1.0 SCOPE

1.1 This specification covers the general requirements for supply, fabrication, preparation of and delivery at site of structural and miscellaneous steel.

1.2 This specification also covers design of all connections and substituted members, preperation of all shop fabrication drawings and inspection of structures.

2.0 APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes are made a part of this specification. All standards, specifications, codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and those referred to herein, this specification shall govern.

(a) MATERIALS

1. IS : 808 - Dimensions for Hot Rolled Steel Sections.
2. IS : 814 - Covered Electrodes for Metal Arc welding of Structural Steels.
3. IS : 1363 - Black Hexagonal Bolts, Nuts and Lock Nuts (diameter 6 to 39 mm) and Black Hexagonal Screws (diameter 6 to 24 mm).
4. IS : 1367 - Technical Supply Conditions for Threaded Fasteners.
5. IS : 1852 - Rolling and cutting tolerance for Hot Rolled Steel products.
6. IS : 1977 - Structural Steel (Ordinary Quality)
7. IS : 2016 - Plain Washers.
8. IS : 2062 - Weldable Structural Steel.
9. IS : 2074 - Ready mixed paint, Air drying, Red Oxide Zinc Chrome and Priming.

10. IS : 3757 - High strength friction grip bolts.

11. IS : 5372 - Taper washers for channels.

12. IS : 5374 - Taper washer for I beams.

13. IS : 6610 - Heavy washers for steel structures.

14. IS : 6639 - Hexagon bolts for steel structures.

(b) CODES OF PRACTICE

1. IS : 800 - Code of practice for general construction in steel.

2. IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel.

3. IS : 817 - Code of practice for training and testing of metal arc welders.

4. IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations.

5. IS : 822 - Code of procedure for inspection of welds.

6. IS : 1182 - Recommended practice for radiographic examination of fusion-welded butt joints in steel plates.

7. IS : 1200 - Method of measurement in building and civil works.

8. IS : 1204 - Code of practice for use of welding in bridges and structures subject to dynamic loading.

9. IS : 1477 - Code of practice for painting of ferrous metals in building.

10. IS : 2595 - Code of practice for radiographic testing.

11. IS : 2598 - Safety code for industrial radiographic practice.

12.	IS	: 3016	-	Code of practices for fire protection in welding and cutting operations.
13.	IS	: 3600	-	Code of practice for testing fusion welded joints and weld metal in steel.
14.	IS	: 3657	-	Radiographic image quality indicators.
15.	IS	: 3658	-	Code of practice for liquid penetrant flaw detection.
16.	IS	: 3664	-	Code of practice for ultrasonic testing by pulse echo method.
17.	IS	: 4000	-	Code of practice for assembly of structural joints using high tensile friction grip fasteners.
18.	IS	: 4225	-	Recommended practice for ultrasonic testing of steel plates.
19.	IS	: 4260	-	Recommended practice for ultrasonic testing of welds in ferritic steel.
20.	IS	: 5334	-	Code of practice for magnetic particle flaw detection of welds.
21.	IS	: 7215	-	Tolerances for fabrication of steel structures.
22.	IS	: 7310 (part-I)	-	Approval test for welders working to approved welding procedures.
23.	IS	: 7318 (part-I)	-	Approval tests for welders when welding procedure approval is not required.
24.	IS	: 9595	-	Recommendations for metal arc welding of carbon and carbon manganese steel.
25.	IS	: 823	-	Code of procedure for manual arc welding of mild steel.
26.	IS	: 1181	-	Qualifying tests for metal arc welders (engaged in welding structures other than pipes).

3.0 STEEL MATERIALS

Steel materials shall comply with IS:2062 or IS:1977. Usage of steel conforming to IS:1977 shall be restricted as indicated below.

All materials to be supplied by the Contractor shall be new, unused and free from defects.

Steel conforming to IS:1977 shall be used only for the following :

Fe310-0(St 32-0) : For general purposes such as door/window frames, grilles, steel gates, handrails, fence posts, tee bars and other non-structural use.

Fe410-0(St 42-0) : For structures not subjected to dynamic loading other than wind loads such as :

Platform roofs, foot over bridges, office building, factory sheds etc.

Fe410-0(St 42-0) : Grade steel shall not be used :

(a) If welding is to be employed for fabrication.

(b) If site is in severe earthquake zone.

(c) If plastic theory of design is used.

4.0 CONSULTANT's Scope of review of Design / Drawings Prepared by The Vendor / Contractor

The CONSULTANT shall review design calculations / Drawings Prepared by the Vendor / Contractor

5.0 FABRICATION

5.1 GENERAL

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined /ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to

view shall be neatly finished. Unless otherwise directed/approved reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

5.2 CONNECTIONS

5.2.1 Shop/field connections shall be welded unless otherwise specified on OWNER'S design drawings and shall be executed as per approved fabrication drawings.

5.2.2 In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers shall be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be atleast three times the pitch of the thread.

5.2.3 In all cases where bearing is critical , the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

5.2.4 All connections and splices shall be designed for full strength of members or load indicated on Engineer's design drawings. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

5.2.5 All bolts, nuts, washers, electrodes, screws etc. shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.

5.2.6 All members likely to collect rain water shall have drain holes provided.

5.3 STRAIGHTENING

All material, if necessary, before being worked shall be straightened and /or flattened by pressure and shall be made free from twists by the CONTRACTOR at his own cost. Heating or forging shall not be resorted to without the prior approval of the ENGINEER in writing.

5.4 Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

5.5 ROLLING AND FORMING

Plates, channels R.S.J etc., for circular bins, bunkers hoppers, gantry girders etc., shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

5.6 HIGH STRENGTH FRICTION GRIP BOLTING

5.6.1 Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

5.7 WELDING

5.7.1 Welding procedure shall be submitted to ENGINEER for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per IS: 817, IS: 7310 (Part I) and IS: 7318 (Part I) .

5.7.2 While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

5.7.3 Approval of the welding procedure by the ENGINEER shall not relieve the CONTRACTOR of his responsibility for correct and sound welding without undue distortion in the finished structures.

5.7.4 No welding shall be done when the surface of the members is wet nor during periods of high wind.

5.7.5 Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be excercised to prevent scaling or flaking of weld and base metal from overpeening.

5.7.6 No welding shall be done on base metal at a temperature below 0 Deg C. Base metal shall be preheated to the temperature as per relevant IS codes.

5.7.7 Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 20 mm and above.

5.7.8 Welding shall be done as per approved fabrication drawing as to type of weld, length and size of weld, whether shop weld or site weld. Efforts shall be made to reduce site welding so as to avoid improper welding due to constructional difficulties.

5.7.9 Welding of structural steel shall be done by an electric are process. The procedure to be followed, materials, plant and equipment to be used and testing and inspection procedures to be applied shall be to the satisfaction of the Engineer-in-Charge and shall conform generally to relevant acceptable standards viz. IS:823 and Indian Standard Hand Book for metal arc welding and other standard codes of practice internationally accepted.

5.7.10 Submerged-Arc-Welding shall be employed for assembling the components of column, crane girders and for main frame beams. The CONTRACTOR shall employ automatic welding machine of the approved make and type for the welding, wherever feasible.

5.7.11 Open Arc Welding process using shielded arc electrodes shall be employed for assembling the components of trusses, welding of stiffeners, brackets etc. and for field welding. In other cases open arc welding shall be restricted to the minimum and shall be used with the specific approval of Engineer-in-Charge.

5.7.12 Whenever open arc manual welding is done for assembling the components of structures, the job shall be so positioned that downhand welding is possible. In cases where such positioning of job is not possible other manual welding positions could be resorted to ; but it should be ensured that the one chosen is the least strenuous for the welder.

5.7.13 Proper edge preparation shall be made for jointing of materials before welding. Suitable edge preparation shall be done for all processes of welding except for square-butt welds.

5.7.14 Type of edge preparation shall depend on the thickness of parent materials that are to be joined. The edge forms shall be chosen to suit the design, technology and production conditions and shall be subject to the approval of Engineer- in –Charge.

5.7.15 The edge form of weldments shall be prepared either by machines or by automatic gas cutting with surface roughness of the welding area not

exceeding Ra = 50. All edges cut by flame shall be ground before they are welded.

5.7.16 The electrodes used for welding shall be of suitable type and size depending upon specifications of the parent material, the method of welding, the position of welding and the quality of welds desired e.g. normal penetration weld or deep penetration welds.

5.7.17 Where covered electrodes are used, they shall be heavy coated shielded arc electrodes and shall conform to requirements of IS:814. Covering shall be heavy to withstand normal conditions of handling and storage. They shall be free from all defects which would interfere with performance of electrodes.

5.7.18 Only those electrodes which give radiographic quality welds shall be used.

5.7.19 Where bare electrodes are used these shall correspond in specification to the parent material. The flux used for submerged arc welding should be specially manufactured for the purpose and should have such a composition which does not evolve any appreciable quantity of gases.

5.7.20 Specific approval of the Engineer-in-Charge shall be taken by the CONTRACTOR for the various electrodes proposed to be used on the work before any welding is started.

5.7.21 Electrodes of classification AWS-E-60 xx & E-70 xx shall be used for welding steel conforming to IS::2062.

5.7.22 All electrodes to be used on work shall be fully dry and shall be heated atleast for 4 hours upto a temperature of 110 deg.C or above in electric oven, prior to use for welding. During welding the electrodes shall be kept covered inside the thermally insulated flasks to avoid ingress of moisture.

5.7.23 The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion. The direction of the welding should be away from the point of restraint and towards the point of maximum freedom.

5.7.24 The beam and column stiffeners shall preferably be welded to the webs before the webs and flanges are assembled, unless the web and flanges of the beam or column are assembled by automatic welding process.

5.7.25 All welds shall be finished full and made with correct number of runs, the welds being kept free from slag and other inclusions, all adhering slag being removed from exposed faces immediately after such runs.

5.7.26 Current shall be appropriate for the type of electrode used. To ensure complete fusion the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.

5.7.27 Puddling shall be sufficient to enable the gases to escape from the molten metal before it solidifies.

5.7.28 Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not lockedup resulting ultimately in cracks.

5.7.29 The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender members extra length should be provided, at the time of fabrication, for shrinkage.

5.7.30 The ends of welds shall have full throat thickness. This shall be obtained on all main welds by the use of run off and run on pieces adequately secured on either side of main plates. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approved means and the ends and surface of the welds shall be smoothly finished.

5.7.31 All main butt welds shall have complete penetration and except where it is impracticable they shall be welded from both sides, back surface of the weld being gouged out clean before first run of the weld is given from the back.

5.7.32 All butt joints in flange plates of columns and other plate girders shall be skew joints at an angle of 45 deg to the axis of the flange for the flanges having width less or equal to 300mm, and at an angle of 60 deg for flanges having width more than 300mm. No extra payment on account of skew joint in place of straight joint shall be made.

5.7.33 All welds shall be inspected for flaws by any of the methods described under clause 10.0 “Inspection“. The choice of the method adopted shall be determined by the PURCHASER/ENGINEER.

5.7.34 The correction of defective welds like improper penetration, blowholes, undercuts, cracking, slag inclusion etc. shall be carried out by removing the defective weld portion by gouging by using gouging electrodes, cleaning burrs etc. and rewelding or as directed by the ENGINEER without damaging the parent metal. When a crack in the weld is removed. magnetic particle inspection or any other equally positive means as prescribed by

the ENGINEER shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. Cost of all such operations incidental to correction shall be to the VENDOR/CONTRACTOR's account.

5.8 WELDERS

5.8.1 Only welders who satisfy the appropriate tests and requirements as per IS:817, IS:1181, IS: 7310 and IS:7318 shall be employed on welding work. Should the welder fail in the first test, two further tests shall be undertaken immediately and the welder, to qualify, must satisfactorily pass both these tests.

5.8.2 Routine tests of all welders shall be required every six months. ENGINEER/OWNER reserves the right to have any welder re-tested at any time.

5.8.3 Structural joints shall be welded by only those welders who are qualified for that particular type and position of welding. The welding of a butt joint shall be completely done by the welder who starts the welding on that joint i.e. welding by more than one welder on a particular joint shall not be allowed. The welder shall punch his identification mark allotted to him after testing, on the joints he welds.

5.9 INSPECTION AND TESTING OF WELDS

5.9.1 Visual Inspection

100 percent of the welds shall be inspected visually for external defects. Dimension of weld shall be checked. Weld gauges shall be used to measure the size of welds. The length and size of weld shall be designed for the design forces. It may be slightly oversized but should not be under sized.

The profile of weld is affected by the position of the joint but it should be uniform. In case of butt and corner welds the profile shall be convex and in case of submerged arc fillet weld it shall be slightly concave. The welds should have regular height and width of heads. The height and spacing of ripples shall be uniform. The joints in the weld run where welding has been recommended shall as far as possible be smooth and should not show any hump or craters in the weld surface. Welds shall be free from unfilled craters on the surface, under-cuts, lags on the surface and visible cracks. Intermittent welds shall not be permitted without approval of ENGINEER. Such inspection shall be done after cleaning the weld surface with

steel wire brushes and chisel to remove the spatter metal, scales slag etc. If external defects mentioned above are noticed there is every possibility of internal defects and further radiographic/ultrasonic examination shall be undertaken as per clause 5.9.5

5.9.2 Mechanical Testing

The following mechanical tests shall be carried out as per IS: 3600

(i) Transverse Tensile Test
(ii) Reduced Section Tensile Test
(iii) Free Bend Test
(iv) Transverse and Longitudinal Bend Test

5.9.3 Test plates shall be incorporated on either side of at least 10% of main butt welds and the weld shall be continuous over the test plate. The test plates shall be cut from extensions of the main plates and shall be fixed so that the metal lies in the same direction as that of the main plate.

5.9.4 Test plates shall be prepared and tested in accordance with the accepted standards, in the presence of the Engineer-in-Charge or his authorised representative. All testing equipment and facilities for carrying out these tests shall be provided by the Contractor within his unit rates. Should any of these tests fail, further radiographic examination of the welds in question on the main members, shall be undertaken in accordance with clause 5.9.5.

5.9.5 Non-destructive and special testing

In addition to the contractor's normal supervision and testing procedure, radiographic/ultrasonic, liquid penetrant test, dry powder magnetic particle test and wet magnetic particle test shall be carried out as and when required by the Engineer-in-charge, on butt or fillet welded joints/and/or on test specimens. These tests of welds except radiographic/ultrasonic tests shall be carried out at the cost of the contractor wherever and whenever required by the Engineer – in Charge. Radiographic/ultrasonic tests shall, however, be carried out by Engineer at department cost through separate independent agency. In case of failure of any of the radiographic/ultrasonic tests, the cost of that portion of the test shall be recovered from the contractor. Rectification of such components shall be carried out by the contractor at his cost.

Not withstanding any other stipulation contained elsewhere in these specification, radiographic/ultrasonic testing shall be done as follows:-

i) 1% radiographic testing at random for all Butt joints excluding the butt joints of tension flanges at Crane girder.
ii) 100% radiographic testing for butt joints for tension flanges of crane girders.
iii) Spot radiographic test in any one butt welds per flange of flanges of main framing beams and columns.
iv) 100% ultrasonic tests on butt welds of flanges of main framing beams and columns not covered by radiography.

5.9.6 Acceptance Of Welded Structures

The acceptance of the welded work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the examination and testing of the joints and the test specimens as per IS, soundness of the welds and upon general workmanship being good. ENGINEER's decision shall be final and binding on contractor in this regard.

5.10 SAFETY PRECAUTIONS

5.10.1 CONTRACTOR shall take all necessary precautions for the safety of his own personnel as well as that of other contractors working in the area.

5.10.2 Welders shall be provided with safety goggles and gloves, etc. All the personnel working in the construction site shall be provided with safety helmets. Personnel working at higher elevations shall be provided with safety belts. Adequate first aid facilities shall be provided by the contractor at his own cost. Any negligence in terms of safety measure and consequences arising out of such negligence will be the sole responsibility of the CONTRACTOR.

5.10.3 CONTRACTOR shall take precautionary measures such as providing sheets/covers below the welding area to provide protection against falling liquid metal and sparks. Area where welding is being done shall be suitably barricaded to prevent movement of personnel underneath and sign boards shall be put in such areas where erection/welding is being done.

5.11 END MILLING

Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment.

5.12 FABRICATION TOLERANCES

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS : 1852 for indigenous steel and equivalent applicable codes for imported steel. The acceptance limits for straightness (sweep and camber) for rolled or fabricated members are :-

Struts and columns	- L/1000 or 10 mm whichever is smaller
For all other members Not primarily in compression such as purlins, girts, bracings and the web members of trusses and Latticed girders	- L/500 or 15 mm whichever is smaller

Where L is the length of finished member or such lesser length as the Engineer may specify.

A limit for twist prior to erection in

Box girders & Heavy columns	-	L/1500
Other members	-	L/1000

The twist of the member between any two sections shall be measured with the web vertical at one of the sections.

Tolerance in specified camber of structural members shall be ± 3mm

Tolerance in specified length shall be as follows:

Type of member	Tolerance
A column finished for contact	± 1 mm
Other members (e.g. beams) under 10 m	+ 0 & -3 mm
Other members (e.g. beams) 10 M long & over	+ 0 & -5 mm

End of Members

Beam to beam and beam to column connections. Where the abutting parts are to be jointed by butt welds, permissible deviation from the squareness of the end is :

Beams upto 600 mm in depth	1.5 mm
Beams over 600 mm in depth	1.5 mm every 600 mm upto maximum of 3 mm

Where abutting parts are to be jointed by bolting through cleats or end plates, the connections require closer tolerance. Permissible deviation from the squareness of the end is :

Beams upto 600 mm in 1 mm per 600 mm of depth to a max. of 1.5 mm.

Butt Joints

For full bearing, two abutting ends of columns shall first be aligned to within 1 in 1000 of their combined length and then the following conditions shall be met.

a) Over atleast 80% of the bearing surface the clearance between the surfaces does not exceed 0.1 mm.
b) Over the remainder of the surfaces the clearance between the surfaces does not exceed 0.3 mm.

Where web stiffeners are designed for full bearing on either the top flange or bottom flange or both, at least half the stiffener shall be in positive contact with the flange. The remainder of the contact face could have a max. gap of 0.25 mm.

Depth of Members

Acceptable deviation from the specified overall depth is:

For depths of 900 mm and under	-	± 3 mm
For depths over 900 mm and under 1800 mm	-	± 5 mm
For depths of 1800 mm and over	-	+ 8 mm - 5 mm

Web Plates

An acceptable deviation from flatness in girder webs in the length between the stiffeners or in a length equal to the girder depth shall be $1/150^{th}$ of the total web depth.

Flanges Plates

A reasonable limit for combined warpage and tilt on the flanges of a built up member is 1/200 of the total width of flange or 3 mm whichever is smaller measured with respect to centreline of flanges.

Lateral deviation between centreline of web plates and centreline of flange plate at contact surfaces, in the case of built up sections shall not exceed 3 mm.

6.0 STEEL GRATINGS, STAIRS, HANDRAILS, LADDERS AND FLOOR PLATE COVERS

6.10 STEEL GRATING

6.1.1 All grating units shall be rectangular and diamond in pattern and welded assembly. The grating are to be designed to sustain the maximum safe load of 500kg/m2 of the plan area. The maximum width of opening for grating shall not exceed 300mm. The minimum thickness of main bars shall be 5mm. The grating bar shall not be less than 38mm deep and span shall not exceed 1500mm.

6.1.2 The gratings shall be made up in panel units designed to coincide with the span of the structural framing as indicated in the drawings or as directed by the Engineer-in-Charge.

6.1.3 The grating units shall be accurately fabricated and finished free from warps, twists or any defects that would impair their strength, serviceability and appearance.

6.1.4 Grating work shall include cut outs and clearance openings for all cols., pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut-outs and clearances shall be treated as follows:

6.1.5 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the component countered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

6.1.6 Openings in gratings for pipes or ducts that are 150 mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width, set flush with the bottom of the bearing bars.

6.1.7 Penetrations in gratings that are more than 50 mm but less than 150 mm in size or diameter shall be banded with plates of the size shown in the detailed drgs. set flush with the bottom of the grating panel.

6.1.8 Penetrations, in grating that are less than 50 mm in size or diameter shall be cut in field by others.

6.1.9 Unless otherwise indicated in the drgs. grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

6.1.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units and supporting structural steel framing members.

6.1.11 All fabricated grating section and accessories shall be primed in the shop prior to erection at site.

6.1.12 Prior to painting all surfaces shall be cleaned, free from rust, mill-scale, grease, oil or any other foreign matter that might affect the adherence of the paint by sand blasting. While the primer shall be applied by Spray guns or by brushes, the final coat of finished paint shall necessarily be applied by means of spray guns only.

6.1.13 The applied coatings shall be uniform, free from voids and streaks. Drilled or punched holes shall be touched up prior to erection or assembly.

6.1.14 In case, the fabrication of gratings is done by him at his own workshop outside the project, then the unit rate quoted by him for this item shall be inclusive of transport of the fabricated materials form his shop to the project site. He shall also in such a case provide all facilities and access to the Engineer-in-charge or his representative to carry out inspection of the components being fabricated at his workshop during all stages of fabrication. Maximum deviation in linear dimensions from the approved dimension shall not exceed 5mm.

6.2 STAIRS

6.2.1 All the stairs and intermediate landings shall be constructed to size, dimensions and design, as indicated in the detailed drawings. Each stairway shall be fabricated as a complete unit which shall include struts, hangers, posts, cross bracings, cleats and accessories, as required for connection to structural steel framing and concrete.

6.2.2 Gratings for stair treads and landings shall be constructed to size, dimensions and design as specified and shall match with floor grating pattern.

6.2.3 Stair treads shall be furnished complete with punched and slotted carrier plates attached ready to bolt to stair stringers. Treads shall be provided with an approved type anti-slip nosing set flush with the stair tread.

6.2.4 Grating treads and gratings for landings of interior stairs shall be paint finished as specified for floor gratings.

6.3 HAND RAILS

Pipe hand rails, as specified in detailed drawings shall be assembled with flush-type fittings and welded joints, ground and polished smooth. Railings shall be provided with all necessary fittings, posts, brackets, bolts, kick plates and similar accessories as shown on the approved drawings, and as required for proper installation. Hand rails shall be provided on open sided of chequered plates and steel grating platforms, steel stairways and around all openings in chequered plate and steel grating floors as shown in drawings.

6.4 LADDERS

Vertical ladders shall be called for on the approved drawings. The ladders shall be provided with support arms formed of bent steel plate or clip angles. Where shown on the drgs. the ladders shall have loose neck supports, designed to form hand grabs and end brackets for fastening to abutting construction. Maximum deviation in the linear dimensions of railings, stairs and ladders, from the approved dimensions, shall not exceed 12mm.

6.5 FLOOR PLATES COVERS

Floor plates for platforms, trench covers, pit covers, etc., shall be formed of raised pattern chequered steel plates of shape and size as shown on the drgs., compete with stiffener ribs, top bars, anchors and necessary accessories. Maximum deviation in the linear dimensions of floor plate covers from approved dimensions shall not exceed 5mm.

