173
20.	CHUKOGU MARINE PAINTS PVT LTD.	UNY MARINE	-	EPICON MARINE FINISH HB	BISCON HB 2001/ACHB
21.	KANSAI NEROLAC PAINTS	NEROTHANE ENAMEL	NEROLAC HB CHLORINATED RUBBER ENAMEL	NEROPOXY HB 262/6061	NEROLAC EPOXY COAL TAR POLYAMINE/POLY AMIDE CURED.

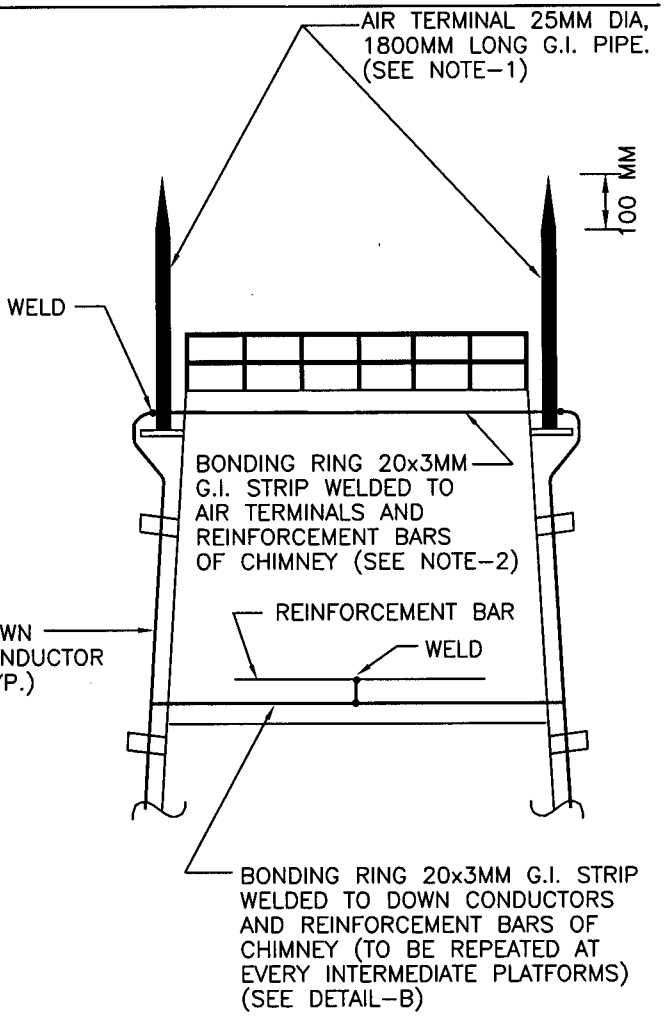
LIST OF RECOMMENDED MANUFACTURERS PRODUCTS (cont. …)

Sl. No.	Manufacturers Name	F8 Epoxy Mastic Coating Surface Tolerant	F-11 Heat Resistant Synthetic Medium Aluminium Paint	F-12 Heat Resistant Silicone Aluminium Paint	F-15 Two Pack Ambient Temperature Curing Epoxy Phenolic Coating
1	ASIAN PAINTS (I) LTD.	APCODOR CF 640	ASIAN HR ALUMINIUM PAINT (PC 300)	HR SILICONE ALUMINIUM PAINT (PC 189)	
2	BERGER PAINTS LTD.	PROTECTO MASTIC	FERROTOL HR ALUMINIUM PAINT	LUMEROS HR SILICONE AL. PAINT(HR/143)	BERGER EPOXY PHENOLIC COATING
3	AMERON	AMERLOCK 400		AMERCOAT 878	
4	CHEMBOND CHEMICALS	KEMGUARD 555	KEMGUARD 250HR	-	-
5	SHALIMAR PAINTS LTD	EPIPLUS 556	HEAT RESISTING LUSTROL ALUMINIUM	LUSTOTHERM HS SILICONE ALUMINIUM	EPIGARD TL 543 HS FINISH
6	SIGMA COATINGS.	SIGMA COVER 630 (7428)	HIGH TEMPERATURE RESISTANT EPOXY SYSTEM UPTO 200^{O}C	SIGMATHERM 540/SUPER THERMOVIT 600	SIGMA PHENGUARD 930 SYSTEM
7	CDC CARBOLINE LTD.	CARBO MASTIC-15	CARBOLINE 1248	CARBOLINE 4674	
8	PREMIER PRODUCTS LTD.	BH EPOXY MASTIC 150B/150A			
9	CORAMANDEL PAINTS & CHEMICALS LTD.	-	SILVOTOL HR ALUMINIUM PAINT	CPC SILICONE HR ALUMINIUM PAINT	
10	ANUPAM ENTERPRISES	ANU-MASTIC-102	-	ANUPAM HEAT GUARD.	
11	GRAND POLYCOATS	GP PRIME GUARD 235	-	-	
12	BOMBAY PAINTS LTD.	PENTADUR MASTIC 5515	KANGAROO HHR ALUMINIUM 4950	PENTHOLITE HRR ALUMINIUM 4951	
13.	HEMPEL MARINE PAINTS	HEMPDUR 1708			
14	AASHISH COATING TECH	GA700SPE	-	-	-
15	AKZO NOBEL COATINGS	INTERSEAL 670HS	INTERTHERM 891	INTERTHERM 50	INTERTHERM 228
16	PALADIN PAINTS	VEGEPOX MASTIC 2285	VEG HR AL PAINT	VEG HHR AL PAINT 600 DEG C	
17	VCM POLYURETHANE PAINTS	-	-	-	-
18	JOTUN PAINTS	PRIMASTIC UNIVERSAL	JOTUN AL PAINT HR 250 DEG.C	SOLVELITT AL SILICONE PAINT	TANKGUARD STORAGE
19	KCC PRODUCTS (KOREA)	EH 4158H		QT 606	
20.	CHUKOGU J&N LTD.	UMEGUARD MT/SX			
21.	KANSAI NEROLAC	NEROMASTIC 400	NEROTHERM 250	NEROTHERM 538	

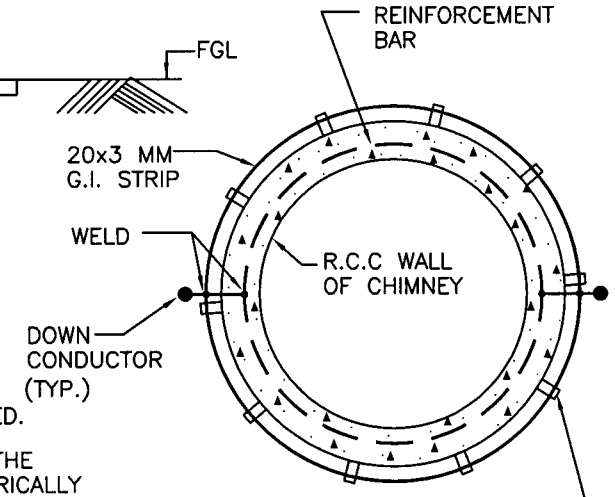
	PAINTS LTD.				