7.0 INSPECTION

7.1.1 The VENDOR/CONTRACTOR shall give due notice to the PURCHASER/ ENGINEER in advance of the works getting ready for inspection. All

rejected material shall be promptly removed from the shop and replaced with new material for the PURCHASER/ENGINEER's approval/ inspection. The fact that certain material has been accepted at the VENDOR/CONTRACTOR's shop shall not invalidate final rejection at site by the PURCHASER/ENGINEER if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall invalidate any claim which the PURCHASER may make because of defective or unsatisfactory materials and/or workmanship.

7.1.2 No materials shall be painted or despatched to site without inspection and approval by the PURCHASER/ENGINEER unless such inspection is waived in writing by the ENGINEER.

7.1.3 The VENDOR/CONTRACTOR shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

7.1.4 For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the ENGINEER.

7.2 Inspection and tests on structural steel members shall be as set forth below :

7.2.1 Materials Testing

If mill test reports are not available for any steel materials the same shall be got tested by the VENDOR/CONTRACTOR to the ENGINEER's satisfaction to demonstrate conformity with the relevant specification at no extra cost to OWNER.

7.3 TESTS ON WELDS

7.3.1 Magnetic Particle Test

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the ENGINEER.

7.3.2 Liquid Penetrant Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Codes. All defects shown shall be repaired and rechecked.

7.3.3 Radiographic Inspection

All full strength butt welds shall be subjected to radiographic/ultrasonic test as per clause 5.9.5 in accordance with the recommended practice for radiographic testing as per relevant IS code.

7.4 DIMENSIONS, WORKMANSHIP & CLEANLINESS

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the VENDOR/CONTRACTOR'S approved fabrication drawing and ENGINEER'S drawings.

7.5 TEST FAILURE

In the event of failure of any members to satisfy inspection or test requirement, the VENDOR/CONTRACTOR shall notify the ENGINEER or his authorised representative. The VENDOR/CONTRACTOR must obtain permission from the ENGINEER before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the ENGINEER.

7.6 The VENDOR/CONTRACTOR shall maintain records of all inspection and testing which shall be made available to the ENGINEER or his authorised representative.

8.0 SHOP MATCHING

Steel work, such as columns along with the tie beams/bracings/trusses etc, may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc. if so desired by the ENGINEER. All these shop assemblies shall be carried out by VENDOR/CONTRACTOR

9.0 DRILLING HOLES FOR OTHER WORKS

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors

shall be drilled by the VENDOR/CONTRACTOR at no extra cost to the OWNER.

10.0 MARKING OF MEMBERS

10.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20mm high and to such optimum depth as to be clearly visible.

10.2 All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

10.3 Erection marks on like pieces shall be in identical locations. Members having length of 7.0m or more shall have the erection mark at both ends.

11.0 ERRORS

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the ENGINEER as defective workmanship. In case ENGINEER rejects the material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the ENGINEER's requirements by VENDOR/CONTRACTOR at no extra cost to the OWNER.

12.0 PAINTING

12.1 All fabricated steel material, shall receive protective paint coating as specified in specification No. TCE. 5178A-405-04 (Section –D38).

1.0 SCOPE

This specification covers the general requirements for erection of structural steel. It covers the supply and delivery of all necessary materials, labour, scaffolding, tools, tackles, equipment and everything that is necessary for the satisfactory completion of the job on schedule.

2.0 APPLICABLE CODES & SPECIFICATIONS

2.1 The following specifications, standards and codes are made a part of this specification. All standards, specifications and codes of practice referred to herein shall be the latest editions, including all applicable official amendments and revisions.

2.2 In case of discrepancy between this specification and other documents referred to herein, this specification shall govern.

2.3 STRUCTURAL

(a) IS:800 Code of Practice for General Construction in Steel

(b) IS:801 Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction

(c) IS:806 Code of Practice for Use of Steel Tubes in General Building Construction

(d) IS:7205 Safety Code for Erection of Structural Steel Work

(e) IS:7215 Tolerances for Fabrication of Steel Structures

(f) IS:4000 Code of practice for assembly of structural joints using high tensile friction grip fasteners.

(g) IS:822 Code of procedure for inspection of welds

3.0 ERECTION SCHEME

3.1 Each Bid shall be accompanied by a broad erection scheme with dates and estimated completion time for various parts of the work prepared by BIDDER after a thorough study of the Bid drawings and the site conditions. This erection scheme shall describe the methods proposed to be employed by BIDDER for transporting his equipment, tools, tackles, gas cylinders, electrodes and all that is necessary to site, unloading, transporting within the site, handling, assembling, hoisting and erecting of the structural steel components and the type, capacity and

quantity of equipment that BIDDER proposes to bring to site for all these operations. The scheme shall also indicate the strength and tradewise composition of the work force and supervisory personnel that will be deployed by BIDDER for the various operations.

4.0 ERECTION PROGRAMME

4.1 Within 15 days of the acceptance of his Bid, the successful BIDDER shall submit, a detailed erection programme. This programme shall be accompanied by a layout plan identifying the areas proposed for unloading, main storage, subsidiary storage, assembly and the transportation of equipment and fabricated material between the storage and work areas. The layout shall clearly indicate the points at which proposed erection begins, direction in which it is proposed to progress, the deployment of equipment, access route for cranes to reach work areas, etc. The locations and extent of site offices and stores, labour quarters if any, layout of electrical cables and water pipes from the tap-off points shall also be indicated in detail on the above layout. Full details of the method of handling, transport, hoisting and erection including false work/staging, temporary bracing, guying, etc. shall be furnished by CONTRACTOR in this erection programme along with complete details of the quantity and capacity of the various items of erection equipment that will be used. A site organisation chart showing the number of supervisory personnel, and the number and composition of the various gangs shall also accompany the erection programme.

4.2 Any modifications to the erection programme directed by ENGINEER for the reasons of inadequacy of the quantity and/or capacity of the erection equipment, erection personnel and supervisors, temporary bracing, guying etc., or safety of the erection methods, or stability of the erected portions of structures, or unsuitability of the erection sequence due to interference with the work of other agencies shall be incorporated by CONTRACTOR and the work shall be carried out in accordance with the revised programme. Approval by ENGINEER shall not relieve CONTRACTOR from the responsibility for the safe, sound, accurate and timely erection of structural steel work as required by ENGINEER/OWNER. CONTRACTOR shall also make no extra claims for bringing additional equipment to site for erection, if so directed by ENGINEER. CONTRACTOR shall be deemed to have visualised all erection problems while bidding for the work and no additional compensation shall be claimed on this account.

5.0 SITE OPERATIONS

5.1 An experienced and qualified Superintendent shall be in full time charge of the job.

5.2 CONTRACTOR shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading and pre-assembly yard,

labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc. as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel at site.

5.3 CONTRACTOR shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. CONTRACTOR shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of OWNER/ENGINEER and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain CONTRACTOR's electrical equipment and connections.

5.4 CONTRACTOR shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by CONTRACTOR shall be rectified entirely at CONTRACTOR's cost,to the satisfaction of OWNER/ENGINEER. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, CONTRACTOR must ensure suitable safety precautions in consultation with ENGINEER.

5.5 If a portion of the work of the project area cannot be made available to CONTRACTOR for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations so as to continue work without interruption. CONTRACTOR shall work in coordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

6.0 ACCEPTANCE OF STEEL, ITS HANDLING & STORAGE

6.1 CONTRACTOR shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of OWNER/ ENGINEER.

6.2 No dragging of steel shall be permitted. All shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by CONTRACTOR. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by CONTRACTOR well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

6.3 Scratched or abraded steel shall be given a coat of primer specified under Data Sheet A for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged.

6.4 Point of delivery of fabricated steel shall be the location where it is to erected.

7.0 ANCHOR BOLTS & FOUNDATIONS

7.1 CONTRACTOR shall carefully check the location and layout of anchor bolts embedded in foundations constructed , to ensure that the structures can be properly erected as shown on the drawings, Any discrepancy in the anchor bolts/foundation shall be reported to ENGINEER.

7.2 Levelling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates at no extra cost to the OWNER.

7.3 A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by CONTRACTOR.

7.4 Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by CONTRACTOR, as a part of his scope of work.

8.0 ASSEMBLY & CONNECTIONS

8.1 Field connections may be effected by welding unless otherwise indicated in the drawings. Connections for removable members shall be by means of bolting

8.2 All assembling shall be carried on a level platform.

8.3 Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the nominal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of ENGINEER.

8.4 Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to ENGINEER.

9.0 ERECTION

9.1 All structural steel shall be erected as shown on the drawings. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc. unless so permitted by ENGINEER in writing. Care shall be taken to see that ropes in use are always in good condition.

9.2 Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls or floor.

9.3 Structural steel frames shall be erected plumb and true. Frames shall be lifted at such points that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

9.4 Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as directed by ENGINEER. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include :

(a) Welding of stiffening angles/vertical stiffening ribs

(b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through

(c) Splicing as shown in relevant drawings

(d) Smoothening of edges

(e) Fixing of chequered plates by tack welding or by countersunk bolts

(f) Providing lifting hooks for ease of lifting.

9.5 As erection progresses, the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses.

9.6 No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by ENGINEER. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of ENGINEER.

10.0 INSPECTION

10.1 ENGINEER/OWNER or their authorised representatives shall have free access to all parts of the job during erection and all erection shall be subjected to their approval. In case of faulty erection, all dismantling and re-erection required will be at CONTRACTOR's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by ENGINEER.

11.0 TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to steel structures where the deviations from true position are intimately linked with and directly influence technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists/suppliers which will be indicated in the drawings.

11.1 COLUMNS

11.1.1 Deviation of column axes at foundation top level with respect to true axes :

(a)	In longitudinal direction	:	± 5 mm
(b)	In lateral direction	:	± 5 mm

11.1.2 Deviation in the level of bearing surface of columns at foundation top with respect to true level : ± 5 mm

11.1.3 Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top :

(a)	For columns upto and including 15 metres in height	:	± 1/1000 of column height in mm or ±15mm whichever is less
(b)	For columns exceeding 15 metres in height	:	± 1/1000 of column height in mm or ± 20 mm whichever is less

11.1.4 Deviation in straightness in longitudinal : ± 1/1000 of column height in

	and transverse planes of column at any point along the height	:	mm or ± 10 mm whichever is less
11.1.5	Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance	:	± 10 mm
11.1.6	Deviation in any bearing or seating level with respect to true level	:	± 5 mm
11.1.7	Deviation in differences in bearing levels of a member on adjacent pair of columns both across and along the building	:	± 10 mm

11.2 TRUSSES AND BEAMS

11.2.1	Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord	:	± 1/250 of height of truss in mm or ± 15 mm whichever is less
11.2.2	Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	:	± 1/1500 of span of truss in mm or ± 15 mm whichever is less
11.2.3	Lateral shift in location of truss from its true vertical position	:	± 10 mm
11.2.4	Lateral shift in location of purlin true position	:	± 5 mm
11.2.5	Deviation in difference of bearing levels of trusses or beams from the true difference	:	i) ±20 mm for trusses ii) For beams : Depth < 1800mm : ±6mm Depth > 1800mm : ±10 mm
11.2.6	Deviation in sag in chords and diagonals of truss between node points	:	1/1500 of length in mm or 10mm whichever is smaller
11.2.7	Deviation in sweep of trusses, beams etc. in the horizontal plane	:	1/1000 of span in mm subject to a maximum of 10 mm

11.3 HIMNEY AND TOWRES

11.3.1	Verticality from the true Vertical axis.	1/1000 of the height of the chimney or tower in mm.

12.0 PAINTING

12.1 After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer specified in Data Sheet A. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

13.0 COMPLETED OR PARTLY COMPLETED WORK

13.1 Owner shall have the right to take possession of or use any completed or partly completed part of work. Such possession or use shall not be deemed to be an acceptance of any work not in accordance with the contact

14.0 CLEAN UP OF WORK SITE

14.1 During erection, the CONTRACTOR shall without any additional payment, at all times keep the working and storage areas used by him, free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to OWNER/ENGINEER.

1.0 SCOPE

1.1 This specification covers the general requirements for painting structural steel work. It covers the supply and delivery of all necessary materials, labour, scaffolding, tools, equipment and everything that is necessary for the job completion on schedule. The specific requirements of the project are indicated in Cl. 4.0.

1.2 Shop painting shall be understood to mean painting prior to erection whether such materials are fabricated in shop or at site. In case the contract covers shop painting only, the contractor shall ensure that the painted surfaces are not abraded / scratched etc. as they leave his works / shops, in case of ex-works delivery contract and in case of FOR site contracts, the materials as received at site should be in good condition. Otherwise all damaged, abraded and scratched surfaces shall be touched up on receipt of materials at site as specified. If the contract covers both shop painting and painting after erection, the responsibility would be total. In case of routine maintenance painting of erected steel work, the surface preparation, primer application and painting shall be as per Cl.4.0.

2.0 APPLICABLE CODES

The following specifications, Standards and Codes are made a part of this Specification. All standards and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and those referred to herein, this specification shall govern.

(a) IS : 101 : Methods of test for ready mixed paints and enamels

(b) ASTM : American standard test methods for paints and coatings

(c) ASA A 13.1-1981 : Scheme for identification of piping systems American National Standards Institution.

(d) SIS-05 5900-1967 (Swedish Standard) : Surface preparations standards for Painting Steel Surfaces,

3.0 PAINT

3.1 All paint delivered to the fabrication shop / site shall be ready mixed, in original sealed containers, as packed by the paint manufacturers and no thinners shall be permitted.

3.2 Paint shall be stirred frequently to keep the pigment in suspension.

4.0 SPECIFIC TECHNICAL REQUIREMENTS

4.1 Following specific technical requirements in addition to those specified above shall be complied with.

4.2 Scope of painting shall be as follows :

a) One shop coat of primer after fabrication.

b) One touch up coat of primer on abraded surfaces after erection

c) Two coats of primer after erection.

d) Two final protective colour coats of chlorinated rubber finish paint

4.3 Surfaces of steel work to be painted shall be thoroughly cleaned by means of mechanical and power tool cleaning.

4.4 First, one Shop coat of Inorganic Zinc Silicate primer (65 microns) after fabrication but before erection shall be applied. After erection apply one coat of Inorganic Zinc Silicate primer as touchup paint at all damaged surfaces (1 x 65 microns) plus two coats of Chlorinated Rubber Zinc Phosphate Primer (2 x 40 microns). Finish paint shall be two coats of Chlorinated Rubber finish paint (2 x 40 microns)

4.5 Surfaces inaccessible after assembly and after erection shall receive 2 coats of the primer paint prior to assembly.

4.6 Colour code shall be as desired by the OWNER and will be indicated during execution.

4.7 Separate colour code or identification mark shall be adopted in the fabrication shop for members fabricated from steel supplied by the OWNER and the VENDOR / CONTRACTOR.

4.8 Welds and adjacent parent metals shall not be applied with primer and / or painting prior to deslagging, inspection and approval.

4.9 Surfaces coming in contact with concrete, and such other areas should not be painted, if so specified or directed by Engineer.

4.10 All machine finished surfaces shall be provided with a coat of white lead or tallow before despatch to site to prevent rust formation.

4.11 No painting shall be done in frosty / foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is 5^0 C or lower.

1. SCOPE

This specification covers the general requirements of earthwork in excavation in different materials, site grading, filling in areas as shown in drawing, back filling around the foundations and in plinths, conveyance and disposal of surplus soils or stacking them to the stockyard or pit with a lead of 3000m with in plant area or outside as directed by the Engineer and all operations covered within the intent and purpose of this specification.

2. APPLICABLE CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

1. IS 783 - Code of practice for laying of concrete pipes.
2. IS 1200 - Method of measurement of building and civil engineering works.
   - (Part 1) Part 1 Earthwork
   - (Part 27) Part 27 Earthwork done by mechanical appliances.
3. IS 3764 - Excavation work-code of safety.
4. IS 2720 - Methods of test for soils:
   - (Part 1) - Part 1 Preparation of dry soil samples for various tests.
   - (Part 2) - Part 2 Determination of water content.
   - (Part 4)- - Part 4 Grain size analysis.
   - (Part 5) - Part 5 Determination of liquid and plastic limit.
   - (Part 7) - Part 7 Determination of water content-dry density relation using light compaction.
   - Part (8) - Part 8 Determination of water content-dry density relation using heavy compaction
   - Part (9) - Part 9 Determination of dry density - moisture content relation by constant weight of soil method.
   - (Part 14) - Part 14 Determination of density index (relative density) of cohesionless soils.
   - (Part 28) - Part 28 Determination of dry density of soils in place, by the sand replacement method.

(Part 29) - Part 29 Determination of dry density of soils in place, by the core cutter method.

(Part 33) - Part 33 Determination of the density in place by the ring and water replacement method.

(Part 34) - Part 34 Determination of density of soil in place by rubber balloon method.

(Part 38) - Part 38 Compaction control test (Hilf Method).

3. DRAWINGS

3.1 The Engineer will furnish drawings wherever, in his opinion, such drawings are required to show areas to be excavated/ filled grade level, sequence of priorities etc. The Contractor shall follow strictly such drawings.

4. GENERAL

4.1 The Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the job in accordance with the specification requirements.

4.2 The Contractor shall carry out the survey of the site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/ grid lines at 8 m. intervals or nearer as determined by the Engineer based on ground profile. These shall be checked by the Engineer and thereafter properly recorded.

4.3 The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night for ensuring safety.

4.4 The rates quoted shall also include for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the Engineer, within the lead specified and levelling the same so as to provide natural drainage. Rock/ soil excavated shall be stacked properly as directed by the Engineer. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

5. CLEARING

5.1 The area to be excavated filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The material so removed shall be burnt or disposed off as directed by the Engineer. Where earthfill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

6. PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITY, etc.

6.1 All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Owner and the Contractor shall duly preserve the same to the satisfaction of the Owner and from time to time deliver the same to such person or persons as the Owner may from time to time authorise or appoint to receive the same.

7. EXCAVATION

7.1 All excavation work shall be carried out by mechanical equipment unless, in the opinion of the Engineer, the work involved and time schedule permit manual work.

7.2 Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final level and extra excavation filled up as directed by the Engineer. The final excavation if so instructed by the Engineer, should be carried out just prior to laying the mud-mat.

7.3 The Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by the Engineer, at his own cost outside the lines shown on the drawings or directed by the Engineer. Should any excavation be taken below the specified elevations, the Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by the Contractor on this account.

7.4 All excavation 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 excavation, including dimensions, side

slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of slipped earth will not be paid for, if the slip is due to negligence of CONTRACTOR.

7.5 Excavation shall be carried out with such tools, tackles and equipment as described hereinbefore. Blasting or other methods may be resorted to in the case of hard rock; however not without the specific permission of the Engineer.

7.6 The Engineer may also direct that in some extreme case, the rock may be excavated by heating and sudden quenching for splitting the rock..

8. STRIPPING LOOSE ROCK

8.1 All loose boulders, semi detached rocks (along with earthy stuff which might move therewith) not directly in the 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, or the work, etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter, or render unstable or unsafe the portion which was originally sound and safe.

8.2 Any material not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the Engineer.

9. FILL, BACK FILLING AND SITE GRADING

9.1 GENERAL

All fill material will be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site at no extra cost to the Owner. Surplus fill material shall be deposited/ disposed off as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

9.2 MATERIAL

To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill up the voids and the mixture used for filling.

9.3 If any selected fill material is required to be borrowed, the Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of the Engineer. The approved borrow pit area shall be cleared of all bushed, roots of trees, plants, rubbish etc. top soil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by the Engineer. The Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

9.4 FILLING IN PITS AND TRENCHES AROUND FOUNDATIONS OF STRUCTURES, WALLS ETC.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm., each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to achieve 90% proctor density to the satisfaction of the Engineer. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to proper profile as directed by the Engineer or indicated on the drawings.

9.5 PLINTH FILLING

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15 cm, watered and compacted with mechanical compaction machines. The Engineer may however permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage. The finished level of the filling shall be trimmed to the level/ slope specified.

Where specified in the schedule of works, compaction of the plinth fill shall be carried out by means of 12 tonne rollers smooth wheeled,

sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer. As rolling proceeds water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

The thickness of each unconsolidated fill layer can in this case be upto a maximum of 300 mm. The Engineer will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of the Engineer, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

At some locations/ areas it may not be possible to use rollers because of space restrictions etc. The Contractor shall then be permitted to use pneumatic tampers, rammers etc. and he shall ensure proper compaction.

9.6 SAND FILLING IN PLINTH AND OTHER PLACES

At places backfilling shall be carried out with local sand if directed by the Engineer. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

9.7 FILLING IN TRENCHES

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centreline of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centreline of the pipe shall be

done with selected earth by hand compaction or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling upto a level 30 cm. above the top of the pipe shall be done with fine materials, such as earth, murrum etc. The filling up of the level of the centreline of the pipe shall be done by hand compaction in layers not exceeding 8 cm. whereas the filling above the centreline of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm. above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

10. GENERAL SITE GRADING

10.1 Site grading shall be carried out as indicated in the drawings and as directed by the Engineer. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under Clause 9.0 and elsewhere unless otherwise indicated below.

10.2 If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 9.4 before the next layer is deposited.

10.3 To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor at his cost.

10.4 Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

10.5 The Contractor shall protect the earthfill from being washed away by rain damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.

10.6 The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

10.7 If specifically permitted by the Engineer, compaction can be obtained by allowing loaded trucks conveying fill or other material to ply over the fill area. Even if such a method is permitted, it will be for the

Contractor to demonstrate that the desired/ specified compaction has been obtained. In order that the fill may be reasonably uniform throughout, the material should be dumped in place in approximately uniform layers. Traffic over the fill shall then be so routed to compact the area uniformly throughout.

10.8 If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

11. FILL DENSITY

11.1 The compaction, only where so called for, in the schedule of quantities/ items shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. The Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

1.0 SCOPE

This specification covers the general requirements of timber shoring for excavation of trenches, pits, open excavations etc.

2.0 Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as directed by Engineer. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walings of strong wood at maximum 1.2 metres spacings, strutted with ballies or as directed by Engineer. The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

2.1 Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by Engineer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc., from collapsing.

2.2 Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from Engineer.

2.3 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 with 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.

2.4 In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacings shall be subject to the approval of Engineer. In all other respects, specification for close timbering shall apply to open timbering.

2.5 In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking for sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. Load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut

1. SCOPE

This specification covers the general requirements of dewatering excavations in general.

2.1. All excavations shall be kept free of water. Grading in the vicinity of excavation shall be properly closed to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations / trenches required for further work. Method of pumping shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

2.2. When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of Engineer, as large, well point system - Single stage or multi stage, shall be adopted. Contractor shall submit to Engineer his scheme of well point system including the stages, the spacing, number and diameter of well points, headers etc., and the numbers, capacity and location of pumps of approvals.

2.3. The coal handling system includes construction of deep under ground structure which will involve heavy dewatering during the construction. The coal handling system being turnkey job, shall include the cost of dewatering maintaining the level of water 1.0 m below the bottom of foundation level during the construction and disposal of water at the location to be decided by the ENGINEER.