Note : This list is subject to revision based on fresh approval/ re-approval/ deletion.





DETAIL–A



DETAIL–B

NOTES:–

1. FOR CHIMNEYS UP TO 1.5 MTR. DIA AT TOP 1 NO. AIR TERMINAL AND 1 NO. DOWN CONDUCTOR SHALL BE PROVIDED. FOR CHIMNEYS MORE THAN 1.5 MTR. DIA AT TOP 2 NOS. AIR TERMINALS AND 2 NOS. DOWN CONDUCTORS SHALL BE PROVIDED.
2. THE DOWN CONDUCTORS SHALL BE CONNECTED TO THE RE–BARS OF CHIMNEY BY WELDING AT TWO DIAMETERICALLY OPPOSITE POINTS. REFER DETAIL–B
3. UNLESS SPECIFIED OTHERWISE ON PLAN DRAWINGS THE EARTH ELECTRODES SHALL BE KEPT SEPARATE FROM SYSTEM EARTHING ELECTRODES.
4. EARTH ELECTRODE SHALL BE LOCATED MINIMUM 1000MM AWAY FROM FOUNDATION.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	13.02.09	REAFFIRRMED AND ISSUED AS STANDARD	BP	RKS/NS	JMS	VC
2	31.03.04	REAFFIRRMED AND ISSUED AS STANDARD	RKS	UAP	VPS	SKG

EARTHWORK IN EXCAVATION AND BACKFILLING

REV. NO.	PRAPARED	APPROVED	DATE
00	MARINA	PMISHRA	00

1.0.0 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc relevant to structures and locations covered under the scope of this contact.

2.00.0 **GENERAL**

2.1.0 **WORK TO PROVIDED FOR BY THE CONTRACTOR**

The work to provided for by the contractor, unless specified otherwise. Shall include but not be the following.

a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, equipment, tools and plants, transportation, etc, required by the Engineer
b) Prepare and submit working drawing showing the approaches, slope, beam, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoil, disposal area, fencing, etc and all other details as may be required by the Engineer.
c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests if required by the Engineer to assess the degree of compaction.
d) Construction, maintenance and removal after completion of Magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out scope of this tender.

2.2.0 **WORK TO PROVIDED FOR BY OTHERS.**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract

2.3.0 **CODES AND STANARDS**.

All works under this specification, unless specified otherwise shall conform to the Latest revision and /or replacement of the following or any other Indian Standard Specifications and codes of practice. In case any particular aspect of work is no Covered specially by Indian Standard Specification any other standard practice as May be specified by the Engineer shall be followed: -

IS: 3664: Indian Standard for Safety Code for Excavation work.

IS: 1200: Indian standard Method of Measurement of Building and Civil Engineering Work, (Part-I): Earthwork.
IS: 4701: Indian standard Code of Practice for Earthwork on Canals

2.4.0 **CONFORMITY WITH DESIGNS.**

The Contractor is to carry out the work as per the drawings issued to him and/ or Contractor's drawings which are approved by the Engineer and/or Engineer's instructions.

2.5.0 MATERIALS TO BE USED

2.5.1 GENERAL

All material required for the work shall be of best commercial variety and approved By the Engineer.

2.5.2 BORROW METERIAL.

Borrow material required for back-filling shall be excavated from approved locations and levels and shall consist of material, approved by the Engineer, free roots, Vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and codes. If specified, clean graded sand free from harmful and deleterious Material from approved quarries, shall be as fill material.

2.6.0 QUALITY CONTROL

The contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall Include but not be limited to the following items of work: -

a) Lines, Levels and Grades: I) periodic surveys
II) Establishment of markers, boards etc.

b) Back- filling: I) Checking the quality of fill material
II) Checking moisture content of the backfill
III) Checking the degree of compaction

3.3.0 EXECUTION

3.1.0 SETTING OUT

Within 15 days of award of Contract, the contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by The Showing the diminutions as per drawings and specification adding his proposals of Slopes, shoring, approaches, dewatering sumps, beams, etc. On Receiving, approval From the engineer with modifications and corrections, if necessary, the Contractor Will set out the work from the control points furnished by the Engineering and fix Permanent point s furnished by the Engineer and fix permanent point and markers for case of future checking. These permanent points and markers for case of furnished by the engineer and fix permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. It should be noted that this checking by the Engineer prior to start of the carrying work will in no way

absolve the Contractor of responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections. If necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.

3.2.0 INITIAL LEVELS

Initial level of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original Ground prior to starting actual excavation work and after setting out. These initial Level will be used for preparing cross-sections for volume measurement or for Crosschecking the depths obtained from tape measurement.

All records of levels, measurements etc. and also any drawing, cross section etc. Made there from, shall be jointly signed by the authorised representative of the Contractor and the engineer before the commencement of and they shall from the Basis of all payments in future.

3.3.0 CLEARING AND GRUBBING, ETC.

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bush, Vegetation, rubbish, slush, etc. and levelled up. Trees unto 300mm girth shall be Uprooted. Trees above 300mm girth to be cut, shall be approved by the engineer And then Marked. Felling of trees shall include taking out roots up to 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out the pot–holes formed shall be filled with good earth in 250mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoil and unserviceable materials and rubbish Shall be burned or removed from the site to approved disposal areas as may be Specified. Ash shall be spread or removed. Useful materials, saleable timber, Firewood, etc, shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.4.0 CLASSIFICATION

All earthworks shall be classified under the following categories:

a) ORDINARY SOIL

This shall comprise vegetable or organic soil, turf, sand, loam, clay, mud, peat, black Cotton soil, soft shale or loose moorum, a mixture of these and similar material which Yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal or any other modular material having diameter in any one direction not exceeding 75mm occurring in such strata shall be covered under this category.

b) HARD SOIL.

This shall include

i) Stiff heavy clay, hard shale, or compact mooruum, requiring grafting tool or pick or both and chovel, closely applied,
ii) Gravel and cobble stone having maximum diameter in any one direction between 75 and 300mm,
iii) Soiling of roads, paths, etc, and hard core,
iv) Macadam surface such as water bound, and bitumen/ tar bound,
v) Lime concrete, stone masonry in lime mortar and brick work in lime/cement Mortar, below ground level,
vi) Soft conglomerate, where the stones may be detached from the matrix with Picks, and

vii) Generally any material, which requires close application of picks, or scarifies to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) And (vi) above.

c) SOFT AND DECOMPOSED ROCK

This shall include:

i) Limestone, sandstone, late rite, hard conglometerate or other soft or Disintegrated rock which may be quarried or spilt with crowbar,

ii) Unreinforced cement concrete, which may be broken up with crowbars or picks And stone masonry in cement mortar belowground level.

iii) Boulders, which do not require blasting having maximum diameter in any Direction of more than 300mm, found laying loose on the surface or embedded In river bed, soil, talus, slope wash and terrace material of dissimilar origin, and

iv) Any rock which in dry state may be hard, requiring blasting, but which when Wet becomes soft and manageable by means other than blasting.

d) HARD ROCK (requiring blasting)

This shall include:

i) Any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is requiring.
ii) Reinforced cement concrete (reinforcement cut trough but separated from the concrete) below ground level, and

iii) Boulders requiring blasting.

c) HARD ROCK (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is Prohibited for any reason and excavation has to be carried out by chiselling, Wedging or other agreed method.

In case any dispute regarding classification, the decision of the Engineer shall be final.

3.4.0 **EXACAVATION FOR FOUNDATIONS AND TRENCHES**

3.5.1 **GENERAL**

All excavations shall be done to the minimum dimensions as required for safety and Working facility. Prior approval of the Engineer shall be obtained by the Contractor, In each individual case, for the method he proposes to adopt for the Excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make Engineer responsible for any Consequent loss Damage. The excavation must be carried out in the most Expeditious and efficient Manner.

All excavation in open cuts shall made true to line, slopes and grades shown on the Drawing or directed by the Engineer. No material shall project within the dimension Of minimum excavation lines marked. Boulders projecting out of the excavated Surfaces shall be removed, if in the opinion of the Engineer they are likely to be a Hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer And the Contractor shall ensure that stability and safety of the excavation, adjacent Structures, to be works.

The Contractor shall be in every case subject to the approval of the excavation and Safety of the workmen. If any slip occurs, the Contractor shall remove all slipped Material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to The Area to be excavated as to be liable, in the opinion of the Engineer, to fall or Otherwise endanger the workmen, equipment of the work, etc, shall be stripped Off Removed away from the areas of excavation. The method used shall be such as Not to Shatter or render unstable or unsafe the portion which was originally sound And safe any materials not requiring removal as contemplated in the work, but Which In the Option of the Engineer, is later to become loose or unstable shall Also be Promptly and satisfactory directed by the Engineer.

Prior starting the excavation, the ground level at the location shall be checked Jointly With the Engineer.

The rough excavation may be carried unto a maximum depth of 150mm above the

Final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling appropriate item Rates.

If the excavation is done to a depth greater than shown on the drawing, or directed By The Engineer, due to the Contractor's fault, the excess shall be filled unto the Required level at the latter's cost (with cement concrete not leaner than 1:4:8 Ordinary Concrete or richer) as directed by the engineer in each individual case.

Information of rock requiring blasting, those over cuts which are unavoidable will be Made unto ordinary cement concrete 1:2:4 which will be paid for under appropriate rate, provided this over cut is not due to negligence of the contractor. The decision of the Engineer as to the admissibility of such over cut for payment will be final. All excavated materials such hard rock, boulders, bricks, dismantled concrete blocks, etc. Shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.5.2 EXACAVATION IN ORDINARY SOIL, HARD SOIL AND SOFT AND DECOMPOSED ROCK

The excavation in ordinary soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workman like manner without endangering the safety of nearby structure/ services or works wnd without causing hindrance to other activates in the area. As the excavation reaches the required dimensions, lines, levels and the grades, the work will be carried out carefully to avoid any over- excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips etc. are expected the engineering may order to suspend the at any stage and instruct the Contractor to carryout the balance work just before the foundation work of the structure can be started. No extra will be paid to the Contractor for such unviable temporary suspension of work.

3.5.3 EXCAVATION IN HARD ROCK

In case where excavation, both in ordinary soil and hard rock, are involved, the Ordinary soil comprising of soft, hard and dense soil (including literate formation) And rock including weathered rocks, lateritic rocks, etc. Which can be excavated Without blasting, shall be completely stripped off and the levels of the hard rock Wall be taken to be enable measurements. Further work in hard shall be resumed Clearance from the Engineer. Personal deployed for track excavation shall be Protected from all hazards such as loose rock/boulder rolling down and from general Slips of excavated surfaces. Where the excavated surface is such that it is not stable Against sliding, necessary from the excavated surfaces is such that it is not stable Against sliding, necessary supports, props, bracing or bulkheads shall be provide and Maintained .

In case where blasting, though otherwise required, is prohibited for any reasons, the

Excavation shall be carried out by chiselling, wedging or any other approved Method and payment appropriate to blasting shall be made, unless otherwise Mentioned in the Schedule.

3.5.4 **BLASTING**

3.5.4.1 **GENERAL**

Storage, handling and use of explosives shall be governed by the current explosive Rules laid down by the state Governments. The Contractor shall ensure that these Rules are strictly adhered to. The following instruction, wherever found in variance With the variance with the above rules, shall be considered as superseded by the Above rules.

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored not they Be allowed to handle the explosives.