1. SCOPE

This section covers the drainage of rain and surface water in excavated areas.

2. Grading in the vicinity of excavation shall be such as to exclude rain / surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same at no extra cost to the owner. The scheme for pumping and discharge of such water shall be approved by the Engineer.

1.0 SCOPE

1.1 This specification covers the general requirements for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting as well as mode of measurement and payment for completed works

1.2 It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices or as directed by ENGINEER from time to time. The decision of ENGINEER as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever will be entertained on this account.

2.0 APPLICABLE CODES AND SPECIFICATIONS

2.1 The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

2.2 MATERIALS

1 IS.269 Specification for 33 grade ordinary portland cement.

2 IS.455 Specification for portland slag cement.

3 IS.1489 (Part 1&2) Specification for portland-pozzolana cement.

4 IS: 8112 Specification for 43 grade ordinary portland cement.

5 IS:12269 Specification for 53 grade ordinary Portland Cement.

6 IS:12330 Specification for sulphate resisting Portland Cement.

7 IS:383 Specification for coarse and fine aggregates from natural sources for concrete.

8 IS:432 (Parts 1 & 2) Specification for mild steel and medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

9 IS:1786 Specification for high strength deformed steel bars and wires for concrete reinforcement.

10 IS:1566 Specification for hard-drawn steel wire fabric for concrete reinforcement.

11 IS:9103 Specification for admixtures for concrete.

12 IS:2645 Specification for integral cement water- proofing compounds.

13 IS:4990 Specification for plywood for concrete shuttering work.

2.3 MATERIAL TESTING

1 IS:4031 (Parts 1 to 15) Methods of physical tests for hydraulic cement.

2 IS:4032 Method chemical analysis of hydraulic cement.

3 IS:650 Specification for standard sand for testing of cement.

4 IS:2430 Methods for sampling of aggregates for concrete.

5 IS.2386 (Parts 1 to 8) Methods of test for aggregates for concrete.

6 IS:3025 Methods of sampling and test (physical and chemical) water used in industry.

7 IS:6925 Methods of test for determination of water soluble chlorides in concrete admixtures.

2.4 MATERIAL STORAGE

1 IS:4082 Recommendations on stacking and storing of construction materials at site.

2.5 CONCRETE MIX DESIGN

1 IS:10262 Recommended guidelines for concrete mix design.

2 SP:23 (S&T) Handbook on Concrete Mixes.

2.6 CONCRETE TESTING

1 IS.1199 Method of sampling and analysis of concrete.

2 IS:516 Method of test for strength of concrete.

3 IS:9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.

4 IS:8142 Method of test for determining setting time of concrete by penetration resistance.

5 IS:9284 Method of test for abrasion resistance of concrete.

6 IS:2770 Methods of testing bond in reinforced concrete.

2.7 EQUIPMENT

1 IS:1791 Specification for batch type concrete mixers.

2 IS:2438 Specification for roller pan mixer.

3 IS:4925 Specification for concrete batching and mixing plant.

4 IS:5892 Specification for concrete transit mixers and agitator.

5 IS:7242 Specification for concrete spreaders.

6 IS:2505 General Requirements for concrete vibrators: Immersion type.

7 IS:2506 General Requirements for screed board concrete vibrators.

8 IS:2514 Specification for concrete vibrating tables.

9 IS:3366 Specification for pan vibrators.

10 IS:4656 Specification for form vibrators for concrete.

11 IS:11993 Code of practice for use of screed board concrete vibrators.

12 IS:7251 Specification for concrete finishers.

13 IS:2722 Specification for portable swing weigh batchers for concrete (single and double bucket type).

14 IS:2750 Specification for steel scaffoldings.

2.8 CODES OF PRACTICE

1 IS:456 Code of practice for plain and reinforced concrete.

2 IS:457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.

3 IS:3370 (Parts 1 to 4) Code of practice for concrete structures for storage of liquids.

4 IS:3935 Code of practice for composite construction.

5 IS:2204 Code of practice for construction of reinforced concrete shell roof.

6 IS:2210 Criteria for the design of reinforced concrete shell structures and folded plates.

7 IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement.

8 IS:5525 Recommendation for detailing of reinforcement in reinforced concrete works.

9 IS:2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.

10 IS:9417 Specification for welding cold worked bars for reinforced concrete construction.

11 IS:3558 Code of practice for use of immersion vibrators for consolidating concrete.

12 IS:3414 Code of practice for design and installation of joints in buildings.

13 IS:4326 Code of practice for earthquake resistant design and construction of building.

14 IS:4014 (Parts 1 & 2) Code of practice for steel tubular, scaffolding.

15 IS:2571 Code of practice for laying insitu cement concrete flooring.

16 IS:7861 Code of practice for extreme weather concreting.

Part 1 Recommended practice for hot weather concreting.

Part 2 Recommended practice for cold weather concreting.

2.9 CONSTRUCTION SAFETY

1 IS.3696 (Parts 1& 2) Safety code for scaffolds and ladders.

2 IS:7969 Safety code for handling and storage of building materials.

3 IS:8989 Safety code for erection of concrete framed structures.

3.0 GENERAL

3.1 ENGINEER shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and ENGINEER's approval obtained, prior to starting of concrete work. This shall, however, not relieve CONTRACTOR of any of his responsibilities. All materials, which do not conform to this specification, shall be rejected.

3.2 Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the ENGINEER and after establishing their performance suitability based on previous data, experience or tests.

4.0 MATERIALS

4.1 CEMENT
Cement shall be supplied by the OWNER at the rate specified in SECTION-F.

4.1.1 Unless otherwise called for by ENGINEER/OWNER, cement shall be ordinary portland cement conforming to IS:269, IS:8112 or IS:12269.

4.2 AGGREGATES (GENERAL)

4.2.1 Aggregates for use in concrete works confirming to grading as per IS:383 shall be used.

Sand for lean concrete, plastering, brick masonry, flooring work shall confirm to IS codes having FM 1.56.

Sand for filling shall be from near by location/pits as approved by ENGINEER.

4.2.2 Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform to IS:383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

4.2.3 Aggregates for special purposes shall be as specified by ENGINEER/OWNER

4.2.4 Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER.

4.2.5 Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse affect on strength, durability and finish, including long term effects, on the concrete.

4.2.6 The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

4.2.7 The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 1/4 of the minimum thickness of the member.

4.2.8 Plums 160 mm and above of a reasonable size may be used where directed. Plums shall not constitute more than 20% by volume of the concrete.

4.3 WATER

4.3.1 Water used for both mixing and curing shall conform to IS:456. Potable waters are generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

4.4 REINFORCEMENT

4.4.1 Reinforcement bars shall conform to IS:432 or IS:1786 and welded wire fabric to IS:1566 as shown or specified on the drawing.

4.4.2 All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirty, dust, or any other substance that will destroy or reduce bond.

4.4.3 If permitted by ENGINEER, welding of reinforcement shall be done in accordance with IS:2751 or IS:9417 as applicable.

4.5 ADMIXTURES

4.5.1 Accelerating, retarding, water-reducing and air entraining admixtures shall conform to IS:9103 and integral water proofing admixtures to IS:2645.

4.5.2 Admixtures may be used in concrete as per manufacturer's instructions only with the approval of ENGINEER based upon evidence that with the passage of time neither the compressive strength nor its durability is reduced. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trail mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedments.

4.5.3 Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

5.0 SAMPLES AND TESTS

5.1 All materials used for the works shall be tested before use.

5.2 Manufacturer's test certificate shall be furnished, for each batch of cement/steel and when directed by ENGINEER samples shall also be got tested by the CONTRACTOR in a laboratory approved by ENGINEER at no extra cost to OWNER. However, where material is supplied by OWNER, all testing charges shall be borne by OWNER, but transportation of material samples to the laboratory shall have to be done by CONTRACTOR at no extra cost.

5.3 Sampling and testing shall be as per IS:2386 under the supervision of ENGINEER. The cost of all tests, sampling etc. shall be borne by CONTRACTOR.

5.4 Water to be used shall be tested to comply with requirements of IS:456.

5.5 CONTRACTOR shall furnish manufacturer's test certificates and technical literature for the admixture proposed to used. If directed the admixture shall be got tested at an approved laboratory at no extra cost.

6.0 STORING OF MATERIALS

6.1 All material shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS:4082 shall be complied with.

6.2 CONTRACTOR will have to make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by OWNER. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cost of such rejected cement, where cement is supplied by OWNER, shall be recovered as specified in General Conditions of Contract. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 10 bags shall be stacked in any tier. Storage arrangement shall be approved by ENGINEER. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

6.3 Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

6.4 CONTRACTOR shall make his own arrangements for storing water at site in tanks to prevent contamination.

6.5 The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/water. Each type and size shall be stacked separately.

7.0 CONCRETE

7.1 GENERAL

7.1.1 Concrete grade shall be as designated on drawings. In concrete grade M15, M20 etc. the number represents the specified characteristics compressive strength of 150 mm cube at 28 days, expressed in N/sq.mm as per IS:456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M5, M7.5 and M10 shall be NOMINAL MIX CONCRETE whereas all other grades, M15 and above, shall be DESIGN MIX CONCRETE.

7.2 DESIGN MIX CONCRETE

7.2.1 Mix Design & Testing

7.2.1.1 For Design Mix Concrete, the mix shall be designed according to IS:10262 and SP:23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS:456. The design mix shall in addition to such that it is cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in water tight concrete. The CONTRACTOR shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

7.2.1.2 Unless otherwise specifically by ENGINEER/OWNER the minimum cement content for Design Mix Concrete shall be as per Appendix-A of IS:456 or as given below, whichever is higher.

Grade of Concrete	Minimum Cement Content in Kg/Cu.m of Concrete
M15	300
M20	340
M25	360

The minimum cement content stipulated above shall be adopted irrespective of whether the CONTRACTOR achieves the desired strength with less quantity of cement. The CONTRACTOR's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR on this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

7.2.1.3 It shall be CONTRACTOR's sole responsibility to carry out the mix designs at his own cost. He shall furnish to ENGINEER at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456.

Grade of concrete	Minimum Compressive strength N/Sq.mm at 7 days	Specified Characteristic compressive strength N/Sq.mm at 28 days
M 15	10.0	15.0

M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

7.2.1.4 A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the ENGINEER is given below

Structure/Member	Slump in millimeters	
	Maximum	Minimum
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	75	25
T.G. and massive compressor foundations	50	25
Slabs, Beams and reinforced walls	100	25
Pump & miscellaneous Equipment Foundations	75	25
Building columns	100	25
Pavements	50	25
Heavy mass construction	50	25

7.2.2 Batching & Mixing of Concrete

7.2.2.1 Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

7.2.2.2 Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by ENGINEER shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

7.2.2.3 Arrangement should be made by CONTRACTOR to have the cubes tested in an approved laboratory or in field at his own expense, with prior consent of

ENGINEER. Sampling and testing of strength and workability of concrete shall be as per IS:1199, IS:516 and IS:456.

7.3 NOMINAL MIX CONCRETE

7.3.1 Mix Design & Testing

7.3.1.1 Mix design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS:456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 3 of IS:456. However it will be CONTRACTOR's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

7.3.2 Batching & Mixing of Concrete

7.3.2.1 Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only.

8.0 FORMWORK

8.1 Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedges etc.

8.2 The design and engineering of the formwork as well as its construction shall be the responsibility of CONTRACTOR. However, if so desired by ENGINEER the drawings and calculations for the design of the formwork shall be submitted to ENGINEER for approval.

8.3 Formwork shall be designed to fulfill the following requirements :

a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

b) Made of suitable materials.

c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limit.

d) Capable of withstanding without deflection the worst combination of selfweight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.

e) Capable of easily striking without shock, disturbance or damage to the concrete.

f) Soffit forms capable of imparting a camber if required.

g) Soffit forms and supports capable of being left in position if required.

h) Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

8.4 The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of ENGINEER. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

8.5 The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

8.6 Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of ENGINEER. CONTRACTOR shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

8.7 Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

8.8 Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

8.9 For liquid retaining structures sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

8.10 Where specified or shown on drawings all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

8.11 Forms for substructure may be omitted when, in the opinion of ENGINEER, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be slightly larger, as directed by ENGINEER, than that required as per drawing to compensate for irregularities in excavation.

8.12 CONTRACTOR shall provide adequate props carried down to a firm bearing without overloading any of the structures.

8.13 The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as directed by ENGINEER. CONTRACTOR shall temporarily and securely fix items to be cast in (embedments/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

8.14 Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at CONTRACTOR's cost.

8.15 The striking time for formwork shall be determined based on the following requirements :

a) Development of adequate concrete strength;

b) Permissible deflection at time of striking form work;

c) Curing procedure employed - its efficiency and effectiveness;

d) Subsequent surface treatment to be done;

e) Prevention of thermal cracking at re-entrant angles;

f) Ambient temperatures; and

g) aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

8.16 Under normal circumstances (generally where temperatures are above 20 Deg.C) forms may be struck after expiry of the time period given in IS:456 unless directed other- wise by ENGINEER. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as directed by the ENGINEER. It is the CONTRACTOR'S responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

9.0 REINFORCEMENT WORKMANSHIP

9.1 Reinforcing bars supplied bent or in coils shall be straightened cold without damage at no extra cost. No bending shall be done when ambient temperature is below 5 Deg.C. Local warming may be permitted if steel is kept below 100 Deg.C.

9.2 All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by ENGINEER.

9.3 Re-bending or straightening incorrectly bent bars shall not be done without approval of ENGINEER.

9.4 Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied inplace reinforcement shall be approved by ENGINEER prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

9.5 Binding wire shall be 16 gauge soft annealed wire. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover. 9.6 Substitution of reinforcement, laps/splices not shown on drawing shall be subject to ENGINEER's approval.

10.0 TOLERANCES

10.1 Tolerance for formed and concrete dimensions shall be as per IS:456 unless specified otherwise.

10.2 Tolerances specified for horizontal or vertical building lines or footings shall not be constructed to permit encroachment beyond the legal boundaries.

11.0 PREPARATION PRIOR TO CONCRETE PLACEMENT

11.1 Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

11.2 All arrangements-formwork, equipment and proposed procedure, shall be approved by ENGINEER. CONTRACTOR shall maintain separate Pour Card for each pour as per the format enclosed.

12.0 TRANSPORTING, PLACING AND COMPACTING CONCRETE

12.1 Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

12.2 In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms CONTRACTOR shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m as stipulated in clause 8.13.

12.3 Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

12.4 While placing concrete the CONTRACTOR shall proceed as specified below and also ensure the following :

a) Continuously between construction joints and predetermined abutments.

b) Without disturbance to forms or reinforcement.

c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.

d) Without dropping in a manner that could cause segregation or shock.

e) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.

f) Do not place if the workability is such that full compaction cannot be achieved.

g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.

h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.

i) Ensure that there is no damage or displacement to sheet membranes.

j) Record the time and location of placing structural concrete.

12.5 Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration shall be avoided.

12.6 Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by ENGINEER. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

12.7 Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes

initial set but not until it has had time to settle as determined by ENGINEER. Concrete shall be protected against damage until final acceptance.

13.0 MASS CONCRETE WORKS

13.1 Sequence of pouring for mass concrete works shall be as approved by ENGINEER. CONTRACTOR shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

14.0 CURING

14.1 Curing and protection shall start immediately after the compaction of the concrete to protect it from :

a) Premature drying out, particularly by solar radiation and wind;

b) leaching out by rain and flowing water;

c) rapid cooling during the first few days after placing;

d) high internal thermal gradients;

e) low temperature or frost;

f) vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

14.2 All concrete, unless directed otherwise by ENGINEER, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessain or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

14.3 Where a curing membrane is directed to be used by the ENGINEER, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be got approved from the ENGINEER before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

14.4 Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

14.5 Extra precautions shall be exercised in curing concrete during cold and hot weather.

15.0 CONSTRUCTION JOINTS AND KEYS

15.1 Construction joints will be as shown on the drawing or as approved by ENGINEER. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of ENGINEER.

15.2 Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as directed by ENGINEER.

15.3 Before resuming concreting on a surface which has hardened all laitance and loose stone shall be thoroughly removed by wire brushing/hacking and surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and a 15mm thick layer of cement sand mortar for horizontal layers, the ratio of cement and sand being the same as in the concrete mix.

15.4 When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

16.0 FOUNDATION BEDDING

16.1 All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy area shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as directed by ENGINEER. The surfaces of absorptive soils shall be moistened.

16.2 Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

17.0 FINISHES

17.1 GENERAL

17.1.1 The formwork for concrete works shall be such as to give the finish as specified. The CONTRACTOR shall make good any unavoidable defects as directed consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. CONTRACTOR shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

17.2 Surface Finish Type F1

17.2.1 This type of finish shall be for non-exposed concrete surfaces against which back fill or concrete is to be placed. The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

17.3 Surface Finish Type F2

17.3.1 This type of finish shall be for all concrete work which will be exposed to view upon completion of the job. The appearance shall be that of a smooth dense, well- compacted concrete showing the slight marks of well fitted shuttering joints. The CONTRACTOR shall make good any blemishes.

17.4 Surface Finish Type F3

17.4.1 This type of finish shall be for concrete work which will be exposed to view but to give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discolouration, blemishes, arrises, airholes etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by CONTRACTOR.

17.5 INTEGRAL CEMENT FINISH ON CONCRETE FLOOR

17.5.1 In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on

the surface. Where specified, a floor hardener as approved by the ENGINEER shall be supplied and used as recommended by the manufacturer.

18.0 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

18.1 Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc. shall be brought to the notice of ENGINEER who may permit patching of the defective areas or reject the concrete work.

18.2 All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

18.3 Rejected concrete shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.

18.4 For patching of defective areas all loose materials shall be removed and the surface shall be prepared as directed by the ENGINEER.

18.5 Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the ENGINEER as to the method of repairs to be adopted shall be final and binding on the CONTRACTOR and no extra claim shall be entertained on this account. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by ENGINEER.

19.0 VACUUM DEWATERING OF SLABS

19.1 Where specified floor slabs, either or grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturers recommendation. The equipment to be used shall be subject to ENGINEER's approval.

20.0 HOT WEATHER REQUIREMENTS

20.1 Concreting during hot weather shall be carried out as per IS:7861 (Part I).

20.2 Adequate provisions like pre-cooling of aggregates, use of ice etc, shall be made to lower concrete temperature which shall not exceed 40°C at the time of placement of fresh concrete.

20.3 Where directed by ENGINEER, CONTRACTOR shall spray non- wax based curing compound on unformed concrete surfaces at no extra costs.

21.0 COLD WEATHER REQUIREMENTS

21.1 Concreting during cold weather shall be carried out as per IS:7861 (Part 2)

21.2 The ambient temperature during placement and upto final set shall not fall below 5 Deg C. Approved anti- freeze/accelerating additives shall be used where directed.

21.3 For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

22.0 LIQUID RETAINING STRUCTURES

22.1 The CONTRACTOR shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.

22.2 The minimum level of surface finish for liquid retaining structures shall be Type F2. All such structures shall be hydro-tested.

22.3 The CONTRACTOR shall include in his price of hydro- testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

22.4 Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

22.5 Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the ENGINEER. All such rectification shall be done by the CONTRACTOR to the entire satisfaction of the OWNER/ENGINEER at no extra cost to the OWNER.

22.6 All construction materials brought to the site shall be used only after getting the approval of ENGINEER-IN-CHARGE of testing laboratory.

23.0 TESTING CONCRETE STRUCTURES FOR LEAKAGE

23.1 Hydrostatic test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by ENGINEER, as described below :
a) In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

b) In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the watertightness of the structure. The ENGINEER shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

c) Each compartment/segment of the structure shall be tested individually and then all together.

23.2 For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

24.0 OPTIONAL TESTS

24.1 If the ENGINEER feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the ENGINEER, as per relevant IS Codes. OWNER shall pay only for the testing of material supplied by the OWNER, otherwise CONTRACTOR shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the CONTRACTOR at no extra cost to OWNER.

24.2 In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths,

ENGINEER reserves the right to order the CONTRACTOR to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. All these tests shall be carried out by CONTRACTOR at no extra cost to the OWNER. Alternately ENGINEER also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

24.3 If the structure is certified by ENGINEER as having failed, the cost of the test and subsequent dismantling/ reconstruction shall be borne by CONTRACTOR.

25.0 GROUTING

25.1 Grout shall be provided as specified on the drawings. The proportion of Standard Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting water in all pockets shall be removed. Grouting once started shall be done quickly and continuously. Variation in grout mixes and procedures shall be permitted if approved by ENGINEER. The grout proportions shall be limited as follows:

Use	Grout Thickness	Mix Proportions	W/C Ratio (max)
a) Fluid mix	Under 25 mm	One part Portland cement to one part sand.	0.44
b) General mix	25 mm and over but less than 50 mm	One part Portland Cement to 2 parts of sand.	0.53
c) Stiff mix	50 mm and over	One part Portland Cement to 3 parts of sand.	0.53

25.2 NON-SHRINK GROUT

25.2.1 Non-shrink grout where called for in the Schedule of Quantities or specified on the drawings shall be provided in strict accordance with the manufacturer's instructions/specifications on the drawings.

26.0 INSPECTION

26.1 All materials, workmanship and finished construction shall be subject to continuous inspection and approval of ENGINEER. Materials rejected by ENGINEER shall be expressly removed from site and shall be replaced by CONTRACTOR immediately at no extra cost to OWNER.

27.0 CLEAN-UP

27.1 Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

28.0 ACCEPTANCE CRITERIA

28.1 Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

a) properties of constituent materials;

b) characteristic compressive strength;

c) specified mix proportions;

d) minimum cement content;

e) maximum free-water/cement ratio;

f) workability;

g) temperature of fresh concrete;

h) density of fully compacted concrete;

i) cover to embedded steel;

j) curing;

k) tolerances in dimensions;

l) tolerances in levels;

m) durability;

n) surface finishes;

o) special requirements such as;
- i) water tightness;
- ii) resistance to aggressive chemicals
- iii) resistance to freezing and thawing
- iv) very high strength
- v) improved fire resistance
- vi) wear resistance
- vii) resistance to early thermal cracking

28.2 The ENGINEER's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the CONTRACTOR.

28.3 For work not accepted, the ENGINEER may review and decide whether remedial measures are feasible so as to render the work acceptable. The ENGINEER shall in that case direct the CONTRACTOR to undertake and execute the remedial measures. These shall be expeditiously and effectively implemented by the CONTRACTOR. Nothing extra shall become payable to the CONTRACTOR by the OWNER for executing the remedial measures.