3.5.4.2. **STORAGE OF EXPLOSIVE**:

Storage of explosive shall be governed by the current explosive rules. Explosive shall be stored in aclean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400mm of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. the ground inside the fence shall be kept class and free from tress, bushes etc. the admission ti this fence without permission of the officer-in-charge. The clear space between the fence and the magazine shall. shall not be less than 90m. The magazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The Lightning conductors shall be once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazines. However, provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60cm masonry and 100cm of air space shall intervene between any detonators in such annexe and not to be opened in a magazine. Cases containing explosives are not to be opened in a magazine. Explosives in open cases are not to be received into a magazine. Explosives which appear to be in damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is to be allowed in any magazine. No smoking shall be allowed within 100m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedges etc, for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives, which have been issued and returned to the magazine
are to be issued first, otherwise those which have been longest of cases in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to kept the floor free from grains of powder of portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dustsorm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.5.4.3. **Carriage of Explosive**

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No persons expect the driver shall be allowed to travel on a vehicle conveying Explosives. No carriage or vessel shall be used for transporting explosives unless all all iron or steel therein with which a package containing any explosive is likely to Come or other suitable material. No lights shall be carried on the vehicle carrying Explosives.

No operation contracted with the leading, unloading and handling of explosives Shall be conducted after sunset.

3.5.4.4 **USE OF EXPLOSIVES**

The contractor shall appoint an agent who shall personally superintend the firing And All operations connected therewith. The contractor
Shall Satisfy himself that the person so appointed is fully acquainted with the Responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling Pattern being so planned that the rock pieces after blasting will be suitable for Handling.

The hole diameter shall be of such a size that cartridges can easily pass down them And undue force is not required during charging. Charging operations shall be Carried out by or under the personal supervision of the shot firer. Wrappings shall neve be removed from explosive cartridges. Only wooden rods shall be used for

Loading and steaming shot holes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work To be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing able in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground., bare wires, rails pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by electric detonator attached to its side with adhesive tape, connecting wire or string.

All connection shall be made by authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting be fore it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number or shots fired at a time shall not exceed the permissible limits.

Blasting shall is carried out at certain specified times to be agreed jointly by the Contractor and the Engineer.

Before any blasting is carried out. It shall be censured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 meters radius from the firing point, or as required by statutory regulation, at least ten minutes before the time or firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be employed by drilling a
Parallel fresh holes hot less than 600mm from the misfired hole and by exploding new charges. The authorised shot fire shall be present during removal of the debris liable to contain unexploded explosive near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

When blasting is conducted in the neighbourhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shot holes and filling the same with light charge of explosives.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.5.5 **DISPOSAL**

The excavated spoil will be disposed of in any or all the following manners.

a) By using it for backfilling straightway.
b) By stacking it temporarily for use in back filling at a later date during execution of the Contract.
c) I) By either spreading, or
ii)Spreading and compacting at designated disposal areas.
d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

3.5.6 **DISPOSAL OF SURPLUS**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the owner and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a mutually Agreed rate for the same.

All sound rock and other assorted materials like excavated bricks, etc shall be stacked separately and shall be measured in stacks deducting 50% volumetric
Measure for voids.

3.5.7 **PROTECTION**

The Engineer shall be notified by the contractor as soon as the excavation is Expected to the completed within a day so that it may be inspected by him at the Earliest. Immediately after approval of the engineer, the excavation must be Covered up in the shortest possible time. But, in no case the excavation shall be Covered up or worked On before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or Trench or half the depth of the pit or trench whichever is more or further away if Directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under- ground services exposed by excavation. The

Contractor shall also divert all surface drains, etc. affected by the excavation to Maintain the working area neat and clean.

3.5.8 **DEWATERING**

All excavations shall be kept free of water and slush. Grading in the vicinity of Excavations shall be controlled to prevent surface water running into excavated Areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rainwater and subsoil water accumulated in Excavation and keep the trench dewatered until the construction of foundation Structure and backfilling are complete in all respects. (Expect where such separate Payment will be made.) Sumps made for dewatering must be kept clear of the Foundations. Method of pumping shall be approved by the Engineer but in any Case, the pumping arrangement shall be no movement of subsoil or blowing in due To Differential head of water during pumping.

If necessary, the Engineer may the contractor to Contractor to continue dewatering Beyond his original or extended contract period in which case will be paid Separately for dewatering as terms mentioned elsewhere under payment and Measurement, provided the contractor has completed all the work satisfactorily

3.5.9.**TIMBER SHORING**

Timber shoring made out of approved quality of timber shall be 'close' or 'open' Type, depending on the nature of soil and the depth of pit or trench and the type of The contractor to take all necessary steps to prevent the sides of Trenches and pits from collapsing.

3.5.9.1 **CLOSE TIMBERING**

Close timbering shall be done by completely covering the sides of the trenches and Pits generally with short, upright members called 'polling board'. These shall be of Minimum 250x40 mm sections as directed by the Engineer. The boards shall generally be placed in pairs, one board on each side of cutting ,and shall be apart by Horizontal walers of strong wood at maximum 1.2 metres spacing, cross struts shall depend of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber piece on the opposite face of the ground. No portion of the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not libel to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of

the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.9.2 **OPEN TIMBERING.**

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250mm width and minimum 40mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

3.10.0 **TREATMENT OF SLIPS**

The Contractor will take all precautions to avoid high surcharges and provide proper surface drainage drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shorting and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him at his own expenses.

3.7.0 **BACK FILLING**

3.7.1 **GENERAL**

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearly areas where excavation work by the same agency is in Progress, from temporary stacks of excavated spions or from borrow pits from Lumps and clods, roots and vegetations, harmful salts and chemicals, organic Materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be Cleaned, well graded and be of quality normally acceptable for use in concrete.

3.7.2 **FILLING AND COMPACTION IN PITS AND TRENCHES AROUND STRUCTURES**

As soon as the work in foundations has been accepted and measured, the spaces Around The foundations structures in pits and trenches shall be cleared of all debris, brick bats,Mortar droppings etc, and filled with earth in layers not exceeding 250mm in loose Thickness each layer being watered, rammed and properly compacted to the Satisfaction of the Engineer. Earth shall be rammed with approved mechanised. Usually, no manual compaction shall be allowed unless specifically permitted by

the Engineer. The final surface shall be trimmed and levelled to proper profile as Desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections to optimise the moisture content.

3.7.3 **PLINTH FILLING**

The plinth shall be filled with earth in layers not exceeding 250mm in loose Thickness, watered and compaction machine or manually, if specifically permitted By the Engineer. When the filling reaches the finished level, the surface shall be Flooded with water for at least 24 hours, allowed to dry and the rammed and Compacted, in order to avoid any settlement at a later stage. The finished level of The following shall be trimmed to the slope intended to be given to the floor.

3.7.4 **FILLING IN TRENCHES FOR WATER PIPES AND DRAIIN**

Earth used for filling shall be free from salts, organic or other foreign matter. All Clods of earth shall be broken or removed. Where excavated material is mostly Rock, the boulders shall be broke into pieces not bigger than 150mm size in any Direction, mixed with fine material consisting of disintegrated rock, moorum or Earth as available, so as to fill up the voids as far as possible and then the mixture Used for filling.

Filling in trenches for pipes and drains be commenced as soon as the joints of pipes And drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the Sides and top of pipes in layers not exceeding 150mm, watered, rammed and Compacted taking care that no damage is caused to the pipe below.

In case of excavation of trenches in rock, the filling unto a depth of 300mm or the Diameter of the pipe whichever is more, above the crown of pipe or barrel shall be Done with fine material such as earth, moorum, disintegrated rock or ash according To the availability at site. The remaining filling shall be done with rock filling of Boulders of size not exceeding 150mm mixed with fine material as available to fill Up the voids, watered, rammed and compacted.

3.7.5 **FILLING IN DISPOSAL AREA**

Surplus material from excavation which is not required for backfilling will be Disposed of in disposal areas. The spoil shall not be dumped haphazardly but Should be spread in layers approximately 250mm thick when loose and compacted With the help of compacting equipment. In wide areas rollers will be employed and Compaction done to the satisfaction of the Engineer as the optimum moisture Content, which shall be checked and controlled by the Contractor.

In certain cases the Engineer may direct disposal without compaction which can be Done by typing the spoils from a high bench neatly maintaining always a proper Level and grade of the bench.

3.8.0 **APPROCHES AND FENCING**

The Contractor should provide and maintain approaches for workmen and for Inspection, the roads and approaches around the excavation pits should be kept Clear at all times so that there is no hindrance to the movement of men, material And equipment of various agencies connected with the project. Sturdy and elegant Fencing is to be provided around the top edge of excavation as well as the bottom Of the filling at the surplus disposal area where dumping from a high bench is in Progress.

3.9.0 **LIGHTING**

Full-scale area lighting is to be provided if night work is permitted or directed by The Engineer. If no night work is in progress, red warning lights should be provided At the corners of the excavated pit and the edges of the fill.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 **EXCAVATION**

On completion of the excavation, the dimensions of the pits will be checked as per The drawings after the pits are completely dewatered the work will be accepted After all undercuts have been set right and all over excavations filled back to Required lines, levels and grades by compacted earth, as directed by the Engineer At the Contractor's cost. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of sides will be made good free of cost by the contractor while carrying out the back filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary Approaches encroaching inside the required dimension of the excavation have been Removed.

4.2.0 **BACK FILLING**

The degree of compaction required will be as the per the stipulation laid down in IS: 4701, if not otherwise mentioned in the Schedule and the actual method of Measuring the compaction achieved will be as decided by the Engineer. Is Satisfied With the degree of compaction achieved.

5.0.0 **INFORMATION TO BE SUBMITTED**

5.1.0 **WITH TENDER**

Detail of equipment proposed to be used for excavation, back filling and Compactions have to be submitted along with the tender.

5.2.0 **AFTER AWARD**

After award of the Contractor the successful tender shall submit the following for Approved and adoption

a) Within 30days of award of the Contractor, the Contractor shall submit a detailed Programme of the work as proposed to be executed giving completion dates of Excavation of the various foundations and the time required for back-filling and Compaction after completing the foundation for structure. In case the earthwork Contractor is also the agency for the foundation work, the Earthwork programme is To be contracted with the foundation programme. The programme should also show How the excavation and back-filling quantities will be balanced, minimising Temporary stacking of spoils. It is to be noted that Engineer even after initial Approval of the programme, may instruct to enhance or retard the progress of Foundations without attracting any claims from the Contractor. The initial Programme being submitted by the Contractor should have sufficient flexibility to Take care of such reasonable variations.

b) Within 15days of award, the Contractor shall submit showing details of slopes, Shorings, approaches, sump pits, dewatering lines, fencing etc, for approval of the Engineer for adoptions.

6.00 **RATES**

The rates for the items shall include cost of all materials consumed in the works, Hire Charges of materials, tools and plant, cost of labour, insurance, all transport, Taxes, Royalties, security and safety arrangements, supervision, profit etc. The rates of Excavation shall be also include the cost of dewatering and stacking the Excavated Spoils properly within a lead of 30 m unless otherwise mentioned in the Schedule of items.

The Contractor will have to give a rebate if the excavated earth is directly used for Back-filling.

Where back- filling is to be done with sand, it shall be of good quality from quarries Approved by the Engineer. The rate shall include all operations including the cost Of sand.

In cases the Contractor is required to continue dewatering of the excavated pits Beyond of the contract, original or extended, he will be paid separately for it as the Schedule of items only for the period beyond the final terminal date of the contact. The rate will be complete in all respects including the cost all respect including the cost of consumables, if any.

7.0.0 **MEASUREMENTS**

7.1.0 **CLEARING AND GRUBBING**

No separate measurement shall be done for this item for the purpose of payment in General except for cutting of trees having girth more than 30cms and works Connected to this.

7.2.0 **EXCAVATION**

Actual quantity of excavation required and approved by the Engineer shall be Measured in Cu.M.No extra shall be paid for keeping the excavations dewatered as Required for completion of the structure to come in. Necessary disposal of the spoil As described in the schedule of items shall be included in the quoted rate.

7.3.0 **SHORING**

The actual efficient area of shoring as approved by the Engineer, shall be measured In Sq.m.All planks, walling, verticals, struts, props and all other materials as Required for the shoring and subsequent safe dismantling and removal shall be Included in the rates quoted.

7.4.0 **BACK-FILLING**

7.4.1 **WITH ASSORTED EARTH FROM EXCAVATIONS, TRENCHES ETC**

Actual quantity of consolidated backfill shall be measured in Cu.M. The cost of Lead, Lift, etc. shall be as per schedule of items and included in the rate quoted.

7.4.2 **WITH EARTH FROM BORROW PITS AND STACKS**

Actual quantity of consolidated back-filling or actual quantity of excavation in the Borrow pits, or the excavated volume of the stack with a deduction of 30% for Voids, in case filling is done by earth from stack, whichever is less, shall be paid in Cu. M. The lead, lift, etc. as mentioned in the Schedule of item shall be included in The rates Quoted.