CONCRETE POUR CARD

CLIENT: DATE: POUR NO
PROJECT: STRUCTURE:
CONTRACTOR: MAX AGGREGATE SIZE/SLUMP: MM/ MM
DRG. NO.: START/COMPLETION TIME: /
CONCRETE GRADE/QUANTITY: M / m^3 MIXING TIME:

SL. NO.		ITEM		CONTRACTOR'S REP. SIGNATURE	ENGINEER'S SIGNATURE	REMARKS
1	BEFORE CONCRETING	CENTERLINES CHECKED				
2		FORMWORK AND STAGING CHECKED FOR ACCURACY, STRENGTH & FINISH				
3		REINFORCEMENT CHECKED				
4		COVER TO REINFORCEMENT CHECKED				
5		VERIFIED TEST CERTIFICATE FOR CEMENT/STEEL		YES/NO	YES/NO	
6		ADEQUACY OF MATERIALS/EQUIPMENT FOR POUR		YES/NO	YES./NO	
7		EMBEDDED PARTS CHECKED (LOCATION AND PLUMB)	CIVIL			
			MECHANICAL			
			ELECTRICAL			

POUR AUTHORISED SITE ENGINEER

8		SOFFIT(S) AND POUR TOP(T) LEVELS CHECKED BEFORE(B) AND AFTER(A) FORM REMOVAL (ONLY OF OVER 10M SPAN AND IMPORTANT STRUCTURES LIKE T.G. ETC.)	S(B) T(B) S(A) T(A)		
9		CONSTRUCTION JOINT LOCATION AND TIME (IF NOT AS PER DRAWING)			
10		CEMENT CONSUMPTION IN KGS			
11		NUMBER OF CUBES AND IDENTIFICATION BANKS			
12		TEST CUBE RESULTS (7 DAYS / 28 DAYS)	/		
13		CONCRETE CONDITION ON FORM REMOVAL	V. GOOD / GOOD / FAIR		

SITE-IN-CHARGE

NOTES:

1. EACH ITEM TO BE CHECKED & SIGNED BY THE RESPECTIVE ENGINEER/SITE-IN-CHARGE.
2. ITEMS 8 TO 13 (BOTH INCLUSIVE) TO BE FILLED BY ONLY ENGINEER.
3. EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE ONE EACH FOR CLIENT, TCE & SITE OFFICE.
4. UNDER REMARKS INDICATE DEVIATIONS FROM DWGS. & SPECIFICATIONS, CONGESTION IN REINFORCEMENT.

IF ANY, UNUSUAL OCCURENCES, SUCH AS FAILURE OF EQUIPMENTS, SINKING OF SUPPORTS/PROPS. HEAVY RAINS AFFECTING CONCRETING, POOR COMPACTION, IMPROPER CURING, OTHER DEFFICIENCES, OBSERVATIONS ETC.

1.0 SCOPE

1.1 This specification covers the general requirements for supplying and laying of water supply pipe line with necessary fittings and fixtures for buildings/structures tapping off from potable water supply distribution system, supplying and laying sewage pipe line with disposal works including provision of all fittings and fixtures of sanitary works and such other related items of work forming a part of the job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labour, materials, and any and everything necessary for satisfactorily carrying out the work.

2.0 APPLICABLE CODES

2.1 The following standards and codes are made a part of this specification. All standards, codes of practice referred to herein shall be the latest editions including all official amendments and revisions.

1. IS.458 : Concrete Pipes (with and without reinforcement).
2. IS.554 : Dimensions for pipe threads where pressure tight joints are required on the threads.
3. IS.651 : Salt glazed stoneware pipes and fittings.
4. IS.774 : Flushing Cisterns for water closets and urinals (valveless siphonic type)
5. IS.775 : Cast iron brackets and supports for wash basins and sinks.
6. IS.781 : Sand-cast brass screw-down bib taps and stop taps for water services.
7. IS.783 : Code of practice for laying of concrete pipes.
8. IS.1068 : Electroplated coatings of nickel and chromium on iron and steel.

9. IS.1239 : Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II).

10. IS.1536 : Centrifugally cast (spun) iron pressurepipes for water, gas and sewage.

11. IS.1626 : Asbestos cement building pipes, gutters and fittings (spigot and socket types).

12. IS.1703 : Ball valves (horizontal plunger type) including floats for water supply purposes.

13. IS.1726 : Cast iron manhole covers and frames.

14. IS.1729 : Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

15. IS.1742 : Code of practice for buildings drainage.

16. IS.2326 : Automatic flushing cisterns for urinals.

17. IS.2470 : Code of practice for design and construction of septic tanks.

18. IS.2556 : Vitreous sanitary appliances (Part I to Part XV)

19. IS.2963 : Non-ferrous waster fittings for wash basins and sinks.

20. IS.3311 : Waste plug and its accessories for sinks and wash basins.

21. IS.5329 : Code of practice for sanitary pipe work above ground for buildings.

22. IS.5434 : Non-ferrous alloy bottle traps for marine use.

3.0 DRAWINGS

3.1 Drawings released for construction showing locations of sanitary and water supply fixtures will be furnished to the CONTRACTOR and drawings so furnished shall form a part of this specification. Drawing will also furnish the details of one or more supply points outside the building for the water supply system and disposal point/ scheme for sanitary works. The CONTRACTOR shall refer to these drawings for all information contained therein which pertains to details as required for this work. CONTRACTOR shall submit to OWNER/ENGINEER for his approval, detailed working drawings showing layout of water supply and sanitary works with necessary fittings and fixtures before the actual construction is undertaken.

3.2 All civil works will be measured and paid under respective items of work.

4.0 SANITARY INSTALLATION

4.1 The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Owner/ Engineer. No extra payment shall be made for such work except when there is any item specifically included for such work in schedule.

4.2 Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor

4.3 All sanitary and plumbing work shall be carried out by licensed plumbers.

4.4 On completion of the work, the site shall be cleaned and disposed of all debris as directed by the Engineer.

4.5 All sanitary appliances including sanitary fittings, fixtures, toilet requisites shall be of size, and design as specified in the item of work and as per sample approved by the Engineer.

4.6 All sanitary fittings and fixtures shall be acceptable to the Owner/Engineer and if there are any variations, they shall satisfy the permissible tolerances in dimensions/slope/ contour as specified in relevant IS codes/ standards.

4.7 All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, `P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks, indentations, or other glazing

defects. No chipped porcelain fixtures shall be used. Joints between iron and earthenware pipes shall be made perfectly air and water tight by caulking with neat cement mortar.

4.8 INDIAN TYPE WATER CLOSET (W.C.)

This shall be the long pan pattern with separate footrests made of white glazed earthenware, white glazed vitreous china or of white glazed fire clayThe general requirements shall conform to IS.2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weephole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified or ordered by the Engineer. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap `P' or `S' type with a minimum 50 mm water seal and 50 mm dia. vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1 part lime mortar to 2 parts brick bats with lime mortar of 1 part lime to 2 parts of sand) or cement-sand admixture as specified in the drawings.

4.9 EUROPEAN TYPE WATER CLOSET (W.C)

Water closets shall be either of white glazed earthenware, white glazed vitreous china or white glazed fire clay as specified and shall be of "Siphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one piece construction with approved plastic/bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weephole at the flushing inlet. Each water closet shall have an integral trap with either "S" or "P" outlet with at least 50 mm water seal. The water closets shall have an antisiphonage 50 mm dia. vent horn on the outlet side of the trap. The inside surface of water closets and traps shall be uniform and smooth in order to ensure in efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed.

4.10 URINALS

Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay, and of size as specified conforming to IS.2556 (Part VI). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. It shall have a weephole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the outlet pipe. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

4.11 WASH BASINS

a) Wash basins shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as specified and conforming to IS.2556

Type	Size
Flat Back	630 x 450 mm
Flat Back	550 x 400 mm

b) Wash basins shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each basin shall have a rim sloping inside towards the bowl on all sides except sides on contact with the walls and shall have skirting at the back. Basins shall be provided with single or double tap holes as specified. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or bevelled internally with diameter of 65 mm at top and a depth of 10 mm to suit a waste plug having 64 mm diameter. Each basin shall be provided with a non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the

under side of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not less than 5 sq.cm. shall be provided and shall be so designed as to facilitate cleaning of the overflow. The specifications for waste plug, chain and stay shall be the same as given for sinks.

(c) All the waste fittings shall be chromium plated. Bottle trap shall conform to IS. 5434. The chromium plating shall be of service grade No. 2 conforming to IS.1068.

4.12 SINKS

a) The sinks shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as specified conforming to IS.2556 (Part V) and shall be of the following sizes :

450 x 300 x 150 mm
600 x 450 x 200 mm

b) They shall be of one piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flange of 64 mm diameter and the waste hole shall have a minimum diameter of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or bevelled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tight when fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not less than 300 mm. There shall be a triangular or D shackle at each end, one of which shall be brazed to the plug and the other securely fixed to the stay. The 150 mm long shank of the waste shall be threaded conforming to the requirements of IS.2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS.1068.

4 13 FLUSHING CISTERNS

The flushing cisterns shall be automatic or manually operated, high level or low level, as specified. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low level cistern a maximum height of 30 cm between the top of the pan and the underside of the cistern. They shall be of cast iron, glazed earthenware, or pressed steel complying with the requirement of IS.774. Automatic flushing cistern for urinals shall conform to IS.2326.

5.0 CAST IRON SOIL, WASTE AND VENT PIPES AND FITTINGS

5.1 All cast iron pipes and fittings shall be of uniform thickness with strong and deep sockets, free from flaws, air holes, cracks, sand holes and other defects and conform to IS.1536. The diameter specified shall be internal diameter of pipe. The pipes and fittings shall be true to shape, smooth and cylindrical and shall ring clearly when struck over with a light hand hammer. All pipes and fittings shall be properly cleaned of all foreign material before being fixed.

5.2 All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers, which shall be fixed with nuts and screws. Pipes shall be fixed to the wall by W.I. or M.S. holder bat clamps, unless projecting ears with fixing holes are provided at socket end of pipe. The pipes shall be installed, truly vertical or to the lines and slopes as indicated. The clamps shall be fixed to the walls by embedding their hooks in cement concrete blocks (1:2:4) 10 cm x 10 cm making necessary holes in the walls at proper places. All holes and breakages shall be made good. The clamps shall be kept 25 mm clear of the finished face of the walls to facilitate cleaning and painting of pipes.

5.3 The annular space between the socket and spigot shall be filled with a gasket of hemp or spun yarn soaked in neat cement slurry. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tool and finished smooth on top at an angle of 45 ø. The joint shall be kept wet for not less then 7 days by tying a piece of gunny bag kept moist. Joints shall be perfectly air tight as well as water tight.

5.4 C.I. pipes and fittings which are exposed shall be first cleaned and then painted with a coat of red lead primer. Two coats of zinc paint with white base and mixed with pigment of required colour to get the approved shade shall be given over the base primer coat.

5.5 The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes.

5.6 The connection between the main pipe and branch pipes shall be made by using branches and bends with access for cleaning. Floor traps shall be provided with 25 mm dia. puff pipe where the length of the waste is more than 1800 mm or the floor trap is connected to a waste stack through bends.

5.7 C.I. pipes shall be measured along the centre lines of pipes including fittings such as branches, plug, bends, etc.

5.8 All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Engineer and left in working condition after completion. The smoke test shall be carried out as stated under :

Smoke shall be pumped into the pipe at the lowest and from a smoke machine which consists of a bellow and a burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell if there is a leak at any point of the pipeline.

5.9 Water test and air test shall be conducted as stipulated in IS.5329.

6.0 ASBESTOS CEMENT PIPES AND FITTINGS

6.1 All A.C. soil, waste, vent pipes, and fittings shall conform to IS.1626. The pipes shall have spigot and socket ends. These shall be composed of an inert aggregate consisting of clean asbestos fibre cemented together by ordinary portland cement conforming to IS.269, or portland blast furnace slag cement conforming to IS.455. No organic material shall be added to the composition.

6.2 The pipes shall be straight and the ends of the pipes and fittings shall be finished square to their axes. The finished pipes and fittings shall be true and smooth, their inner and outer surfaces shall be concentric. They shall be in all respects sound, homogenous and free from impurities or other imperfections.

6.3 The permissible tolerance on the thickness and external dimensions of pipes and fittings including hydraulic test pressure of the pipes and fittings shall conform to IS.1626.

6.4 All AC pipes and fittings shall be of approved make and with necessary accessories, wherever required. The diameter wherever specified for pipes

and fittings shall be clear internal diameter. All gaps between pipes and fittings and walls shall be filled with cement mortar 1:3 neatly finished for which no extra cost will be paid. All pipes and fittings shall be supported with standard fixing brackets.

6.5 The annular space between the socket and spigot shall be filled with a gasket of hemp of spun yarn soaked in tar. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tools and finished smooth on top with neat cement paste at an angle of 45^0. The joint shall be kept wet for not less than 7 days by tying a piece of gunny bag kept moist. Joints shall perfectly air-tight as well as water-tight.

6.6 A.C. pipes shall be measured along the centre lines of pipes including fittings such as junctions, bends, etc.

6.7 Pipes and fittings shall be tested with a smoke test as specified in Clause 5.8.

7.0 **G.I. PIPES**

7.1 The pipes shall be galvanised mild steel welded pipes and seamless screwed and sockets tubes conforming to the requirements of IS.1239, for heavy grade. They shall of the diameter (nominal bore) specified in the description of the item. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanised on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

7.2 All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

7.3 The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as specified for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS.554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

7.4 a) The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded the ends shall be carefully

filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are crewed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for turning of the threads so as the make them slack, water tight joint. The screw-thread of pipes and fittings shall be protected from damage until they are fitted.

b) The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the pipe.The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter.

c) Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

7.5 a) For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried. Where directed by the Engineer, a M.S. pipe sleeve shall be fixed at a place where a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion/contraction and other movements/maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contract with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as directed by the Engineer.

b) G.I. pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS.3114.

7.6 a) The work of excavation and backfilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches for pipes laid underground.

b) The pipes shall be laid on a layer of 7.5 cm sand and filled upto 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. when excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.

7.7 The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as specified by the Engineer and shall satisfactorily pass the test. Pipe line system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped, the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking shall be removed and replaced by the Contractor without extra cost.

7.8 The G.I. pipe line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipes shall be threaded. The meter and stop cock shall be fixed in position by means of connecting pipe, G.I. nuts, sockets, etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipe line, the pipe line will have to be completely washed before fixing the meter. For this purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

7.9 The G.I. pipes with fittings completely fixed in position shall be measured and paid for based on the finished centre line lengths.

8.0 STONEWARE PIPES AND FITTINGS

8.1 All pipes with spigot and socket ends shall conform to IS.651 and shall be of grade `A' as specified. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters. The pipe shall be handled with sufficient care to avoid damage to them.

8.2 Pipes shall be laid to the correct grade and alignment shown in the plan/sections with their sockets up the gradient. Laying and jointing shall conform to the general requirements specified in IS.651.

8.3 Stoneware pipes used for sewers shall be subjected to a test pressure of 1.5 m head of water at the highest point of the section under test. The test shall be carried out suitably by plugging the low end of the drain and the ends of the connection if any and filling the system with water. A buckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. Where leakage will be visible the defective part of the work shall be removed and made good.

8.4 In measuring the length of sewer pipes, thick length between faces of manholes shall only be measured omitting lengths of channels between inside faces of walls of manholes or chambers.

9.0 STOP COCK AND BIB COCK

9.1 A bibcock (bibtap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to be chromium plated, the chromium plating shall be of service Grade No. 2 conforming to IS.1068. In finish and appearance, the plated articles shall be free from plating defects such as blisters, pits, roughness and shall not be stained or discoloured.

9.2 These fittings shall be of brass heavy class, chromium plated (C.P) and of approved manufacture and pattern with screwed of flanged ends as specified. The fittings shall in all respects comply with the requirements of IS.781. The standard size of brass fittings shall be designated by the nominal bore of the pipe to which the fittings are attached. A sample of each kind of fitting shall be got approved from the Engineer and all supplies made according to the approved samples.

9.3 All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the waterway of the fittings shall not be less than the area of the nominal bore.

9.4 The fittings shall be fully examined and cleared of all foreign matter before being fixed. The fittings shall be fitted in the pipe line in a workmanlike manner. The joints between fittings and pipes shall be made leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test specified by the Engineer and the defective fittings and joints shall be replaced or redone.

10.0 SOAK PIT

10.1 Soak pit shall be constructed as detailed in working drawings at the location as directed by the Engineer. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit upto 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level upto ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

11.0 MANHOLES

11.1 Manholes of types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer. The size specified indicate the inside dimensions of the manhole.

11.2 Excavation and backfilling shall be as per respective specifications.

11.3 Manhole shall be built on a bed of cement concrete 1:4:8 (1 cement : 4 sand : 8 graded stone aggregate of 40 mm nominal size). The thickness of the bed concrete shall be 23 cm unless otherwise specified or directed by the Engineer. In bad ground special foundation as suitable shall be provided.

11.4 Brick work shall be with first class country bricks in cement mortar 1:4 (1 cement : 4 sand). The external joints of the brick masonry shall be finished smooth. The joints of the pipes with the masonry shall be made perfectly leak-proof.

11.5 The brick walls of manholes shall be plastered inside with 13 mm thick cement plaster 1:2 (1 cement : 2 sand) finished smooth with a floating coat of neat cement.

11.6 Channels and benching shall be in cement concrete 1:2:4 (1 cement : 2 sand : 4 graded stone aggregate).

11.7 The depth of channels and benching shall be as indicated in the table given below :

Size of drain mm	Top of channel at the centre above bed concrete mm	Depth of benching at side wall above bed concrete mm
100	150	200
150	200	300
200	250	350
250	300	400
300	350	450
350	400	500
400	450	550
450	500	600

11.8 All manholes deeper than 0.8 m shall be provided with staggered M.S. rungs as specified in drawings. Rungs shall be painted with coal tar, the portion embedded in cement concrete block being painted with thick cement slurry before fixing.

11.9 C.I. manhole covers and frames shall conform to IS 1726. The covers and frames shall be neatly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All casting shall be free from voids whether due to shrinkage or other causes. Cover shall have a raised chequered design on the top surface to provide an adequate non-slip grip. The cover shall be capable of easy opening and closing and it shall be correctly fitted in the frame. The cover shall be gas tight and water tight. The cover shall be coated with black bituminous composition. It shall not flow when exposed to a temperature of 63^0C and shall not be brittle as to chip off at temperature of 0^0C.

11.10 The frame of the manhole cover shall be firmly embedded to correct alignment and levels in plain cement concrete 1:2:4 (1 cement : 2 sand : 4 graded stone aggregate) on top of the brick masonry. After completion of the work, manhole covers shall be smeared with thick grease.

11.11 Manhole cover and frame shall conform to "Medium Duty", 500 mm internal diameter and shall weigh not less than 116 kg. (weight of cover 58 kg. and weight of frame 58 kg.).

11.12 The depth of the manholes shall be reckoned from top level of C.I cover to the invert level of channel. The depth shall be measured correct to centimetres.

11.13 Inspection chambers shall be constructed similar to manholes as detailed in working drawings.

11.14 Sewers of unequal sectional area shall not be jointed at the same invert level in a manhole. The invert of the smaller sewer at its junction with main shall be at least 2/3 the diameter of the main, above the invert of the main. The branch sewer should deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in the main is not impeded. No drains from house fittings e.g. gully trap or soil pipe etc. to manhole shall normally exceed a length of 6 meters unless it is unavoidable.

12.0 DROP CONNECTION

12.1 In cases where branch sewer enters the manholes of main pipe sewer at a higher level than the main sewer, a drop connection should be provided. Pipes and specials conforming to IS 1729 shall be of the same size as the branch pipe sewer.

12.2 For 150 mm and 250 mm main line, if the difference in level between the water line (peak flow level) and the invert level of branch line is less than 600

mm a drop connection may be provided within the manhole by giving a suitable ramp. If the difference in level is more than 600 mm the drop should be provided externally.

12.3 The excavation shall be done for the drop connection at the place where the branch line meets the manhole. The excavation shall be carried up to the bed concrete of the manholes and to the full width of the branch line. Excavation and backfilling shall be done as per respective specifications.

12.4 At the end of branch sewer line C.I. tee shall be fixed to the line which shall be extended through the wall of manhole by a horizontal piece of C.I. pipe to form an inspection or cleaning eye. The C.I. drop pipe shall be connected to the tee at the top and to the C.I. bend at the bottom. The bend shall be extended through the wall of the manhole by a piece of pipe which shall discharge into the channel. Necessary channel shall be made with cement concrete of grade M15 and finished smooth to connect the main channel. The joint between C.I. pipe and fittings shall be lead caulked. The joint between C.I. tee and S.W. branch line shall be made with cement mortar 1:1 (1 cement : 1 fine sand). The exposed portion of the drop connection shall be encased alround with minimum 150 mm. thick concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size) and cured. For encasing the concrete around the drop connection, necessary centering and shuttering shall be provided. The holes made in the walls of the manhole shall be made good with brick work in cement mortar 1:4 (1 cement : 4 coarse sand) and plastered with cement mortar 1:2 (1 cement : 2 fine sand) on the inside of the manhole wall. The excavated earth shall be back filled in the trench in level with the original ground level. Drop connection shall be measured in numbers.

13.0 ROAD GULLY CHAMBERS

13.1 The chamber shall be of brick masonry/RCC and shall have a C.I. grating with frame fixed in 150 mm thick cement concrete of grade M15 at the top. The size of the chamber shall be taken as clear internal dimensions of the C.I. frame. The chamber shall have a S.W. connection pipe, the length of which between road gully chamber and the point of discharge to drain or to open ground shall be measured separately. The chamber shall be built at the locations indicated in drawings.

13.2 Bed concrete, brick work, plastering, RCC work, excavation, backfilling, etc. shall be as per details given on the drawing and in compliance with the requirements laid down in the specifications for the respective items.

13.3 The gully grating cover shall be hinged to the frame to facilitate its opening for cleaning and repairs. The weight of grating shall be 75 kg. minimum.

13.4 After completion of the work, the exposed surfaces of the grating and the frame shall be painted with a thick coat of coal tar.

14.0 SEPTIC TANK

14.1 Hume pipe septic tank and accessories shall be horizontal type of standard manufacture as approved by the Engineer. Septic tank shall be installed exactly as per manufacturer's requirements and instructions at locations indicated by the Engineer. 230 mm thick and 500 mm internal diameter brick manhole shall be constructed upto grade level and covered with 500 mm circular medium duty cast iron frame and cover. Internal face of brick work shall be plastered with 13 mm thick cement mortar 1:3.

14.2 RCC/brick masonry septic tanks shall be constructed as per the drawings. All other requirements shall conform to IS : 2470.

15.0 GUARANTEE FOR WATER SUPPLY, SOIL & VENT SYSTEMS

15.1 The Contractor shall deliver to the Owner/Engineer upon completion of his work under this contract, a written guarantee that :

i) for a period of one (1) year after acceptance by the Engineer, plumbing and drainage work shall be free from defective material and workmanship;

ii) for a period of one (1) year after acceptance by the Engineer, the Contractor shall be responsible for the water/air tightness of all joints;

iii) he will, at his own expense, repair, replace all such defective work and all other works damaged thereby, during the term of guarantee.

15.2 After completion of the work, the Contractor shall obtain and handover to the Engineer necessary certificates.

1.0	**FLY ASH/BED ASH TRANSMITTERS**		
1.1	Type		SUITABLE FOR DENSE PHASE PRESSURE TYPE PNEUMATIC CONVEYING
1.2	Material to be Handled		FLY ASH / BED ASH/ BED MATERIAL
1.2.1	Temperature of material handled	^{0}C	REFER SYSTEM DATA SHEET
1.3	Material Properties		
1.3.1	Range of bulk density Fly ash Bed ash Bed material	kg/cu.m	REFER SYSTEM DATA SHEET 800 1800 1800
1.4	Quantity		REFER SYSTEM DATA SHEET
1.5	Duty		24 HOURS/DAY
1.6	Holding Capacity of Transmitters		BIDDER TO INDICATE
1.7	Flow Through Transmitter Vessels Below		
1.7.1	Air preheater hoppers	t/hr	REFER SYSTEM DATA SHEET
1.7.2	ESP hoppers	t/hr	}
1.7.3	Stack hopper	t/hr	} AS PER SYSTEM DESIGN }
1.7.4	Bed ash hopper	t/hr	}
1.8	Materials of Construction		
1.8.1	Transmitter Vessel		CAST IRON/FABRICATED OUT OF MIN. 10 THK. MS PLATE
1.9	Construction of Vessel		AS PER ASME CODE FOR UNFIRED PRESSURE VESSEL OR IS-2825
1.10	Accessories to be Provided		
1.10.1	Level probe for hopper		YES
1.10.2	Level probes for transmitters		YES

1.10.3	Timers as back up for level probes		YES
1.10.4	Control panel		YES
1.10.5	Pneumatically operated vent valve and vent port at top of vessel to release air displaced during ash filling in case discharge valve is provided		YES
1.10.6	Safety valve on vessel		YES
1.11	Tests to be Conducted		
1.11.1	Visual and dimensional check at works		YES
1.11.2	Hydrostatic test at works, with 1.5 times the maximum operating pressure		YES
1.11.3	Capacity test at site		YES
1.11.4	Testing of the fabricated transmitter vessels		AS PER ASME SECTION VIII
1.12	The emptying of bed ash/fly ash hoppers shall be controlled automatically by level probes and timers. However, it shall be possible to empty them selectively as per operators wish		
2.0	**BED ASH/ FLY ASH VALVES**		
2.1	HOPPER ISOLATION VALVES/ BRANCH ISOLATION VALVES		
2.1.1	Type		KNIFE GATE VALVES
2.1.2	Location		OUTDOOR BELOW BED ASH/ FLY ASH COLLECTING HOPPERS BED ASH/FLY ASH PIPE LINES.
2.1.3	Number required		REFER FLOW DIAGRAM
2.1.4	Operation - Branch Isolation valve		PNEUMATIC CYLINDER

	- Hopper Isolation valve		OPERATED MANUAL OPERATED
2.1.5	Flow rate through valve	t/hr	TO MEET SYSTEM DESIGN
2.1.6	Material of Construction and Hardness		
	(a) Valve body		CI FG-260
	(b) Slide plate		SS 304
	(c) Valve seat		CI FG-260
	(d) Valve shaft		SS-304
	(e) Deflector cone(for branch isolation valve)		Alloy C.I , 350 BHN
2.1.7	Provision of operating handle for manual operation and position indicator		YES
2.2	FLY ASH INLET VALVES		
2.2.1	Type		DOME VALVES/KNIFE GATE VALVES/ SWING DISC VALVE
2.2.2	Location		AT INLET TO ASH TRANSMITTER
2.2.3	Number required		REFER FLOW DIAGRAM
2.2.4	Operation		PNEUMATIC CYLINDER OPERATED - SOLENOID ACTUATED
2.2.5	Flow rate through valve		TO MEET SYSTEM DESIGN
2.2.6	Material of Construction & Hardness		DOME VALVE KNIFE GATE VALVE
	(a) Valve body		CI FG-260
	(b) Valve seat		CI FG-260
	(c) Valve plate/dome		SS304, EDGE STELLITED TO 1 MM THICK

	(d) Deflector cone for knife gate valve	ALLOY CI, 350 BHN
	(e) Dome	CI FG-260
	(f) Shaft	SS 304
	(g) Seal (for dome valve)	INFLATED RUBBER SEAL (NEOPRENE)
2.2.7	Life of valve seal	BIDDER TO INDICATE IN HRS. OF OPERATION.
2.2.8	Tests to be conducted	
	(a) Hydrostatic/vacuum test for all valves	YES
	(b) Test certificates for material of construction	YES
2.3	Valves at Outlet of Transmitter Vessel (If Required)	
2.3.1	Type	KNIFE GATE VALVE/BALL VALVE
2.3.2	Operation	PNEUMATIC CYLINDER OPERATED - SOLENOID ACTUATED

2.3.3	Material of construction	KNIFE GATE VALVE	BALL VALVE
	(a) Valve body	SAME AS SHOWN AGAINST ITEM 2.2.6	ASTM A 216
	(b) Valve seat		SS 304-STELLITED
	(c) Valve plate/ball		SS 304 - HARD CHROME PLATED
	(d) Sleeve		--
	(e) Stem		Ni HARD
3.0	**AIR-ASH TRANSPORT PIPING AND FITTINGS**		
3.1	Piping	MS ERW pipe to IS-3589 for pipes above 150 NB (min. 9.52 mm for 1st and 2nd field and 7mm for other fields) For 150 NB and below, the pipes shall conform to IS-1239.	
3.2	Fittings	Ni-Cr ALLOY CAST IRON AS PER IS:4771, TYPE 1a WITH MINIMUM AND HARDNESS OF 550 BHN	
3.3	Type of Wear Back for Fittings	INTEGRAL	
3.4	Min. Thickness of Wearback	TWICE THE PIPE WALL THICKNESS	
3.5	Radius of 90^0 bends	MINIMUM 3 TIMES PIPE DIAMETER	
3.6	Type of Coupling for Fly Ash pipes	SLEEVE TYPE WITH STEEL SLEEVE & STEEL/CI FLANGES	
3.7	Deflection in Coupling (Allowable)	MINIMUM 3 DEG.	
3.8	Gap between Ends of Pipes at Coupling	SUFFICIENT TO TAKE CARE OF EXPANSION IN PIPES.	
3.9	Necessary Steel Hangers, Supports and Inserts in Concrete for Piping	BY BIDDER	
3.10	Location	OUTDOOR	

3.11	Pipelines to be Included		
3.11.1	Piping from fly ash hoppers to fly ash silo		YES
3.12	Hydrostatic Testing of all the Piping after Installation at Site, with 1.5 times the Maximum Operating Pressure		YES
3.13	Span between Piping Supports		NOT TO EXCEED 3.0 M
4.0	**AIR PIPING**		
4.1	Conveying Air Piping		
4.1.1	Material - Piping - Fittings		GI FORGED STEEL
4.1.2	Velocity in air piping		10 M/S (AVERAGE) / BIDDER TO INDICATE
4.2	Instrument Air Piping		
4.2.1	Branch piping		GI
4.2.2	From tap off point upto gauges,		SEAMLESS COPPER TUBING WITH SWITCHES, ETC. COPPER ALLOY FLANGES & FITTINGS
4.3	Hydrostatic Testing of all the Piping after Installation at Site, with 1.5 times the Maximum Operating Pressure	YES	
5.0	**BAG FILTER**		
5.1	Location		AT FLY ASH SILO,
5.2	Type		COMPRESSED AIR CLEANED, REVERSE PULSE JET TYPE
5.3	Duty		CONTINUOUS-24 HOURS/ DAY
5.4	Material Handled		FLY ASH/BED ASH
5.5	Bulk Density of Handled Material	kg/m3	REFER DATA SHEET C-13

5.6	Material of Construction		
5.6.1	Bags		POLYESTER NEEDLE FELT OF ANTISTATIC TYPE
5.6.2	Cages		GI
5.6.3	Casing & Duty		MS
5.7	Volume of Dust Laden Air to be Handled	m3	SHALL MATCH THE FLOW RATE OF ASH-AIR MIXTURE INTO FLY ASH SILO
5.8	Air-to-Cloth Ratio	m/min	ONE
5.9	Maximum Dust Concentration in Air that will be Let Out to Atmosphere	mg/Nm3	100
5.10	All Required Accessories Provided		YES - BIDDER TO FURNISH LIST
5.11	Are Controls for Automatic On-line Bag Cleaning System Required?		YES
5.12	Tests		
5.12.1	Visual and dimensional check at works		YES
5.12.2	Site tests for functioning of the automatic on-line bag cleaning system		YES
5.12.3	Check for dust concentration in the air to be let out to atmosphere at site		YES
5.13	Bag Filter Cleaning Air		TO BE OBTAINED FROM PLANT AIR CONNECTION
6.0	**EXHAUST FAN**		
6.1	a) Location		AT THE AIR OUTLET OF BAG FILTERS
	b) Quantity		BIDDER TO DECIDE

6.2	Type		CENTRIFUGAL
6.3	Capacity	m3/s	*
6.4	Suction Pressure	kPa (mWc)	*
6.5	Discharge Pressure	kPa (mWc)	*
7.0	WHETHER THE COMPRESSORS/ BLOWERS OF REQUIRED CAPACITY AND NUMBER NEED TO BE INCLUDED BY THE VENDOR		IF YES, REFER COMPRESSOR DATA SHEET.
7.1	If yes, the No of Compressors/ Blowers Operating & Standby		THREE (3) (2W+1S) SCREW COMPRESSORS
8.0	TYPE OF STANDBY FOR COLOUR MONITOR OF MICRO PROCESSOR BASED CONTROL SYSTEM		~~CONVENTIONAL MIMIC CUM CONTROL PANEL~~/ REDUNDANT STANDBY COLOUR MONITOR
9.0	PERFORMANCE TEST AT SITE		
	Is Capacity Test for Fly Ash/Bed ash Conveying Required to be conducted?		YES
10.0	EXPANSION JOINTS		
10.1	Type of Expansion Joints		SS
11.0	Painting at site by		VENDOR
11.1	Paintings shall as specified in specification		YES
12.0	NOTES		
12.1	All parts of valves coming in contact with ash shall be wear resistant.		
12.2	All supports and supporting structures for the pneumatic conveying equipment and piping together with platform, hand railing and access ladders, as required shall be provided.		
12.3	All air + ash line valves and fittings shall be tested as per API-598.		
12.4	All remote operated valves shall be pneumatically operated.		

12.5 If the Bidder feels that purge air line is required for their system, the same shall be provided.

12.6 All the vent valves (if provided) in transmitter vessel shall be connected 1 m above the maximum ash level in ESP hoppers.

12.7 Provision shall be given to operate the ash transmitter selectively keeping other transmitter isolated.

12.8 If fly ash discharge valve is offered by the bidders in their system, they shall give minimum one year guarantee for the life of the valve for 1st and 2nd field of ESP hoppers. For other fields, they shall give 2 years guarantee for the life of valve. If it is not furnished, cost loading for the same will be done on their quoted price.

12.9 For 50 NB and smaller sizes air piping valve, 3 piece ball valves shall be provided.

* - Bidder to indicate.

1.0 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the VENDOR's / SUB-VENDOR's works, delivery to site, commissioning and performance testing at site of Pressure type pneumatic conveying system for fly ash / bed ash handling.

2.0 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of pneumatic conveying system equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the VENDOR of his responsibility.

The following are some of the important Indian Standards relevant to this specification.

IS 1239 (Parts I & II)	-	Mild steel tubes, tubular & other wrought steel fittings
IS 2062	-	Steel for general structural purposes
IS 2825	-	Code for unfired pressure vessels
IS 3589	-	Seamless or Electrically welded steel pipes for water, gas and sewage (168.3 to 2032 mm OD)
IS 4771	-	Abrasion resistant iron castings
IS 4894	-	Centrifugal fans
IS 5456	-	Code of practice for testing of positive displacement type air compressors & exhausters
IS 6206	-	Guide for selection, installation & maintenance of reciprocating compressors upto 10 bars
IS 7938	-	Air receivers for compressed air installations

Other National standards are also acceptable, if they are proved to be equal or superior to the relevant Indian standards or where equivalent Indian standards do not exist.

3.0 DESIGN REQUIREMENTS

3.1 General

All rotating parts such as couplings, V-belts, shafts, etc. shall be covered with suitable protective guards.

3.2 Pneumatic Conveying System

3.2.1 The pneumatic conveying system shall be lean phase/dense phase pressure type and for conveying the fly ash / bed ash collected at various fly ash / bed ash hoppers to the fly ash / bed ash silo, via buffer hoppers, if required and it shall comply with this standards. This system shall be complete with air compressors and accessories (if specified in Data Sheet-A), transmitter vessels, buffer hoppers, remote operated fly ash / bed ash inlet valves and isolation gates, piping, pipe supports, dust tight seals, bag filters and extraction fans (if necessary) with drive motors, solenoid valves, etc.

3.2.2 The BIDDER shall calculate

a) Total air quantity required for conveying the ash.
b) Size of conveying pipes.
c) Pressure drop in the pipelines and equipment etc., based on the following
   i) Quantity of the ash to be conveyed from each hopper.
   ii) Required system capacity.
   iii) No. of cycles per hour.
   iv) Distances and elevation difference between the ash collecting hopper and the fly ash / bed ash silo, fly ash / bed ash density range specified etc.
   v) Cycle time.

Accordingly, the BIDDER shall select the pneumatic conveying units of suitable size.

3.2.3 The capacity of transmitter vessels shall be decided based on one of the following alternatives, whichever is more conservative:

(a) The capacity of transmitter vessels shall be decided based on four (4) hours or as specified in data sheet-A, continuous operation in a shift of eight (8) hours. However, normally the vessels shall operate intermittently in cyclic manner for all eight (8) hours in a shift. Maximum number of cycles in which case is 40 cycles per hour / as specified in data sheet-A.

(b) Maximum twenty (20) cycles per hour when operating in cyclic manner for all eight (8) hours in a shift.

3.2.4 There shall be one independent transmitter vessel below each fly ash / bed ash collecting hopper. The fly ash / bed ash collected in these hoppers shall be transmitted to the fly ash / bed ash silo.

3.2.5 The allowable dust concentration in the air let out to atmosphere shall be limited to that specified in Data Sheet-A. Based on this the BIDDER shall select the type of the bag filter at the air outlet of silo.

3.2.6 Each fly ash / bed ash hopper as well as the buffer hoppers (if provided) shall be provided with a level probe, knife gate valve for isolation and fly ash / bed ash inlet valve. All the transmitter vessels connected to common fly ash / bed ash lines shall operate sequentially / simultaneously depending upon the manufacturer's recommendation. In case manufacturer recommends the operation of transmitter vessels connected to common fly ash / bed ash conveying line, shall be one after another, there shall be remote operated automatically controlled isolating valve between each transmitter vessel and common conveying line.

(a) In case of pressure pneumatic system with ash transmitter vessels without valves, the operation shall be as described below:

When adequate ash is collected in the fly ash / bed ash hopper / buffer hopper, and the ash level reaches the level of the level probe in the ash hoppers the level probe shall actuate opening of the inlet valve. The fly ash / bed ash inlet valve shall open and after a preset time conveying air shall enter the vessel and pressurise the vessel. When the preset pressure is reached in the vessel, the air-ash mixture shall be conveyed to the buffer hopper or to the fly ash silo. In case fly ash / bed ash is conveyed from the fly ash hopper to the buffer hopper, the transmitter below the buffer hopper shall convey fly ash / bed ash similarly to the fly ash / bed ash silo.

(b) In case of dense phase pressure pneumatic system with ash transmitters with discharge and vent valves the operation shall be as described below:

(i) When adequate ash is collected in the fly ash / bed ash hopper, and fly ash / bed ash reaches the level probe level, the level probe shall actuate the vent valve, allowing the air with ash trapped in the vessel in the previous cycle to escape. After a preset time inlet valve shall open allowing the fly ash to be let in to the vessel. After a preset time, the inlet valve as well as vent valve shall close and conveying air shall be let in to the vessel and shall pressurise the vessel. After a preset time the discharge valve shall open and the air-ash mixture shall be conveyed to buffer hopper / fly ash / bed ash silo as described earlier.

(ii) Where fluidisation of ash in the vessel is required in the system, fluidising air shall be admitted after inlet valve and vent valve are closed.

3.2.7 A back up timer shall be provided to actuate the fly ash inlet valve in case the level probe in the fly ash hopper / buffer hopper does not function.

3.2.8 The emptying of fly ash / bed ash hoppers shall be controlled automatically by level probes and timers. However, the controls shall be such that it shall be possible to empty the fly ash / bed ash hoppers selectively as per the will of the operator.

3.2.9 The ash transport piping shall be complete with sleeve type coupling / Flanged coupling with expansion joints, bends, laterals, gaskets, etc.

3.2.10 The air piping shall be designed, based on an average velocity of 10 m/s.

3.2.11 The fly ash / bed ash valves shall be complete with body, gate, seats / neoprene seals, gaskets, connecting flanges, actuating mechanism and solenoid valves (where required).

3.2.12 The equipment / piping shall be designed for indoor / outdoor operation as specified in Data Sheet-A complete with all accessories.

3.2.13 The dense phase conveying system shall be complete with the following:

(a) Air compressors and accessories, if specified, in Section-C.

(b) Air receivers with associated instrumentation, air piping, supporting structures etc.

(c) Air dryers if specified in Data Sheet-A of this specification with associated accessories, instrumentation, air / water piping, supporting structures etc. to meet instrument air requirements.

(d) Motor / pneumatically operated type fly ash inlet valves / vent valves and outlet valves (if required) for the transmitter vessels and knife gate valves for isolation and expansion joint below each of the fly ash collecting hoppers.

(e) Buffer hoppers if provided shall have two (2) numbers of transmitter vessels, out of which one shall be operating while the other one shall be standby – or as specified in data sheet-A.

(f) Complete air-ash mixture piping from fly ash hoppers upto fly ash / bed ash silo and/or from fly ash hopper / bed ash hopper to buffer hoppers and from buffer hoppers to fly ash / bed ash silo.

(g) Complete air piping between air compressors and air receivers, between air receivers and dryers, and from air dryers upto each of the transmitter vessels, necessary butterfly valves and fittings as required.

(h) Supports and supporting structure for the pneumatic conveying equipment and piping together with platform, hand railing and access ladders.

(i) All anchor bolts, nuts, bolts, washers, base frame and loose fittings required for erection.

(j) Final grouting of all the equipment.

(k) All pressure switches, level switches, timers and any other hardware required for interlocking and controlling of the pneumatic conveying system equipment.

(l) Micro processor based logic control system with redundant CPU, key board, monitor, programming unit, back up control panel, necessary I/O units with 10% spare capacity etc.

(m) All other equipment and/or materials which are not specifically mentioned above, but are required for completeness and trouble free

operation of the pressure type pneumatic conveying system and also to ensure safe and satisfactory operation of the system.

4.0 CONSTRUCTIONAL REQUIREMENTS

4.1 Fly Ash Transmitters

4.1.1 The fly ash transmitter vessel shall be sized to convey the fly ash at the rate specified in Data Sheet-A. The inlet and outlet shall be so designed as to prevent any plugging & choking.

4.1.2 The fly ash transmitter shall be fitted with a connection for compressed air inlet and fly ash outlet pipes.

4.1.3 The transmitter shall be cylindrical in shape with conical bottom and shall be made out of 10 mm thick TISCRAL plates / cast iron (CI).

4.1.4 The fly ash inlet valve at ash vessel inlet shall be of sturdy construction capable of operating against the head of material flowing through the ash transmitter. The materials of construction of valves shall be as specified in Data Sheet-A. The valves shall be motor / pneumatically operated. The valve seat and valve disk shall match perfectly. The valve design shall be such that it can be easily removed for checking and maintenance.

4.1.5 An air-cylinder operated vent valve and vent port shall be provided at the top of the vessel to release displaced air during filling in case fly ash discharge valve is provided.

4.1.6 Transmitter vessels should be constructed in accordance with either the ASME code for unfired pressure vessels or IS 2825 – code for construction of unfired pressure vessels.

4.1.7 Safety valves set to relieve pressure in excess of the safe working pressure of the vessel should be mounted directly on the vessel and the valve size shall be determined by ASME code requirements.

4.2 Buffer Hopper

4.2.1 The buffer hopper shall have adequate capacity to store the fly ash collected in one (1) hour.

4.2.2 The operation of the transmitter vessels installed below the buffer hopper shall be actuated by the level switch / probe in the hopper and they shall be of continuous duty type.

4.2.3 The buffer hopper shall be made out of min. 10 mm thick MS plates.

4.3 **Piping**

4.3.1 The piping used for conveying air-ash mixture shall be as called for in Data Sheet-A of this specification. All fittings such as bends, laterals, etc. shall be of alloy cast iron construction having integral / removable type wear backs as called for in Data Sheet-A. The nominal radius of 90° bends shall be three times the nominal diameter of the pipe. Minimum thickness of wear backs shall be twice the pipe wall thickness. The pipe shall have plain ends and joining of pipe shall be achieved by sleeve type couplings. The coupling shall have steel sleeve, steel / CI flanges, gaskets, tightening bolts and nuts. The couplings shall be capable of taking a minimum of 3° deflection. Sufficient gap between ends of pipe at coupling shall be provided to take care of expansion of pipes. The gasket shall be of high temperature asbestos compound. The couplings shall permit easy rotation of pipes, when required.

4.3.2 The compressed air piping other than branch connections to instruments shall be of galvanized iron (GI) as specified in Data Sheet-A of this specification. All fittings shall be of forged steel construction. For pipe sizes less than or equal to 50 mm, the line joint shall be screwed type and for pipe sizes greater than 50 mm, it shall be flanged type. The flanges shall be of forged steel with serrated facing.

4.3.3 Instrument air piping for gauges, switches etc. from the tap off point shall be of seamless copper tubing and shall have flanged joints. The flanges and fittings shall be of copper alloy.

4.3.4 The piping supports shall conform to good engineering practice and the span between the supports shall not exceed 3.0 m. The hangers and supporting arrangement shall be approved by the PURCHASER / ENGINEER and as per layout drawings.

4.4 **Bag Filter**

4.4.1 A bag filter shall be provided at the air outlet of silo to achieve an outlet dust concentration in the exhaust air as specified in Data Sheet-A.

4.4.2 The bag filter shall be of compressed air cleaned, reverse pulse jet type and shall be with low air-to-cloth ratio.

4.4.3 The bag filter shall be complete with casing, bags, cages, ducting, valves, dampers, supports, maintenance platforms, etc., as required.

4.4.4 The bag filter shall be suitable for outdoor installation.

4.4.5 The bag filter shall be provided with automatic on-line bag cleaning system complete with necessary valves, solid state electronic timers, air piping etc. The compressed air required for bag cleaning shall be obtained from the compressed air system provided for pneumatic conveying. In case dry air is envisaged for bag filter cleaning, the BIDDER shall provide suitable arrangement

4.4.6 The bags shall be made of polyester needle felt of antistatic type or any other material which gives long life while its casing and ducts shall be made of mild steel with adequate thickness. Bag filter cages shall be of GI. Adequate access for maintenance of bags and other components shall be available.