7.4.3 SAND FILLING

Actual quantity of consolidated sand filling shall be measured in Cu. M. The rate shall include cost of sand and all necessary works for execution of the item.

7.5.0 **LEADS AND LIFTS**

The leads for excavation and/or back filling will be measured between the centroid of the actual disposal area and that of the plan of pit. The distance between these Two points will two points will be measured along the shortest practicable haulage

Path as decided by the Engineer.

Lift will be measured vertically between the average ground level from where the Pit Excavation was started and the bottom level of the excavated pit. Level lines Corresponding to the stages where lifts become payable will be drawn on the cross Section of the pit and the volumes of excavation contained between these horizontal Planes will be computed and paid according to the corresponding rates.

7.6.0 **DEWATERING**

Dewatering for work beyond the contract period original or excavated will be Measured on the basis of horse power –hour which will be obtained by multiplying The estimated requirement of horse power required to run the pumps or actually Employed, whichever is less, by the actual hours run, approximated to the nearest Half hour.

7.7.0 **TRANSPORTATION OF SURPLUS EARTH**

7.7.1 Payment shall be made only for the lead beyond initial 100M from construction Area. Rate shall include reexcavation, loading, transportation, dumping, stacking or Spreading (as per directions of the engineer-in-charge) the surplus earth and the soil In the area demarcated by the Engineer-in – charge. Payment shall be made on Cubic Meter (M^3) basis on the difference of measurements of the volumes of the Excavated Pits and the measurement of the back filling. Quantity generated due to Voids in back Filled volume of earth, shall also be removed by the Contractor at no Extra cost and This disposal of earth shall not measured and paid under any item.

7.7.2 In exceptional circumstances the Engineer- in-charge may direct the Contractor to Remove surplus earth, concrete of debris or any other material from site to the area Of disposal on the basis of truck measurement. In such cases volume of material Shall be calculated on the basis of truck volume reduce by 30% for voids in case of Soft/hard soil sand 50% for soft/hard rock. All other provisions of disposal such as Spreading, levelling, grading shall apply in this case also.

ANNEXXURE F3.1- VERY BROAD SPECIFICATIONS FOR SOIL TO BE CONSIDERED AS CNS MATERIAL

SL.NO.	PROPERTY	VERY BROAD SPECIFICATION RANGE
1.	Grain size analysis	
	(i) Clay	15-25%
	(ii) Silt	35%-50%

	(iii) Sand	30-40%
	(iv) Gravel	< 10%
2.	Consistency limits	
	(i) Liquid limits	30-50%
	(ii) Plastic limit	20-25%
	(iii) Plasticity index	10-25%
	(iv) Shrinkage limit	15% and above
3. (a)	Swelling pressure when compacted to Maximum dry density corresponding to Standard proctor compaction with zero Initial compaction moisture constant, for No volume charge condition.	Less than 0.1kg/cm^2 10kN/m^2
(b)	Swelling pressure when compacted to Maximum corresponding to standard Proctor compaction and initial compaction Moisture corresponding to optimum moisture Content for no volume change condition	less than 0.05kg/cm^2
4.	Clay minerals	Preferable kaolinite Illite
5.	Shear strength of/ compacted to maximum dry Density correspond to standard proctor compaction And initial moisture content corresponding to Optimum moisture content, but sample test on Saturation.	
	(a) From unconfined compression	Cu0.15- 0.35 Kg/cmsq.
	(b) From consolidated undrained direct Shear test	Cu0.0.1-0.3 kg/cmsq. (10-30 kN/m sq)

ADDENDUM TO SPECIFICATION NO. PEDC/STD.SPEC/032 REV 00 FOR EARTHWORK

Add under clause 3.70 back filling.

If it is required to use clayey soil exhibiting swelling properties for filling Around foundations and under pavement and floor slabs due to non Availability of suitable filling material nearby, then the back filled clayed Swelling soil should be well compacted and a layer of not less than 250m Thick cohesive non-swelling (CNS) soil shall be placed on top of the clayey soil and well compacted. Very broad specifications for soil to be Considered as CNS material is given in Annexure F3:1 enclosed at the end of the section.

ERECTION OF STRUCTURAL STEEL WORK

REV. NO.	PRAPARED	APPROVED	DATE
00	marina	P Mishra	

1.0.0 **SCOPE**

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at Site, and/or from Owner's Site stores and store Yard. Installing the same in position, painting and grouting the stanchion bases all-complete as per drawings, this Specification and provision of the Contract.

2.0.0 **GENERAL**

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified in the Contact, shall include but not be limited to the following:-

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at site including prompt attendance to all insurance matter as necessary, for all fabricated steel materials arriving at site. The Contractor shall pay all demurrage and/ at Wharf age charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads transportation of fabricated steel structures.

d) Checking centre lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, levelling, riveting, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.

f) Painting of erected steel structures if required by the Contract.

g) All minor modifications of the fabrications of the fabricated steel structures as directed by the Engineer including but not limited to the following:-

1) Removal of bends, kinks, twists etc. for parts damaged during transport and Handling.

2) Cutting, chipping, filling, grinding etc. if required for preparation and Finishing of site connections.

3) Reaming of holes for use of higher size rivet or built if required.

4) Welding of connections in place of riveting or bolting for which holes are

Either not drilled at all or wrongly drilled during fabrication. Welding in place of riveting or bolting will be permitted only the discretion of the Engineer.

5) Refabrication of parts damaged beyond repair during transport and Handling of Refabrication of parts, which are incorrectly fabricated.

6) Fabrication of parts omitted during fabrication by error, or subsequently Found necessary.

7) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

8) Carry out tests in accordance with this Specification if directed.

2.2.0 **WORK BY OTHERS**

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract

2.3.0. CODES **AND STANDARDS**:

All work this specification unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of practice of equivalent:-

IS – 800: Code of practice for use of structural steel in general building construction.

IS - 456: Code of practice for plain or reinforced concrete.

2.4.0 **CONFORMITY WITH DESIGNS**

The Contractor will erect the entire fabricated steel fabricated steel structure, align the all members, complete all field connections and group the foundations all as per the provisions of this specification and sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of the relevant Indian Standard Specifications and/ or the instructions the engineer. The testing and acceptance of the erected structures shall be in accordance. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and / or the Instruction of the Engineer.

2.5.0 **MATERIAL**

2.5.1 **GENERAL**

All fabricated steel structures and connection materials shall be supplied by the Contractor for fabrication work through the Owner. The Contractor for erection work will take delivery of all the materials from the Owner’s Stores or storage yard at sire. The Contractor may also have to take delivery directly from railway wagons or trucks at Site, in which case he shall

have to unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.1.0 and as specified hereinbefore.

While taking delivery, the Contractor will check the quantity, quality and the sizes of the materials and verify the adequacy of the same in accordance with the Drawings and Specifications. In case the Contractor finds any materials inadequate, he shall inform the Engineer immediately prior to taking delivery of the same. No claim whatsoever, in respect of bad quality, shortage or difference in size will be entertained once the delivery is taken and the Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as be directed, by the Engineer at the Contractor's Own cost.

Excepting all field connection materials like rivets, bolts, nuts, washers and electrodes, which will be supplied by the fabrication Contractor to the extent of 10% in excess of the estimated requirements as per Drawings, all other consumables like Oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other materials that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been including in this rates.

2.5.2 **MATERIALS TO CONFORM TO INDIAN STANDARDS**

All materials required to the supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

2.6.0 **STORAGE OF MATERIALS**

2.6.1 **GENERAL**

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.6.2 **YARD**

The Contractor will have to be establishing a suitable yard in the approved location at site for storing the fabricated steel structures and other materials will be delivered to him by the Owner recording to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipment and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

The Tender should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.6.3 **COVERED STORE**

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in the ground in a property covered store building to be built at the cost of the Contractor.

2.2.0 QUALITY CONTROL

The Contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the record of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work:-

1) Erection: Lines, levels, grades, plumbs, joint characteristics including Tightness of bolts.
2) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, administers, consistency and strength of grout.
3) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.2.0 **TAKING DELIVERY**

The erection Contractor shall take delivery of fabricated structural steel and necessary connection materials supplied by the Fabrication Contractor from railhead, trucks and/or the Owner's stores at site as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The erection Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damaged during transit and handling and all loss there of shall be borne by him.

The erection contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect and deliver all the packing materials to the Owner free of charge.

3.0.0 **WORKMANSHIP**

3.1.0 **ERECTION**

3.1.1 **PLANT AND EQUIPMENT**

The suitability and adequacy of all erection tool s and equipment proposed to used shall be efficient, dependable, in good working condition and shall have the approval of Engineer.

3.1.2 **METHOD AND SEQUENCE OF ERECTION**

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the contract.

3.1.3 **TEMPORARY BRACING**

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the owner, temporary guys and bracings
Where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well loads due to erection equipment and erection operations.

If additional temporary guys are required to resist or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erecter shall be made free of cost to the owner.

The responsibility of the contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work and cribbing shall not be the property of the Owner and they maybe removed immediately upon completion of the steel erection unless other agreed arrangements are made. The Owner shall remove and return the same in good condition to the Contractor without any charge if they have been left in place under such other agreed arrangements.

3.1.4 **TEMPORARY FLOORS FOR BUILDINGS**

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of parliament and/or by laws of state, Municipal or other local authorities.

3.1.5 **SETTING OUT**

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level. No extra payment shall be made for this. Each tire of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by riveting bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.1.6 Filed riveting

All riveting shall be heated and driven with pneumatic tools. Hand passing or ‘throwing’ of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving

point must be approved by the engineer. No cold rivets shall be driven. All other requirements of reverting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steel work of the project.

3.1.7 Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of structural Steelwork applicable the Project shall also be applicable for filed bolting in addition to the following: -

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scale except tight mill scale. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut-method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a 'snug tight' condition to ensure that the parts of the joint are brought into good contract with each other. 'Snug tight' is defined as the tightness attained by a few impacts of an impact wrench or the full effort of man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the applicable amount of nut rotation specified in table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of part not turned by the wrench.

TABLE-1

Bolts length not	Bolts length	Remarks
Exceeding 8 dia. Or 200mm	Exceeding 8 dia. or 200mm	
½ turn	2/3 turn	Nut rotation is relative To bolt regardless of The Element (nut or bolt) being turned. Tolerance on rotation - 30^0 over or under.

Bolts may be installed without hardened washers when tightening is done by the Turn- of – nut method. How ere, normal washers shall be used.

Bolts tightened by the turn- of – nut method may have the outer face of the nut Match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual not rotation such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque wrench tightening

When torque wrenches are used to produce the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II. Nuts shall be in tightening motion when torque wrenches to install several bolts in a single joints, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm)	Torque to be applied (keg's) for bolts Class 8.8 of IS: 1367
20	59.94
22	81. 63
24	103. 73

In either of the above two methods, if required, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this clause.

3.1.8 **FIELD WELDING**

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions herein which manifestly apply to shop conditions only. Where the fabrication structural steel members have been delivered paints, the paint shall be removed before field welding for a distance of at least 50 mm on either side of joints.

3.1.9 **HOLES, CUTTING AND FITTING**

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and/or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contractor or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.2.0 **DRIFTING**

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connection. Reaming, that weakens the member or makes it impossible to fill the holes property or to adjust accurately after reaming, shall not be allowed

Any error in shop which prevents the prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.2.0 **GROUTING OF STANCHION BASES AND BEARINGS OF BEAMS AND GRIDERS ON STONE, BRICKS OR CONCRETE (PLAIN OR REINFORCE)**

Grouting shall be carried out with Ordinary Cement grout as described bellow:-
The mix shall be one (1) part cement and one (1) part sand just enough water to Make it workable. The positions to be grouted shall be cleaned thoroughly with Compressed air jet and placed under expect supervision, taking care to avoid air-Looks. Edges shall be finished properly. If the thickness of grout is 25 mm or More, two (2) parts of 6 mm down graded stone chips may be added to the above Noted cement-sand grout mix, if required, by the Engineer or shown on the Drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of Stanchions have been properly lined, levelled and plumbed and sufficient floor Beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, “ironies” or equipment, may be required to the grout. The Contractor will, when so directed by the Engineer, take delivery of the material from the Owner’s site stores and use it in the grout in proportions to be decided by the Engineer and carry out the allowance of 5% (five percent) for wastage shall be allowed over the above theoretical requirement of the admixtures. Cost of any wastage beyond the above limits shall be paid for by the Contractor or will be realised from his dues at the rates prescribed by the owner.