4.5 **Valves**

4.5.1 **Fly ash / bed ash valves**

(a) Hopper isolation valves

The isolation valves below fly ash hoppers shall be knife gate valves. These shall be of rugged construction. The parts subject to wear due to abrasive action of fly ash shall be made of nickel-chromium alloy cast iron of hardness not less than 340 BHN. Provision shall be made to operate the valve manually also in case solenoid / motor operated valves are specified in Section-C / Data Sheet-A.

(b) Fly ash / bed ash inlet valves

These shall be fitted in the transmitter vessels. These shall be used for feeding the fly ash from the collecting hoppers into the transmitter vessel below it. These valves shall be air-electric type. The valves shall be pneumatically operated and the operation shall be actuated by a solenoid valve.

(i) Dome valves

- There shall be inflatable rubber seal so that in the closed position of dome valve, the gate will be air tight and there will not be any escape of compressed air.

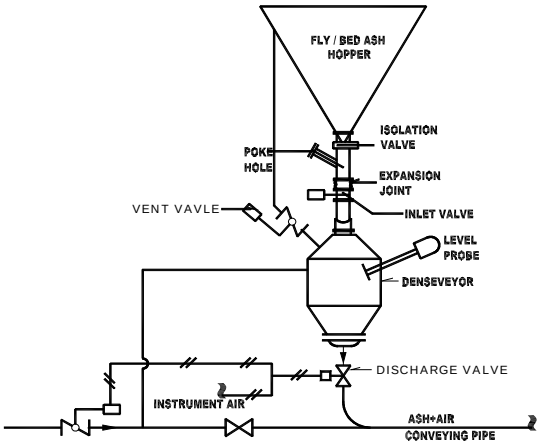
- All components of the valve subject to wear shall be made out of Ni-Cr alloy cast iron having a hardness of not less than 340 BHN.

(ii) Swing disc valves

- The body and the disc of Swing disc valve shall be of alloy C.I having minimum hardness of 450 BHN.

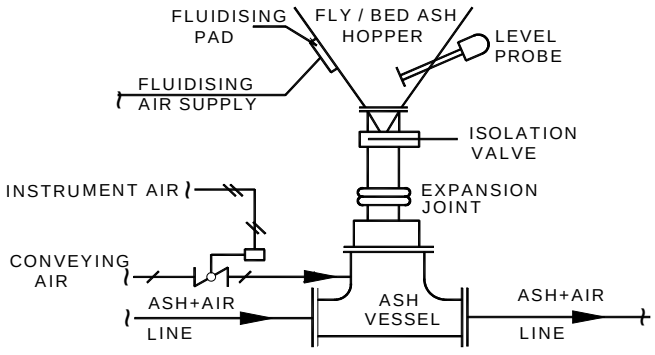
(iii) - Any other types of valves shall be as specified in Data sheet-A

ANNEXURE



FLY / BED ASH TRANSMITTER VESSEL
WITH DISCHARGE & VENT VALVES

SKETCH - 1



FLY / BED ASH TRANSMITTER VESSEL
WITHOUT DISCHARGE & VENT VALVES

SKETCH - 2

ISSUE R2

DATA SHEET – C

DATA TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT

1.0 Schedule of drawings and documents to be submitted for review, approvals and information with submission dates.

2.0 Quality assurance plan (QAP).

3.0 Calculation for air quantity, pressure drop, line sizing, equipment sizing thickness calculation ETC..

4.0 Detailed pi diagram indicating scope of supply of equipment, piping with line sizes and material specifications, valves, specialties, expansion joints, instrumentation and control and all the accessories. Drawing shall also indicate all design data and information furnished in data sheets a and b.

5.0 Instrumentation data sheets.

6.0 Power wiring, control wiring, logic diagrams.

7.0 Control cabinet drawing.

8.0 ASH TRANSMITTERS

8.1 General arrangement drawings of ash transmitter vessel with supporting structure, giving all necessary dimensions, space required for handling and materials of construction. Above drawing should show the level probe and also the control panel in position.

8.2 Material test certificates giving material composition and physical properties, for material of construction of transmitter vessel, inlet & discharge valves, vent valve etc.

8.3 Capacity test certificates.

8.4 Other data as called for in System Data Sheet-C in this specification.

8.5 Procedure for performance testing.

8.6 Calculations for the conveying air requirement.

8.7 Operation and maintenance manual with lubrication schedule.

9.0 **BAG FILTERS**

9.1 Detailed dimensioned general arrangement drawing of the bag filter with mounting details, design parameters and dust concentration of air let out to atmosphere, air to cloth ratio, quantity of dust laden air handled, materials of construction loading data, etc.

9.2 Write-up on operation of the bag filter including the operation of the automatic on-line bag cleaning system.

9.3 Rating on fan motor.

9.4 Material test certificates giving material composition and physical properties.

9.5 Procedure for performance testing.

9.6 Operation and maintenance manual with lubrication schedule.

ISSUE NO. R2

SPECIFICATION NO.	TATA CONSULTING ENGINEERS	SECTION D1
TCE-M4-116-68	DATA SHEET - B PRESSURE TYPE PNEUMATIC CONVEYING SYSTEM FOR FLY ASH / BED ASH HANDLING	SHEET 1 OF 2

ENQUIRY /SPECIFICATION NO.

SR.NO.	ITEM →	BIDDER →	
1.0	**GENERAL**		
1.1	Type of System Offered		
1.2	Total Capacity of Conveying System from Fly Ash Hoppers to Fly Ash Silo	TPH	
1.3	**Compressed Air Requirement**		
1.3.1	Flow rate	NM^3/S	
1.3.2	No. of operating hours	HRS	
1.3.3	Pressure	KPA (KG/CM^2)	
2.0	**ASH TRANSMITTERS**		
2.1	Make and Type		
2.2	Capacity of Ash Transmitter Vessel	M^3	
2.3	Diameter of Fly Ash / Bed Ash Conveying Pipes from Various Hoppers	MM	
2.4	Pick-up Velocity of ash	M/S	
2.5	Velocity of Air-Ash Mixture in the Pipeline	M/S	
2.6	Type of Ash Inlet Valves		
2.7	Material of construction for the inlet valve components		
2.8	Time Required for Emptying the Ash Transmitter Vessel	SECONDS	
2.9	Average Ash Conveying Rate from Transmitter to Silo / Buffer Hopper		
	a) ESP ash transmitter vessel	TPH	
	b) Economiser transmitter vessel	TPH	
	c) Air preheater ash transmitter	TPH	
	d) Stack hopper ash transmitter vessel	TPH	

NOTE TO BIDDER
1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

SR.NO.	ITEM →	BIDDER →	
2.10	Average Ash Conveying Rate from Buffer Hopper to Fly Ash Silo	TPH	
2.11	Compressed Air Requirement for the Specified Fly Ash Conveying Rate of Various Ash Transmitter Vessels		
	- Flow rate - Pressure	NM^3/S KPA (KG/CM^2)	
2.12	Are All Tests as per Data Sheet-A included?		YES/NO
2.13	Is Drawing Enclosed?		YES/NO
3.0	**BAG FILTERS**		
3.1	Type and Make		
3.2	Number of Bag Filters		
3.3	Volume of Dust Laden Air Handled	M^3/S	
3.4	Air to Cloth Ratio	M/S	
3.5	Dust Concentration of Air Let Out to Atmosphere	MG/NM^3	
	Cleaning air requirement	M^3 / S, KPA	
3.6	Are Catalogues / General Arrangement Drawing of Bag Filter Furnished?		YES/NO
3.7	Is Descriptive / Write-up of Bag Filter Furnished?		YES/NO
4.0	**EXHAUST FAN**		
4.1	Type and Make		
4.2	Capacity	M^3/S	
4.3	Suction Pressure	KPA (MWC)	
4.4	Discharge Pressure	KPA (MWC)	
4.5	Motor Rating	KW	

NOTE TO BIDDER
1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

1.0	Type		SCREW - NON LUBRICATED / WITH OIL FILTERS
2.0	No. Required/Service		THREE (3) NOS. (2W + 1S) ASH CONVEYING AIR
3.0	Capacity (FAD)	m^3/hr	*
4.0	Suction Pressure	$kg/cm^2(g)$	0.935
5.0	Discharge Pressure	$kg/cm^2(g)$	*
6.0	Type of Cooling		WATER
7.0	Bearing Lubrication		FORCED OIL LUBRICATION
8.0	Type of Control		DUAL
9.0	CONNECTIONS Flanged for 65 mm & larger flanged Drilled to IS/BS/ASA screwed for 500 mm & below		YES
10.0	MATERIALS OF CONSTRUCTION		
10.1	Casing		CI C.G.20
10.2	Rotor		CARBON STEEL ST 50-2
10.3	Screw Elements		CARBON STEEL ST 50-2 WITH TEFLON COATING
11.0	Drive Motor by		VENDOR
12.0	Type of Drive		ELECTRIC MOTOR
	Accessories to be Supplied by the VENDOR		
13.0	Suction Air Filter area twice compressor inlet size : Particle size retained 10 micron and above		YES
14.0	Suction Silencer		YES
15.0	Instrumentation required		YES (AS PER STANDARD PRACTICE)
16.0	Foundation Bolts		YES

17.0	Counter Flanges with Gaskets, Nuts and Bolts for Air and Cooling Water connections		YES	
18.0	Test Certificates for Materials of Construction for Compressor parts		YES	
	NOTE : Compressor shall be controlled by PLC and the control panel shall be integrated with main ash handling system control panel.			
	TESTS TO BE WITNESSED BY PURCHASER AT MANUFACTURER'S WORKS			
19.0	Visual Inspection and Dimensional Check		YES	
20.0	Check for Capacity at specified discharge pressure. Flow measurement as per ISO 1271		YES	
(B)	INTERCOOLER AND AFTERCOOLER			
1.0	Designation		Intercooler	Aftercooler (If applicable)
2.0	Number required		One no. each for each compressor	
3.0	Type		Shell and tube type with removal tube and bundle	
4.0	Type of Flow		-------- Counter current ----------	
5.0	Capacity	m^3/hr	*	*
6.0	Operating Pressure – Air side	$kg/cm^2(g)$	*	*
7.0	Design Pressure – Air side	$kg/cm^2(g)$	1.25 times of operating pressure	
8.0	Cooling Medium – Air/Water		Water	Water
9.0	Water Temperature (maximum)	ºC	34	34
10.0	Maximum acceptable outlet air/gas Temperature	ºC	8ºC above inlet water temp.	
11.0	CONNECTIONS Flanged for 65 mm & larger flanged Drilled to IS/BS/ASA screwed for		YES	

	500 mm & below	
	MATERIAL OF CONSTRUCTION	
12.0	Shell	---------- Steel ----------
13.0	Tubes	---------- Copper ----------
14.0	Tube sheets	----------Copper/Steel----------
15.0	Tube support plates	---------- Steel ----------
16.0	Trap – Body - Trim	----------CI/Steel---------- ----------Bronze----------
17.0	Centrifugal/baffle type moisture and oil separator with moisture reservoir	---------- Yes ----------
18.0	Automatic bucket type trap to Discharge moisture and oil to drain	----------Yes----------
19.0	Thermometers	
	Bi-metallic, dial type or filled System type	
	Air inlet Air outlet Cooling water outlet	----------Yes---------- ----------Yes---------- ----------Yes----------
20.0	Safety valve to relieve full compressor Discharge	----------Yes----------
21.0	Foundation bolts	----------Yes----------
22.0	Counter flanges for air inlet and outlet connection, with gaskets, bolts and nuts	----------Yes----------
23.0	Pressure gauge at air inlet and outlet	----------Yes----------
	TESTS AT MANUFACTURER'S WORKS TO BE WITNESSED BY PURCHASER'S REPRESENTATIVE	
24.0	Visual inspection and dimensional check against approved manufacturer's drawing	----------Yes----------

25.0	Hydrostatic test of shell and tube side at 1.5 times the design pressure		----------Yes----------
26.0	Test certificates for material of construction of inter and/or after cooler parts		----------Yes----------
(C)	AIR RECEIVER		
1.0	Designation		Air Receiver
2.0	Number required		Two (2) nos.
3.0	Type		Vertical
4.0	Working Pressure	$kg/cm^2(g)$	
5.0	Design Pressure	$kg/cm^2(g)$	1.25 times of operating pressure
6.0	Nominal Volume of each receiver	m^3	Bidder to indicate suitable capacity of ash handling system
7.0	Material		IS 2062
8.0	Corrosion Allowance	mm	3.0
9.0	Code of Construction BS 487 (Part-I)/ IS 2825 ASME Section VII		Yes
10.0	Supporting Stand		Yes
11.0	Manhole with cover for inspection & cleaning		Yes
12.0	One suitably sized safety valve set at 1.25 times the operating pressure of the receiver to relieve full compressor discharge capacity		Yes
13.0	One Pa range pressure gauge with isolating valve branch tap-off with isolating valve for Purchaser's test pressure gauge and fittings for mounting on the receiver		Yes
14.0	Counter flanges for all flanged connections with gaskets, bolts and nuts		Yes
15.0	Foundation Bolts		Yes
16.0	Blowdown connection with isolating		No

	valve required		
17.0	Auto drain trap		Yes
18.0	Piping from receiver to auto drain trap		Yes
19.0	Pressure switches for start/stop of compressors		Yes
20.0	Material test certificate required?		Yes
	TESTS AT MANUFACTURER'S WORKS TO BE WITNESSED BY PURCHASER'S REPRESENTATIVE		
21.0	Visual inspection and dimensional check against approved manufacturer's drawing		Yes
22.0	Hydrostatic test at 1.5 times the design pressure		Yes
23.0	Flanged connections for air inlet and air outlet		Yes, as applicable
24.	All flanges to Indian/ASA standards		Yes
25.0	Screwed connections (BSP/NPT) for pressure gauge, pressure switch, drain valve / relief vale		Yes
(D)	<u>Oil Filter</u>		
1.0	Oil content in outlet air		3 ppm (max)
2.0	Efficiency of filter		*
3.0	Material of filter element		*
4.0	Life of filter element		*
'*'	Bidder to indicate		

ISSUE NO. R5	SPECIFICATION NO. TCE.M4-107-01	**TCE CONSULTING ENGINEERS LIMITED** **DATA SHEET B** **AIR / GAS COMPRESSORS**	SECTION : D SHEET : 1 OF 7

ENQUIRY/ SPECIFICATION NO. TCE.

	SL. NO.	ITEM / BIDDER				
GENERAL	1.	DESIGNATION		COMPRESSORS FOR		
	2.	NUMBER OFFERED		(W+S)		
	3.	TAG NUMBERS				
	4.	TYPE OF COMPRESSOR		RECIPROCATING/CENTRIFUGAL/SCREW LUBRICATED / NON-LUBRICATED		
	5.	MAKE AND MODEL NUMBER				
	6.					
	7.					
COMPRESSOR DATA				RECIP	CENT	SCREW
	8.	NUMBER OF STAGES				
	9.	NUMBER OF CYLINDERS PER STAGE			NA	NA
	10.	TYPE OF CYLINDER		VER / HOR	NA	NA
	11.	CYLINDER LINER PROVIDED		YES / NO	NA	NA
	12.	SINGLE ACTING /DOUBLE ACTING		SINGLE/ DOUBLE	NA	NA
	13.	CAPACITY (FAD)	M^3/ Hr			
	14.	MASS FLOW RATE	Kg/Hr	NA		NA
	15.	TYPE OF SUCTION AND DISCAHRGE VALVE		PLATE / CHANNEL TYPE	IGV/ BUTTERFLY VALVE (OP) AT SUCTION	BUTTERFLY / PISTON VALVE (OP) AT SUCTION
	16	SUCTION PRESSURE	Kg/ cm^2(g)			
	17.	DISCHARGE PRESSURE	Kg/ cm^2(g)			
		LEGEND : RECIP = RECIPROCATING, CENT= CENTRIFUGAL, VER = VERTICAL, HOR = HORIZONTAL,IGV = INLET GUIDE VANES, OP = OPTIONAL, NA = NOT APPLICABLE				

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

	SL. NO.	ITEM / BIDDER				
COMPRESSORS DATA (CONTD.)				RECIP	CENT	SCREW
	18.	SUCTION TEMPERATURE - EACH STAGE	^{0} C			
	19.	DISCHARGE TEMPERATURE - EACH STAGE	^{0} C			
	20.	SELECTED COMPRESSOR SPEED	RPM			
	21.	BKW AT SELECTED COMPRESSOR SPEED	KW			
	22.	RECOMMENDED MAXIMUM SPEED	RPM			
	23.	BKW AT RECOMMENDED MAXIMUM SPEED	KW			
	24.	VOLUMETRIC EFFICIENCY	%			
	25.	MECHANICAL EFFICIENCY	%			
	26.	MOTOR RATING AND SPEED	KW/RPM	/	/	/
	27.	LUBE OIL CONSUMPTION FOR EACH COMPRESSOR	LPM			
	28.	LUBE OIL PUMP DRIVEN BY COMPRESSOR MOTOR		YES/ NO	YES/ NO	YES/ NO
	29.	MOTOR RATING, IF LUBE OIL PUMP IS DRIVEN BY SEPARATE MOTOR	KW			
	30.	AUXILIARY LUBE OIL PUMP TO BE PROVIDED		WHETHER PROVIDED YES/ NO		
	31.	AUXILIARY LUBE OIL PUMP MOTOR RATING AND SPEED	KW/RPM	/	/	/
	32.	TYPE AND MAKE OF BEARINGS				

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

	SL. NO.	ITEM / BIDDER		RECIP	CENT	SCREW
COMPRESSOR DATA (CONTD.)	33.	COOLING WATER REQUIREMENTS (NOTE 1)				
	33.1	FOR COMPRESSOR COOLING				
	33.1.1	FLOW RATE	M^3/ Hr			
	33.1.2	INLET AND MINIMUM OUTLET PRESSURE	Kg/cm ^{2}(g)	/	/	/
	33.1.3	INLET AND MAXIMUM OUTLET TEMPERATURE	^{0} C	/	/	/
	33.1.4					
	33.1.5					
	33.1.6					
	33.2	FOR BEARING COOLING - IF REQIRED				
	33.2.1	FLOW RATE	M^3/ Hr			
	33.2.2	INLET AND MINIMUM OUTLET PRESSURE	Kg/cm^2 (g)	/	/	/
	33.2.3	INLET AND MAXIMUM OUTLET TEMPERATURE	^{0} C	/	/	/
	33.2.4					
	33.2.5					
	34.	INTAKE FILTER TYPE				
	34.1	FILTER ELEMENT				
	34.2	RATED CAPACITY	M^3/ Hr			
	34.3	EFFICIENCY	%			
	34.4	DESCRIPTIVE LITERATURE TO BE ENCLOSED		WHETHER ENCLOSED YES/ NO		
	34.5					

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER

DATE

ENQUIRY/ SPECIFICATION NO. TCE.

	SL. NO.	ITEM / BIDDER		RECIP	CENT	SCREW
COMPRESSOR DATA (CONTD.)	35.	CAPACITY CONTROL				
	35.1	TYPE AND NUMBER OF STEPS		BY SPEED VARIATION / AT CONSTANT SPEED AND		
	35.2	METHOD EMPLOYED IN CASE OF CONSTANT SPEED TYPE				
	35.3	CONTROL SYSTEM WRITE-UP TO BE ENCLOSED		WHETHER ENCLOSED YES/ NO		
	35.4	WIRING AND TUBING DIAGRAM WITH CONTROL SCHEME TO BE ENCLOSED		WHETHER ENCLOSED YES / NO		
	36.	EQUIPMENT AND ACCESSORIES MOUNTED ON COMMON BASE FRAME WITH THE COMPRESSOR				
	36.1	WEIGHT OF ENTIRE UNIT MOUNTED ON COMMON BASE FRAME	Kg			
	36.2	OVERALL DIMENSIONS OF COMMON BASE FRAME L X W	M	X	X	X
	37.	EQUIPMENT AND ACCESSORIES MOUNTED ON SEPARATE BASE FRAME				
	37.1	WEIGHT OF EQUIPMENT AND ACCESSORIES MOUNTED ON SEPARATE BASE FRAME	Kg			
	37.2	OVERALL DIMENSIONS OF SEPARATE BASE FRAME L X W	M	X	X	X
	38.	NAME AND OVERALL DIMENSIONS OF SINGLE LARGEST COMPONENT TO BE LIFTED L X W X H	M	X	X	X
	39.	NAME AND WEIGHT OF HEAVIEST SINGLE COMPONENT TO BE LIFTED	Kg			

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER

DATE

ISSUE NO. R5	SPECIFICATION NO. TCE.M4-107-01	**TCE CONSULTING ENGINEERS LIMITED**	SECTION : D
		DATA SHEET B **AIR / GAS COMPRESSORS**	SHEET : 5 OF 7
	ENQUIRY/ SPECIFICATION NO. TCE.		

	SL. NO.	ITEM / BIDDER					
COMPRESSOR DATA (CONTD.)				RECIP	CENT	SCREW	
	40.	SUCTION FLANGE - FIRST STAGE SIZE/ STANDARD/ RATING	mm NB/				
	41.	DISCHARGE FLANGE -FINAL STAGE - SIZE/ STANDARD/ RATING	mm NB/				
	42.	IF DRIVE MOTOR IS TO BE FURNISHED BY THE PURCHASER					
	42.1	RATING/ SPEED	KW/RPM				
	42.2	STARTING TORQUE	Kg M				
	42.3	DIRECTION OF ROTATION OF MOTOR AS VIEWED FROM COUPLING END		/	/	/	
	43.	ALL THE ACCESSORIES AS CALLED FOR IN DATA SHEET A TO BE INCLUDED		WHETHER INCLUDED YES / NO			
	44.						

INTER-COOLERS / AFTER-COOLERS				I/C			A/C
				1 STG	2 STG	3 STG	
	45.	DESIGNATION					
	46.	NUMBER OFFERED					
	47.	TAG NUMBERS					
	48.	TYPE		VER/ HOR			VER/HOR
	49.	CAPACITY (FAD)	M^3/Hr				
	50.	COOLING WATER FLOW RATE	M^3/ Hr				
	51.	AIR/ GAS INLET/OUTLET TEMPERATURE	^{0} C	/	/	/	/
	52.	COOLING WATER INLET/ MAXI-MUM OUTLET TEMPERATURE	^{0} C	/	/	/	/

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

ISSUE NO. R5	SPECIFICATION NO. TCE.M4-107-01	**TCE CONSULTING ENGINEERS LIMITED**	SECTION : D
		DATA SHEET B **AIR / GAS COMPRESSORS**	SHEET : 6 OF 7

ENQUIRY/ SPECIFICATION NO. TCE.