3.3.0 **PAINTING AFTER ERECTION**

Field painting, if required to be done by the Contract, shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural Steel work applicable for the project.

Painting shall not be done in frosty or foggy, weather or humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabrication steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication for fabrication of structural of structural steelwork applicable to the project. The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.4.0 **FINAL CLEANING UP**

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove free of cost all false work. Rubbish and all Temporary works resulting in connection with the performance of his work.

4.0.0 **TESTING AND ACCEPTANCE CRITERIA**

4.1.0 **GENERAL**

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure on a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract of either fabrication or erection of steelwork whoever is responsible for it and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor, unless it is proved that the deficiency is due to reasons beyond the Contractor’s scope. On the basis of the tests, the Engineer will decide

whether the fabricator or the erector is responsible for the unacceptable member or structure and his decision will be final. In case it is established that the unacceptability of the member or structure is due to design deficiency, the cost of replacement and/or modifications will borne by the Owner. In course of dismantling, if any damage is done to any other parts of the Contractor responsible, to the satisfaction of the Engineer, The cost of the tests specified hereinafter shall be borne by the Owner. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead as long a time as possible before testing and the tests shall be conducted as indicated in the following. Sub-clauses 4.1.1,4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.1.1 STIFFNESS TEST

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limits. If after removal of the tests load, the member or structure dose not show are recovery of at least 80 % of the maximum strain or deflection shown during 24 hours under to have load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery, after this second test not less than 90% of the maximum increase in stain or deflection recorded during the second test.

4.1.2 STRENGTH TEST

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified Superimposed load, and shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load Shall be applied and maintained for 24 hours, either with or without the vertical Test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part falls and if on removal of the test load, the structure shows a recovery of at least 20% of the maximum deflection or strain recorded during the 24 hours under load.

4.1.3 STRUCTURE OF SAME DESIGN

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1,5 times the specified superimposed load has been maintained for 24 hours. This information is required as basis of comparison in any check test carried out on sample of structure.

When a structure of the same type is selected type is selected for a check test, it Shall be subjected, in addition to its actual dead load, to a superimposed test load, Equal to 1.5 time the specified live load, to a superimposed test load, equal to 1.5 Time the specified live load. In a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the Maximum deflection shall be recorded. The check test shall be considered Satisfactory, provided that the maximum strain or deflection should be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded at similar load in test on the prototype.

4.1.4 **REPAIR FOR SUBSEQUENT TEST AND USE AFTER STRENGTH TESTS**

An actual structure, which has passed the "Strength Test" as specified in Sub-Clause 4.1.2 herein before and is subsequently to be erected for use, shall be Considered satisfactory for use after it has been strengthened by replacing any Distorted members and has subsequently satisfied the 'Stiffness Test' as specified In Sub-clause 4.1.1 hereinbefore.

4.2.0 TOLERANCES

Some variation is to be expected in the finished dimensions of structural steel Frames. Unless otherwise specified, such variations are deemed to be within the Limits of good practice when they are not in excess of the cumulative effect of Detailed erection clearances, fabricating tolerances for the finished parts and the Rolling tolerance for the profile dimensions permitted under the Specifications for fabrications of structural steel work applicable to this project and as specified Below:

1 For Building Containing Cranes

Component	**Description**	**Variation Allowed**
1.	**2.**	**3.**
Main column	a) Shifting of column axis at foundation Level with respect to building line	
	i) In longitudinal direction	i) $\pm$ 3.0 mm
	ii) In lateral direction	ii) $\pm$ 3.0 mm
	b) Deviation of both major or column axis From vertical between foundation and Other member connection levels:	
	i) For a column up to and including IOM height true vertical	i) $\pm$ 3.5 mm from
	ii) For a column greater than IOM but less	ii) $\pm$ 3.5 mm from vertical

	than 40M height	for any 10M length measured between connection levels, but not more than ± 7.0 mm per 3.0mm length
	c) For adjacent pairs of columns across the width of the building prior to placing shown on drawings	± 9.0 mm on true span
	d) For any individual column deviation of Any bearing from levels shown on drawings	± 3.0 mm
	e) For adjacent pairs of column either across The width of building or longitudinally level difference allowed between bearing or seating Level supposed to be at the same level	3 mm.
Trusses	a) Deviation at centre of span of upper chord Member from vertical plane running through Canter of bottom chord.	1/1500 of the span or not greater than 10mm Whichever is the least.
Trusses	b) Lateral displacement of top chord At centre of span from vertical plane running through centre of support.	1/250 of depth of truss or 20mm which Ever is the least
Crane Girders& Tracks	a) Difference in levels of crane rail measured between adjacent columns	2.0 mm
	b) Deviation to crane rail gauge	± 3.0 mm
	c)Relative shifting of ends of adjacent Crane rail in plan and elevation after thermit welding	1.0mm
	d) Deviation to crane rail axis from centre line of web	± 3.5 mm
Setting of Expansion Gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or Below 30^0 C. The coefficient of expansion or contraction shall be taken as 0.000012 per^0 C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel works shall be ± 3.0mm on Any part of the structure. The structure shall not be out plumb more than 3.5mm On each 10M section of height and not more than 7.0 mm 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.3.0 ACCEPTANCE

Structures and members which have passed the tests and conform to all requirements specified in the foregoing sub-clause 4.1, 4.1.1, 4.1.2, 4.3.1 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and / or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfilment of the provisions of this Contract.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 Before t ender

Along with the tenders the Tenderers will be required to submit the following Information:

5.1.1 TENTATIVE PROGRAMME

The Tender shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure wise erection schedule proposed to be maintained by the Contractor to complete the job in time accordance with the Contract.

5.1.2 CONSTRUCTIONAL PLANT AND EQUIPMENT, TOOLS, TEMPORARY WORKS & MANPOWER.

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tender which he will be able to employ on the job to maintain the progress of work in accordance with the contract hall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.1.3 ERRECTION YARD

A site showing the layout and location of the erection yard proposed to be established by the Tender shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.2 AFTER AWARD OF THE CONTRACT

After award of the contract, the Contractor shall submit the following:-

5.2.1 DETAILED PROGRAMME

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in a accordance with in

Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a perform a approved by the Engineer.

5.2.2 **FORTNIGHTLY PROGRESS REPORT**

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and
All details of actual achievements against the target programme specified in Sub-clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall
Also furnished details of fabricated materials in hand at site and the strength of his workers.