	SL. NO.	ITEM / BIDDER					
INTER-COOLERS / AFTER-COOLERS (CONTD.)				I/C			A/C
	53.	AIR/ GAS INLET AND OUTLET PRESSURE	$Kg/cm^2(g)$	/	/	/	/
	54.	COOLING WATER INLET/ MINIMUM OUTLET PRESSURE	$Kg/cm^2(g)$	/	/	/	/
	55.	COOLING SURFACE AREA	M^2				
	56.	DESIGN PRESSURE - AIR/ GAS SIDE	$Kg/cm^2(g)$				
	57.	DESIGN PRESSURE - WATER SIDE	$Kg/cm^2(g)$				
	58.	CODE OF CONSTRUCTION					
	59.	CORROSION ALLOWANCE	mm	3	3	3	3
	60.	NUMBER OF PASSES					
	61.	EMPTY WEIGHT	Kg				
	62.	OPERATING WEIGHT	Kg				
	63.	WATER FILLED WEIGHT	Kg				
	64.	ALL THE ACCESSORIES AS CALLED FOR IN DATA SHEET A TO BE INCLUDED		WHETHER INCLUDED YES / NO			
RECEIVERS	65.	DESIGNATION		RECEIVERS FOR			
	66.	NUMBER OFFERED					
	67.	TAG NUMBERS					
	68.	TYPE		VER/ HOR	VER/ HOR	VER/ HOR	
	69.	CAPACITY	M^3				
	70.	SIZE					
	70.1	DIAMETER	mm				
	70.2	HEIGHT TAN TO TAN	mm				
	71.	DESIGN PRESSURE	$Kg/cm^2(g)$				
	72.	CODE OF CONSTRUCTION					
	73.	CORROSION ALLOWANCE	mm				

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

ISSUE NO. R5	SPECIFICATION NO. TCE.M4-107-01	**TCE CONSULTING ENGINEERS LIMITED** **DATA SHEET B** **AIR / GAS COMPRESSORS**	SECTION : D SHEET : 7 OF 7

ENQUIRY/ SPECIFICATION NO. TCE.

	SL. NO.	ITEM / BIDDER				
RECEIVERS (CONTD.)	74.	THICKNESS				
	74.1	SHELL	mm			
	74.2	DISHED ENDS	mm			
	75.	WEIGHT				
	75.1	EMPTY	Kg			
	75.2	OPERATING	Kg			
	75.3	FILLED WITH WATER	Kg			
	76.	ALL THE ACCESSORIES AS CALLED FOR IN DATA SHEET A TO BE INCLUDED		WHETHER INCLUDED YES / NO		
MISCELLANEOUS	77.	ALL THE VALVES, SPECIALITIES, INSTRUMENTS, COUNTER FLANGES, FOUNDATION BOLTS ETC. AS CALLED FOR IN DATA SHEET A AND AS PER ENCLOSED P & I D TO BE INCLUDED		WHETHER INCLUDED YES / NO		
PERFORMANCE GUARANTEES	78.	CAPACITY OF COMPRESSOR	M^3/ Hr	(+)	(–)	
	79.	DISCHARGE PRESSURE	$Kg/cm^2(g)$	(+)	(–)	
	80.	POWER CONSUMPTION	KW	(+)	(–)	
	81.	TEMPERATURE OF AIR AT OUTLET OF AFTER-COOLER	^{0} C	(+)	(–)	
	82.	COOLING WATER FLOW RATE	M^3/ Hr	(+)	(–)	
	83.	COOLING WATER OUTLET TEMP.	^{0} C	(+)	(–)	
	84.	COOLING WATER PRESSURE DROP	$Kg/cm^2(g)$	(+)	(–)	
	85.					

NOTES

1. IF AIR COOLED COMPRESSOR IS OFFRERED, BIDDER TO FURNISH COOLING SYSTEM DETAILS LIKE NATURAL OR FORCED COOLING, FAN CAPACITY, MOTOR RATING ETC.

LEGEND : I/C = INTER-COOLER, A/C = AFTER-COOLER, STG = STAGE

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

1.0 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, handling at site, erection, testing, commissioning, performance testing and handing over of Air / Gas Compressors and Accessories.

2.0 CODES AND STANDARDS

2.1 The design, materials, construction, manufacture, inspection, testing and performance of the air/ gas compressors and accessories shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

2.2 The following are some of the important codes and standards relevant to this specification.

API 617	Centrifugal Compressors for Petroleum, Chemical, and Gas Service Industry Services
API 618	Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services
API 619	Rotary Type Positive Displacement Compressors for Petroleum, Chemical, and Gas Industry Services
API 672	Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services
ASME SEC. VIII DIV.1	Boiler and Pressure Vessel Code
TEMA	Standards of the Tubular Exchanger Manufacturers Association
IS 2825	Code for Unfired Pressure Vessels
IS 5456	Code of Practice for Testing of Positive Displacement Type Air Compressors and Exhausters
IS 6206	Guide for Selection, Installation and Maintenance of Air Compressor Plants with Operating Pressures up to 10 bars
IS 7938	Air Receivers for Compressed Air Installation
IS 11780	Code for Selection and Testing of Rotary Screw Air Compressors (Oil Flooded)
IS 13124	Reciprocating Gas Compressors - Technical Supply Conditions

3.0 DESIGN AND CONSTRUCTION FEATURES

The compressor shall be of reciprocating or centrifugal or screw type as specified in data sheet A.

3.1 RECIPROCATING COMPRESSORS

3.1.1 Frame

The frame shall be a single casting and robust in construction. It shall be provided with sufficiently large and easily removable inspection doors so that the bearings and other parts are readily accessible for checking and adjustments. Inspection doors shall be dust-proof and oil-tight.

3.1.2 Cylinder

The cylinder shall be made of cast iron or stainless steel or as specified in data sheet A. The cylinder heads and barrels shall be provided with cooling water jackets. The design of jackets shall be such that low air discharge temperature and minimum carbon formation are ensured. The water jackets shall be so constructed that the flow of water is uniform throughout the cooling surface and no stagnant water pockets are formed. The walls of the cylinder shall have sufficient thickness suitable for maximum working pressure and temperature and shall be suitable for reboring. It shall be provided with liberally sized valve openings and stream-lined passages. The internal surface of the cylinder shall be highly polished to reduce wear of the piston rings.

3.1.3 Piston and Piston Rod

The piston shall be of such a design and construction that the piston rings exert equal pressure at all points of the cylinder bore. The piston rod shall be designed to take up the full thrust acting on the piston. The piston rings for non- lubricated type compressor shall be of self lubricating type. Piston speed shall be maximum 300 M/Min for large capacity compressors and 350 M/Min for small capacity compressors.

3.1.4 Cross Head

The cross head shall be of solid box type with the faces ground to work closely with the groove of the guides. The cross head pin shall be case hardened and ground.

3.1.5 Connecting Rod and Crank Shaft

The connecting rod shall be of I cross-section providing adequate strength and rigidity. The crank shaft shall be adequately designed so as to ensure smooth running, without vibrations. It shall be accurately finished to size and shall have sufficient length so as to be fitted to main bearing and flywheel.

3.1.6 Flywheel

The flywheel shall be designed such that it is well balanced and is of sufficient weight to give an even turning moment. The wheel shall be of robust construction. The spokes shall have oval cross-section and the boss shall have split construction such that the wheel runs true with the shaft. The flywheel shall be suitable for type of power transmission i.e. flat belt, V-belt, direct coupling etc. between the driver and compressor.

3.1.7 Main Bearings

The main bearings shall be of robust construction assuring long bearing life and shall have sufficiently large diameter and adequate length. The bearing at the crank pin end of connecting rod shall be fitted with bronze lined with best quality white metal. The bearing at the cross head end shall be fitted with a bushing made of bronze. The bearings shall be made in halves and shall have forced feed lubrication.

3.1.8 Valves

The valves shall have straight and uniform lift and maximum effective area so as to ensure low air velocity and minimum valve clearance. The valve plate discs shall be heat treated, tempered and ground and the valve seat shall be case hardened. The valve springs shall be capable of effecting quick opening and closing and shall also provide the required cushioning effect. The valve design shall be such that the valve can be easily removed for checking and maintenance.

3.1.9 Lubrication

(a) Frame Lubrication

Frame lubrication for small compressors with motor rating upto 55 kW shall be of splash type. The pressurised i.e. forced feed system shall be used for compressors with higher motor rating. In case of force feed lubrication, the oil pump shall be either driven by crank shaft of the compressor or shall be separately driven. The pump shall draw the oil from the adequately sized oil well.

(b) Cylinder Lubrication

For lubricated type of compressors, multi plunger pump or metering pump shall be used for cylinder lubrication. In case of non-lubricated type air compressors, a wiper ring shall be provided such that the crank case oil is not carried to the cylinder along with the piston rod.

3.2 CENTRIFUGAL COMPRESSORS

3.2.1 Casing

Casing shall be either horizontally split or vertically split type made of cast iron for moderate pressure applications, cast steel for high pressure applications or as specified in data sheet A. The thickness of casing shall be suitable for maximum working and test pressures and shall have a corrosion allowance of at least 3 mm.

3.2.2 Impellers

Impellers shall be open, semi-open or closed type consisting of disk, hub and blades. The blades shall be either radial or backward leaning type only. The material of construction shall be as specified in data sheet A. The design shall be such as to produce low operating stress levels giving high mechanical integrity.

3.2.3 Gears

The gears shall be of high speed precision helical type designed as per AGMA standards. The bull gear shall be directly connected to the driver by a low speed coupling. The bull gear may be integrally forged with its shaft. In case bull gear is forged separately, same shall be assembled with an interference fit on its shaft. The pinion shall be integrally forged with its shaft. It shall be hardened and precision ground to AGMA 13 quality of AGMA 2000-A88 for longer life.

3.2.4 Bearings and Seals

The bearings used for pinion and impeller shall be such that high stability and low vibrations are achieved. Tapered - land thrust bearings shall be provided for rotor assembly. Bearing shoes shall be pressure lubricated and steel babbited. Bearings shall be comparatively insensitive to load changes and variations in oil supply pressure. Hydrostatic squeeze film bearings are also acceptable. The bull gear shall be supported by horizontally split sleeve journal bearings and thrust shall be absorbed in either direction by thrust bearings. To prevent any oil vapour contamination and to ensure oil-free air, mechanical type air and oil seals shall be provided on the pinion shaft.

3.2.5 Rotor Assembly

Rotor assembly shall consist of pinion shaft to which impellers are attached. The shaft shall be of forged carbon steel or stainless steel or as specified in data sheet A. A thrust collar shall be provided on pinion shaft.

3.3 SCREW COMPRESSORS

3.3.1 Casing

Casing shall be of barrel type made of cast iron or fabricated steel for moderate pressure applications, cast steel or stainless steel for high pressure applications or as specified in data sheet A. For water injected applications the casing shall be of stainless steel or as specified in data sheet A. Casing shall have built-in air passages either as cast or machined.

3.3.2 Rotors

Rotors shall be of asymmetric profile. The material of construction of rotors shall be as specified in data sheet A. The rotors shall be dynamically balanced before and after mounting timing gears and thrust collars. The rotors shall be ultrasonically tested. For non-lubricated screw compressors rotors shall be lined with PTFE.

3.3.3 Gears

Gear pair shall be used to step up speed of the compressor. Helical gear hardened to minimum 55 RC shall be used. Gear shall be shrink fit on drive shaft and shall mesh with pinion mounted on extended portion of male rotor. Gears shall be designed as per AGMA standards.

3.3.4 Bearings

The rotors shall be carried in heavy duty ball and roller bearings to take radial and axial loads or journal bearings with thin babbitt metal lining.

3.3.5 Air- Oil Separator

In case of lubricated screw compressors, high efficiency air-oil separation system shall be provided to ensure removal of oil.

4.0 **ACCESSORIES**

Accessories such as intake filter, silencer, inter-coolers, after -coolers, oil-coolers, receivers, control cabinet etc. shall be supplied to make the system complete in all respects.

4.1 INTAKE FILTER

The intake filter shall be generally as per IS 6206. The type of intake filter shall be as specified in data sheet A. The filter shall be designed to retain particles of one (1) micron and above with ninety-seven (97) percent efficiency. In case of cloth filter, the filter element may be of nylon, polypropylene or woollen cloth attached to the wire netting .

4.2 INTER-COOLERS

For multi stage compressors, inter-coolers shall be provided. These shall be of shell and tube type, with removable tube bundles. The tubes shall have sufficient thickness to withstand the operating pressure and shall be carefully expanded into the tube sheets. Capacity of inter-coolers shall be twenty (20) percent more than the compressor capacity or as specified in data sheet A. Design pressure shall be twenty-five (25) percent more than the working pressure or as specified in data sheet A. The material of construction and design shall be as specified in data sheet A.

4.3 AFTER-COOLERS AND OIL-COOLERS

The construction features, design etc. shall be as per inter-coolers described above. Capacity of after-coolers and oil-coolers shall be twenty (20) percent more than the compressor capacity or as specified in data sheet A. Design pressure shall be twenty-five (25) percent more than the working pressure or as specified in data sheet A.

4.4 RECEIVERS

Receivers shall generally conform to IS 7938. Receivers shall be provided with two (2) suitably sized safety valves to relieve the full compressor discharge capacity individually and shall be set at a pressure 1.25 times the operating pressure. The material of construction and design shall be as specified in data sheet A.

5.0 MOTOR RATING

Motor shall be of suitable rating considering compressor power requirements. Motor rating shall be calculated as follows :

(a) If compressor shaft input power requirement is 100 KW and above,

$$\text{Motor rating in KW shall be} = 1.10 \times \frac{SKW}{\eta_t}$$

(b) If compressor shaft input power requirement is less than 100 KW,

$$\text{Motor rating in KW shall be} = 1.12 \times \frac{SKW}{\eta_t}$$

Where,
SKW = Shaft Power at selected speed in KW
η_t = Efficiency of transmission

6.0 CAPACITY CONTROL

Capacity control shall be achieved either by speed variation or at constant speed as specified in data sheet A. In case where capacity control is to be achieved at constant speed, following methods are generally available. Data sheet A shall be referred for method to be actually employed.

(a) Automatic start-stop of the compressor
(b) Automatic load-unload of the compressor
(c) Throttling of suction valve
(d) By-passing air or gas from delivery to suction inlet
(e) Increasing clearance volume by a clearance pocket
(f) Variable filling using a by-pass valve.
(g) Movable inlet guide vanes.

6.1 DUAL TYPE CONTROL

Capacity control by start-stop and load-unload of compressors is also known as ‘dual type control’, and same is described below.

6.1.1 The dual type control system shall permit operation of each compressor in either of the following two regulations :

(a) Continuous Run-Load-Unload Regulation.
(b) Automatic Start-Stop Regulation.

6.1.2 Under continuous Run-Load-Unload Regulation, the drive motor shall run continuously while the compressor shall be loaded at pre-set (adjustable) cut-in pressure as the receiver pressure falls and unloaded at a higher pre-set (adjustable) cut-out pressure, as the receiver pressure rises. With automatic Start-Stop Regulation, the drive motor shall automatically start at pre-set

(adjustable) cut-in pressure as the receiver pressure falls and automatically stop at a pre-set (adjustable) higher cut-out pressure as the receiver pressure rises.

6.1.3 With either system, the compressor shall always be unloaded when the drive motor starts. The unloaders shall keep the compressor unloaded till the drive motor comes to full speed.

6.1.4 Each compressor shall be provided with one selector switch having three positions marked AUTO-OFF-ON for the following functions :

(a) OFF - Stops the motor.

(b) AUTO - Keeps the compressor(s) in load / unload mode as selected by master selector switch.

- Starts the motor of the compressor in strart-stop regulation as selected by master selector switch.

(c) ON - For manual start up by push buttons with load / unload regulation.

6.1.5 Two (2) Compressors Operation

A master selector switch common to both the compressors shall be provided having two positions marked ‘AB’ and ‘BA’. When the master selector switch is in position ‘AB’and the individual compressor control switches are in ‘AUTO’ position, compressor ‘A’ shall have continuous run-load-unload regulation and compressor ‘B’ shall have auto start-stop regulation. In the other position of the master selector switch ‘BA’, compressor ‘B’ shall have continuous run-load-unload regulation while compressor ‘A’ shall have start-stop regulation.

6.1.6 Three (3) Compressors Operation

A master selector switch common for three (3) compressors shall be provided having three (3) positions marked ‘AB/C’, ‘BC/A’ and ‘CA/B’. When the individual compressor control switch is in ‘AUTO’ position and the master selector switch is in position ‘AB/C’, compressors ‘A’ and ‘B’ shall have continuous run-load-unload regulation and compressors ‘C’ shall have auto start-stop regulation. Similarly with master selector switch in position ‘BC/A’, compressors ‘B’ and ‘C’ shall have continuous run-load-unload regulation and compressor ‘A’ shall have auto start-stop regulation. With master selector in position ‘CA/B’, compressors ‘C’ and ‘A’ shall have the continuous run-load-unload regulation while compressor ‘B’ shall have auto start-stop regulation.

6.1.7 Four (4) Compressors Operation

A master selector switch common for four (4) compressors shall be provided having four (4) positions marked ‘AB/C’, ‘BC/D’, ‘CD/A’, ‘DA/B’. When the individual compressor control switches are in ‘AUTO’ position and the master selector switch is in position ‘AB/C’, compressors ‘A’ and ‘B’ shall have continuous run-load-unload regulation and compressor ‘C’ shall have auto start-stop regulation. Similarly with master selector switch in position ‘BC/D’, compressors ‘B’ and ‘C’ shall have continuous run-load-unload regulations and compressor ‘D’ shall have auto start-stop regulation. With master selector in position ‘CD/A’ compressors ‘C’ and ‘D’ shall have continuous run-load-unload regulation while compressor ‘A’ shall have auto start-stop regulation. With master selector in position ‘DA/B’ compressors ‘D’ and ‘A’ shall have the continuous run-load-unload regulation while compressor ‘B’ shall have

auto start-stop regulation. Fourth compressor not indicated in the selector position shall be on manual control.

6.2 Two pressure switches shall be provided to monitor receiver pressure for each compressor, one for load-unload control and the other for start-stop control considering two (2) steps regulation for load-unload mode. In case number of steps are more as indicated in data sheet A, number of pressure switches provided shall be sufficient to meet the requirement.

6.3 Pressure switches with alarm initiating contacts shall be provided for the receiver high and low pressures.

6.4 The dual control units shall be complete with pressure switches, solenoid valves, control air tubing, air filter (if required) and other accessories as required for the afore-mentioned operations.

6.5 For centrifugal compressors anti-surge control shall also be provided to protect compressor from surging.

6.6 One potential free contact shall be made available for each compressor for remote alarm under trip condition and a common contact for compressor auto start.

6.7 Green and red lamps shall be provided to indicate motor running and stop conditions respectively.

6.8 Motors shall be provided with motor winding over-heat sensors and bearing temperature sensors for alarm indication and to trip the motor.

6.9 For compressors driven with turbine, the required turbine control and instrumentation shall be provided.

6.10 For air / gas compressors, depending on the hazardous area classification, motors and instrument enclosures shall be explosion-proof certified for the specific area.

7.0 NOISE AND VIBRATIONS

7.1 Noise level produced by any rotating equipment individually or collectively shall not exceed 85 dB(A) measured at a distance of 1.5 metres from the source in any direction.

7.2 The overall vibration level shall be as per zones A and B of ISO 10816-1. Vibration dampening pads if required, shall be provided.

8.0 PERFORMANCE GUARANTEES

Performance parameters to be guaranteed by the CONTRACTOR and tolerances permitted shall be as indicated in section C and / or data sheet A. BIDDER shall confirm acceptance of these by indicating values in data sheet B. Compressor or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

DATA SHEET C

DATA TO BE FURNISHED BY THE CONTRACTOR AFTER THE AWARD OF CONTRACT

1. List of drawings and documents to be submitted for review, approval and information with scheduled submission dates

2. Quality Assurance Plan (QAP)

3. Calculations for compressor capacity, drive motor rating, selection of speed reducers and couplings. Torsional vibration analysis for centrifugal and screw compressors

4. Thermal design calculations for inter-coolers, after-coolers and oil-coolers

5. Detailed P&I diagram showing clearly the scope of supply of equipment, piping with line sizes and material specifications, valves, specialities, instrumentation and control and all the accessories. All equipment, lines, valves, specialities and instruments shall be tagged as per the PURCHASER's procedure to be given to the successful BIDDER. All terminal points shall be clearly identified. All design data and other information furnished in data sheets A and B shall be covered either in this drawing or other relevant drawings or documents mentioned below.

6. Detailed equipment list and bill of materials of all items in the CONTRACTOR's scope

7. Sub-vendor list for all bought-out items

8. Mechanical design calculations for inter-coolers, after-coolers, oil-coolers, moisture and oil separator and receivers

9. Characteristic curves of compressors. For centrifugal compressors, in addition to curves for operating conditions, characteristic curves shall be submitted considering minimum and maximum ambient temperature, minimum and maximum humidity and minimum and maximum frequency conditions

10. Dimensioned to-scale equipment layout drawing showing all equipment, accessories, relevant external dimensions, location and elevation of terminal points, details of piping and electrical connections to be made by the PURCHASER, clearances required for erection, dismantling, operation and maintenance

DATA SHEET C (CONTD.)

11. Dimensioned cross-section drawings of compressors and other proprietary items with part list and materials of construction

12. Detailed fabrication drawings of all fabricated equipment like inter-coolers, after-coolers, air receivers etc.

13. Line designation schedule for all lines in the CONTRACTOR'S scope

14. List of valves, specialities and instruments in the CONTRACTOR'S scope with tag numbers, type, makes, pressure ratings, materials of construction and ranges for instruments etc.

15. Manufacturer's drawings, data sheets and catalogues for valves, specialities and instruments etc.

16. Dimensioned to-scale piping layout drawing for piping in the CONTRACTOR's scope with allowable forces and moments on the piping nozzles and displacement of the nozzles

17. Overall foundation plan, base frame drawing for each equipment, static and dynamic loads on each of the anchor bolts and dimensional details of pockets and anchor bolts

18. Motor drawings

19. Electrical control wiring diagrams with all interlocks

20. Control philosophy, interlock description and logic diagrams

21. Dimensional to-scale general arrangement and section drawings of MCC and instrument control panel with complete bill of materials

22. List of alarms and trip settngs

23. Erection, start-up, operation and maintenance manual complete with lubrication schedule etc.

	GENERAL DATA		
1.0	DESIGNATION		CONVEYING AIR COMPRESSORS .
2.0	TYPE		--DUAL FOR A SET OF 4COMPRESSORS FOR CONV.AIR ---DUAL FOR A SET OF 2 COMPRESSORS FOR INST. AIR3
3.0	NOS. REQUIRED		TWO(2)
4.0			
5.0			
	DESIGN DATA		
6.0	ADJUSTABLE RANGE FOR PRESSURE SWITCHES	Pa	SHALL BE ADJUSTABLE THROUGHOUT THE RANGE
7.0	EXPECTED SETTING OF PRESSURE SWITCHES FOR -		
7.1	LOADING – UNLOADING REGULATION	Pa(g)	
	(a) Loading (b) Unloading		* *
7.2	AUTOMATIC START-STOP REGULATION	Pa(g)	
	(a) Start (b) Stop		* *
7.3	VERY LOW AIR RECEIVER PRESSURE ALARM	Pa(g)	*
7.4	HIGH AIR RECEIVER PRESSURE ALARM	Pa(g)	*
7.5	DETAILS OF POWER SUPPLY TO -		
7.5.1	CONTROLS	V, Ph, Hz	110V, 1 Ph, 50 Hz
7.5.2	ALARM CONTACTS	V, AC/V, DC	110V, 1 Ph, 50 Hz
7.6	SOLENOID VALVE SUITABLE FOR OPERATION	VOLTS	110V, 1 Ph, 50 Hz

NOTES

1)Conveying air compressors
Out of four (4) compressors provided, two(2) compressors shall be operating normally on "load – unload" control, while another two compressors will be on "auto standby".

2)Instrument air compressors
Out of twor (2) compressors provided, one (1) compressor shall be operating normally on "load – unload" control, while another one compressor will be on "auto standby".

* BIDDER TO INDICATE

1.0	**GENERAL DESIGN DATA**		
1.1	Type of Silo Construction /Quantity		RCC FLY ASH & BED ASH SILOS / 2 NOS.
1.2	Construction of Silo by		BY VENDOR
1.3	Bulk Density of Ash for Volume Calculations Fly ash Bed ash	kgs/cu.m	(REFER SYSTEM DATA SHEET) 800 1800
1.4	Bulk Density of Fly Ash for Structural Design Calculations Fly ash Bed ash	kgs/cu.m	 1600 3600
1.5	Amount of Ash to be Stored Bed Ash Fly Ash		 280 tonnes 665 tonnes
1.6	Method of Venting Conveying Air from Silo		THROUGH BAG FILTER TO ATMOSPHERE
1.7	Type of Bunker Level Measurement		CONTINUOUS/RF TYPE
1.8	No. of Outlets Required with Purpose		THREE (3) FOR FLY ASH SILO - -- TWO FOR UNLOADING FLYASH TO CLOSED TRUCKS IN DRY FORM. .--ONE FOR SLURRY PUMPING UPTO ASH SLURRY SUMP. TWO (2) FOR BED ASH SILO - -- ONE FOR UNLOADING BED ASH TO CLOSED TRUCKS IN DRY FORM. .--ONE FOR SLURRY PUMPING UPTO ASH SLURRY SUMP.
1.9	Type of valve at silo outlets		Knife gate valve-Pneumatically operated)
2.0	**ACCESSORIES AND MOUNTINGS**		TO BE SUPPLIED BY BIDDER
2.1	Manhole		YES
2.2	Ladder for Access Inside Silo		YES (SS - LADDER)

2.3	Pressure and Vacuum Relief Door		YES
2.4	Vent Bag Filter		YES
2.4.1	Bag material type		ANTI STATIC
2.4.2	Air to cloth ratio	m/min	1.0
2.4.3	Ash particles in the exhaust of bag filter	mg/ NCu.m	100
2.4.4	Materials of construction		
	a) Casing		G.I
	b) Hopper (if required)		M.S
2.5	Access Staircase from Ground Level to Silo Top		YES
2.6	Silo Fluidising Equipment with Air Slides		YES
2.7	Adequately Sized Openings		YES
2.8	Operating Floor at Slurry Preparation		YES
2.9	Floor Opening as Required		YES
2.10	Silo Ash Level Indication		YES
2.11	Hand Rails and Toe Plates all Round Roof Area Required		YES
2.12	Silo Lining Material		REFRACTORY LINING
2.13	Silo Top Cover		AIR & WATER TIGHT RCC SLAB
2.14	Clear head room from the ash discharge chute upto ground level for trucks to pass through		5 m CLEAR
2.15	Steel bracket assemblies including brackets for vertical pipe runs attached to fly ash silo		YES
2.16	Mono rail with hoist to handle		YES

	equipment from silo top to ground		
2.17	Grating platform for inter-connecting silos at silo unloading platform level and also at silo top		YES
3.0	TESTS AT MANUFACTURER'S WORKS		
3.1	Visual and Dimensional Check of all the Accessories of Silo		YES
3.2			
4.0	NOTES		

ISSUE NO. R6

SPECIFICATION NO.	TCE CONSULTING ENGINEERS LIMITED	SECTION – D4
TCE.M4-116-57	DATA SHEET - B ASH DISPOSAL EQUIPMENT – FLY ASH / FURNACE ASH STORAGE SILO AND ACCESSORIES	SHEET 1 OF 1

ENQUIRY /SPECIFICATION NO.			
SR.NO.	ITEM →	BIDDER →	
1.0	CONSTRUCTION OF SILO BY:		
2.0	QUANTITY OF ASH TO BE STORED	Tonnes	
3.0	METHOD OF VENTING CONVEYING AIR FROM SILO		
4.0	SILO LINING MATERIAL, IF PROVIDED		
5.0	IS PAINTING AS SPECIFIED INCLUDED		YES/NO
6.0	VENT FILTER:		
6.1	Manufacturer		
6.2	Material of Filter Bags		
6.3	Type of Bag Cleaning Arrangement		
6.4	Materials of Construction		
6.4.1	Casing		
6.4.2	Hopper		
7.0	TYPE AND MAKE OF SILO LEVEL INDICATING DEVICE		
8.0	IS CATALOGUE FOR LEVEL INDICATOR ENCLOSED?		YES/NO
9.0	NO OF OUTLETS PROVIDED		

NOTE TO BIDDER
1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

DATA SHEET – C

DATA TO BE FURNISHED BY THE VENDOR AFTER AWARD OF THE CONTRACT

1.0 Dimensional drawing of the silo indicating loadings, openings, connections, etc., to enable the PURCHASER to make detailed design drawings if silo construction is by the PURCHASER.

2.0 Detailed dimensional drawings of silo, indicating all the equipment included in the VENDOR's scope of supply and are to be mounted on the silo, platforms, staircases, handrails, arrangement of silo unloading equipment, (both plan and elevation), if included in the VENDOR's scope of supply, with loading details, fixing details, details of openings required in the floors etc.

3.0 QAP for all the equipment shall be submitted for approval.

4.0 Manufacturers' test certificates for the material of equipment supplied.

5.0 Operation and maintenance manuals for silo mounting equipment.

JET PUMP

1.0	DESIGN DATA	
1.1	Number Required At bottom of Fly Ash Silo At bottom of Bed Ash Silo	 One (1) One(1)
1.2	Location At bottom of Fly Ash Silo At bottom of Bed Ash Silo	 One (1) One(1)
1.3	Max. Size of Ash Particles to be handled (mm)	REFER SYSTEM DATA SHEET IN SECTION C-13
1.4	Design Rate at which Ash has to be Conveyed Fly Ash Bed Ash	 50 TPH 20 TPH
1.5	Discharge Point	ASH SLURRY SUMP
2.0	MATERIALS OF CONSTRUCTION	MATERIAL — HARDNESS BHN (Min.)
2.1	Inlet Piece	ALLOY CI TO IS 4771 WITH MIN. 2.5% NICKEL - 340
2.2	Nozzle Tip (Replaceable)	TUNGSTEN CARBIDE - 500
2.3	Discharge Piece	ALLOY CI TO IS 4771 WITH MIN.2.5% NICKEL - 340
2.4	Nozzle	- DO - - 340
2.5	Throat	- DO - - 340
2.6	Gaskets	RUBBER COMPOUND
3.0	TESTS TO BE CONDUCTED AT MANUFACTURER'S WORKS	
3.1	Visual Inspection and Dimensional Check against Manufacturer's Approved Drawing	
3.2	Hydrotest at 1.5 times the design pressure for various components of jet pump	

2.0	ROTARY FEEDER		
2.1	Designation		FLY ASH & BED ASH
2.2	Number Required 2 dry outlet+1 Slurry outlet for FA 1 dry outlet+1 Slurry outlet for FA	NOS.	 THREE FOR FLY ASH SILO TWO FOR BED ASH SILO
2.3	Design Capacity Slurry Disposal Bed Ash (Design) Fly ash (Design) “Dry Form” Disposal Bed Ash (Design) Fly ash (Design)	 TPH TPH TPH TPH	 20 50 40 98 x 2 Outlets,
2.4	Duty	hrs/day	24
2.5	Material Handled		BED ASH/FLY ASH
2.6	Maximum Lump Size	mm	REFER SYSTEM DATA SHEET
2.7	Density (BED ASH /FLY ASH)	kg/m^3	1800/800
2.8	Temperature	^0C	REFER SYSTEM DATA SHEET
2.9	Abrasive Property		HIGHLY
2.10	Inlet		NOTE-1
2.11	Rotor		NOTE-1
2.12	Shaft		FORGED STEEL
2.13	Housing Outlet		NOTE-1
2.14	Motor by		BY VENDOR
2.15	Control Cabinet		BY VENDOR
2.16	Types of Coupling Transmission Details		V BELT TRANSMISSION, FLEXIBLE COUPLING
2.17	Type of Construction		SPARK RESISTANT CLASS A/B/C
	Notes		

1. Alloy CI - Type 1a as per IS-4771 with hardness of 500 BHN min., for all parts coming in contact with fly ash/bed ash. Alternatively MS fabricated with 10 thick TISCRAL/ SAILHARD liners construction.

SPECIFICATION NO.	TCE CONSULTING ENGINEERS LIMITED	SECTION D5
TCE.M4-116-53	DATA SHEET - B ASH DISPOSAL EQUIPMENT CONTINUOUS DUST CONDITIONER UNLOADER & ROTARY FEEDER	SHEET 1 OF 2

ENQUIRY /SPECIFICATION NO.

SR.NO.	ITEM →	BIDDER →	
1.0	<u>CONTINUOUS DUST CONDITIONER & UNLOADER</u>		
1.1	Number		
1.2	Capacity	T/hr	
1.3	Water quantity required	m^3/hr	
1.4	Pressure of inlet water	Kg/cm^2	
1.5	Location of spray headers		
1.6	<u>Paddle Mixer</u>		
1.6.1	Diameter of paddle mixer		
1.6.2	Speed		
1.6.3	Outlet type		
1.6.4	Shaft of mixer (Type & diameter)		
1.6.5	Type of trough		
1.6.6	Type of shaft		
1.6.7	<u>Material of Construction</u> i) Trough/top cover ii) Paddles iii) Shaft iv) Spray nozzles		
1.7	Head room required for installing the conditioner including metering device (Enclose a sketch)		

NOTE TO BIDDER
1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

SR.NO.	ITEM	BIDDER →	
2.0	ROTARY FEEDER		
2.1	Capacity	T/hr	
2.2	Speed of feeder	RPM	
2.3	Pressure differential for which feeder can seal		
2.4	Material of Construction and thickness of		
2.4.1	Feeder housing		
2.4.2	Inlet piece		
2.4.3	Rotor Vanes		
2.5	Material of rotor shaft		
2.6	Drive Unit		
2.6.1	KW rating of motor	kW	
2.6.2	Type of enclosure for the motor		
2.7	Feeder inlet opening size		
2.8	Feeder outlet opening size		

NOTE TO BIDDE
1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER

DATE

DATA SHEET – C

DATA TO BE FURNISHED BY THE VENDOR AFTER AWARD OF THE CONTRACT

1.0 General arrangement drawings indicating the dimensions, design data and materials of construction.

2.0 Water requirement giving the quantity and pressure.

3.0 Detailed dimensioned general arrangement drawing giving fixing details, loading data, etc. of rotary feeder and conditioner.

4.0 Motor data for rotary feeder and conditioner.

5.0 Operation and maintenance manuals.

6.0 All test certificates

1.0 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's works and delivery at site of Air Blowers.

2.0 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of air blowers shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

3.0 CONSTRUCTION FEATURES

Each air blower shall be a complete unit with casing, inlet and outlet, impeller or rotor, shaft, stuffing box and drive unit etc.

3.1 CASING

3.1.1 Casing shall be of robust construction. It shall be made from casting or fabricated from heavy gauge steel sheets or plates. Castings shall be free from all defects and blowholes and shall be machined to close tolerance. In case of fabricated casings, it shall be rigidly reinforced and supported by structural members. Weld seams shall be continuous to have air-tight enclosure. Casings shall also have smooth interior to avoid accumulation of dense particles. Inlet shall be spun to have a smooth contour. For large blowers, gasketed and bolted split casings are preferable. Using gaskets shall prevent leakage of air from casing joints.

3.1.2 If necessary, provision for ready access to the interiors of casings and other possible trouble points shall be made by means of readily removable, bolted on plates or by hinged and latched doors.

3.2 IMPELLER OR ROTOR

Impeller or rotor shall have die formed blades welded to the rim and back plate. Rim shall be spun to have a smooth contour. Blades shall be of backward, radial or forward type as specified in data sheet A. Rotor assembly shall be securely keyed to the shaft by key and/or nuts. Suitable means shall be provided to prevent loosening during operation. Rotor along with any other rotating parts shall be statically and dynamically balanced to ensure efficient, vibration-free performance and long bearing life.

3.3 SHAFT, SLEEVES AND BEARINGS

3.3.1 The shaft shall be finished to close tolerance at the rotor, coupling, pulley and bearing diameters. The size of shaft shall be calculated on the basis of maximum combined shear stress. This shear stress shall not exceed 30 percent of the elastic limit in tension or 18 percent of ultimate tensile strength.

3.3.2 The design of shaft shall also take into consideration the critical speed of the shaft, which shall be at least 20% above the operating speed or 60 to 75% of the operating speed, to minimise vibrations.

3.3.3 Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing box. The end of the shaft sleeve shall extend through the packing gland. Shaft sleeves shall be securely locked or keyed to the shaft to prevent loosening or rotating.

3.3.4 The bearings may be ball, roller or sleeve bearing. If sleeve bearings are used these shall be machined for close running fit. The bearings shall be designed to take the necessary radial load as well as the net axial thrust. Bearings shall be lubricated properly and sized for a minimum of 40,000 hours of continuous operation.

3.4 STUFFING BOX

Stuffing box shall be provided to ensure leak-proof seal between shaft and casing. Stuffing box shall be designed such that it can be repacked without removing any part other than the gland.

3.5 DRIVE-UNIT

The drive-unit shall be complete with drive motor and coupling or secondary transmission. Secondary transmission may be chain drive with chain and sprocket or belt drive with V-belts and pulleys. Coupling shall be of flexible type. The VENDOR shall furnish both halves of the coupling. Coupling halves shall be bored and keyed to fit shafts of the blower and the motor by VENDOR. A common base plate shall be provided for blower assembly and motor. It shall be rigidly constructed, adequately braced and provided with finish pads for mounting the motor and blower. Suitable holes shall be provided for grouting and these shall be so located that the base plate can be grouted in place without disturbing the blower and motor. Even if the PURCHASER supplies drive motor, the VENDOR shall supply both the halves of coupling duly machined and keyed and base plate with motor mounting bolt holes.

4.0 GENERAL REQUIREMENTS

4.1 Blower shall also be suitable to operate as an exhauster for the vacuum specified.

4.2 Air filter if specified in data sheet A shall have filtering efficiency of 99% down to a particle size of 5 microns.

4.3 Drive motor shall be rated as least 15% higher than the power requirement at duty point or 10% higher than the maximum power requirement at selected speed, whichever is higher. Starting torque requirements of blower shall also be considered while selecting the motor.

4.4 All rotating parts such as coupling, chain or belt drives etc. shall be covered with suitable protective guards. Guards shall be easily removable type.

4.5 Noise level produced by any rotating equipment individually or collectively shall not exceed 85 dBA measured at a distance of 1.5 metres from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1. Balance quality requirement shall be G-6.3 conforming to ISO 1940/1. Vibration dampening pads if required, shall be provided.

4.6 Suitable drain connection shall be provided.

5.0 PERFORMANCE GUARANTEE

Performance parameters to be guaranteed by the VENDOR and tolerances permitted shall be as indicated in section C and/or data sheet A. The BIDDER shall confirm acceptance of these by indicating values in data sheet B. Blower or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

DATA SHEET C

DATA TO BE FURNISHED BY THE VENDOR AFTER THE ISSUE OF PURCHASE ORDER

1. List of drawings and documents to be submitted for review, approval, and information with scheduled submission dates

2. Quality Assurance Plan (QAP)

3. Calculations for capacity, drive motor rating, selection of speed reducers and couplings

4. Performance curves for blower with duty point marked. In addition to curves for operating conditions, characteristic curves shall be submitted considering minimum and maximum ambient temperature, minimum and maximum humidity and minimum and maximum frequency conditions

5. Torque - Speed curve

6. Detailed to-scale dimensioned general arrangement drawing of blower and motor giving foundation details, loading data like static and dynamic loads, unbalanced forces and moments if any, pocket details etc. Drawings shall also include all data and information furnished in data sheets A and B

7. Part list of blower components such as casing, impeller or rotor, inlet and outlet, shaft etc. with materials and codes of construction

8. Overall space and headroom requirement with details of handling during erection, operation and maintenance of the equipment

9. Relief valve and other instrument data sheets, if applicable

10. Erection, operation and maintenance manual with lubrication schedule

1.0	GENERAL DESIGN DATA		
1.1	Designation		*
1.2	Number Required		**
1.3	Capacity	m^3/hr	*
1.4	Discharge Pressure	$kg/cm^2(g)$	*
1.5	Medium Handled		AIR
1.6	Specific Gravity of Medium		
1.7	Maximum Speed	rpm	1500
1.8	Type of Coupling		V.BELT
1.9	Type of Shaft Sealing		MFG. STD
1.10	Type of Drive		ELECTRIC MOTOR
2.0	MATERIAL OF CONSTRUCTION		
2.1	Casing		STEEL
2.2	Shaft		EN-8
2.3	Base Plate		MS/CI
2.4	Rotor		STEEL/MFG STD
2.5	Shaft Sleeves		MFG. STD
2.6	Bearings		ANTI FRICTION
3.0	MOTOR DETAILS		
3.1	Drive Motor By		VENDOR
3.2	Insulation Class		B
3.3	Supply		415 V, 3 PHASE, 50 Hz
3.4	Common/Separate Base Plate By		VENDOR/PURCHASER

4.0	DATA TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT	
4.1	Characteristic Curves to be Compute Delivery Capacity for Air	Yes
4.2	Operating Instructions and Maintenance Manuals	Yes
5.0	NOTES	
5.1	* - Bidder to decide/furnish	
5.2	** - Please refer following table and flow diagram	

SL. NO.	DESIGNATION	QUANTITY	LOCATION
1.	Fly ash/bed ash silo fluidising blower	2(1W +1S) for both silos	In door at AHEH
2.	Ash hopper fluidising blowers	2(1W +1S)	In door at AHEH

ISSUE NO. R4	SPECIFICATION NO. TCE.M4-106-01	**TCE CONSULTING ENGINEERS LIMITED** **DATA SHEET B** **AIR BLOWERS**	SECTION: D6 SHEET: 1 OF 3

ENQUIRY/SPECIFICATION NO. TCE.

	SL. NO.	ITEM / BIDDER		
GENERAL	1.	DESIGNATION		AIR BLOWER FOR
	2.	NUMBER OFFERED		(W + S)
	3.	TAG NUMBERS		
	4.	MAKE AND MODEL NUMBER		
	5.			
	6.			
DESIGN AND PERFORMANCE	7.	CAPACITY (FAD) NORMAL/ MAXIMUM	M^3/Hr	/
	8.	VACUUM CREATED		cm Hg VACUUM
	9.	DISCHARGE PRESSURE	Kg/cm^2g	
	10.	SELECTED SPEED OF BLOWER	RPM	
	11.	CASING MATERIAL/THICKNESS		/ mm
	12.	IMPELLER OR ROTOR DIAMETER	mm	
	13.	IMPELLER OR ROTOR MATERIAL/ THICKNESS		/ mm
	14.	SHAFT MATERIAL/DIAMETER		/ mm
	15.			
ACCESSORIES	16.	MATERIAL OF CONSTRUCTION/ EFFICIENCY OF AIR FILTER		/
	17.	PRESSURE DROP ACROSS AIR FILTER	mm WC	MAXIMUM
	18.	SIZE/MATERIAL OF CONSTRUCTION OF CASING DRAIN VALVE		mm NB/
	19.	SIZE/MATERIAL OF CONSTRUCTION OF RELIEF VALVE		INLET___INCH, OUTLET___ INCH ORIFICE_____ /
	20.	SIZE/MATERIAL OF CONSTRUCTION OF OUTLET DAMPER		mm/
	21.	VIBRATION DAMPENING PADS		CUSHYFOOT(DUNLOP)/
	22.			

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.

2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

ISSUE NO. R4	SPECIFICATION NO. TCE.M4-106-01	**TATA CONSULTING ENGINEERS**	SECTION: D6
		DATA SHEET B **AIR BLOWERS**	SHEET: 2 OF 3

ENQUIRY/SPECIFICATION NO. TCE.

	SL. NO.	ITEM / BIDDER				
DRIVE DATA				MOTOR	COUPLING	V-BELT
	23.	TYPE				
	24.	MAKE				
	25.	MODEL NUMBER				
	26.	ABSORBED POWER AT SHAFT	KW		NA	NA
	27.	POWER INPUT AT DUTY POINT	KW		NA	NA
	28.	RATING	KW			
	29.	SPEED	RPM			
	30.	REDUCTION RATIO		NA	NA	
	31.	EFFICIENCY	%		NA	
	32.	SERVICE FACTOR		NA		
MISCELLANEOUS	33.	NOISE LEVEL AT 1.5 M DISTANCE FROM BLOWER	dBA			
	34.	WEIGHT OF ENTIRE UNIT MOUNTED ON COMMON BASE PLATE	Kg			
	35.	TOTAL DYNAMIC LOAD	Kg			
	36.	DOCUMENTS TO BE ENCLOSED		WHETHER ENCLOSED		
	36.1	GENERAL ARRANGEMENT DRAWING WITH MAJOR DIMENSIONS		YES/NO		
	36.2	PART LIST WITH CODES AND MATERIALS OF CONSTRUCTION		YES/NO		
	36.3	PERFORMANCE CURVE WITH DUTY POINT MARKED		YES/NO		
	36.4	SELECTION CHARTS OR CURVES		YES/NO		
	36.5	LIST OF START-UP SPARES		YES/NO		
	36.6	LIST OF RECOMMENDED SPARES FOR 2 YEARS NORMAL OPERATION		YES/NO		

LEGEND: NA: NOT APPLICABLE

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.

2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

ISSUE NO. R4	SPECIFICATION NO. TCE.M4-106-01	**TCE CONSULTING ENGINEERS LIMITED** **DATA SHEET B** **AIR BLOWERS**	SECTION: D6 SHEET: 3 OF 3

ENQUIRY/SPECIFICATION NO. TCE.

	SL. NO.	ITEM / BIDDER			
PERFORMANCE GUARANTEES	39.	CAPACITY (FAD)	M^3/Hr	(+)	(–)
	40.	DISCHARGE PRESSURE	Kg/cm^2g	(+)	(–)
	41.	POWER CONSUMPTION	KW	(+)	(–)
	42.				
	43.				

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.

2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

1.0 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's works, delivery at site and performance testing at site of Electrically Operated Hoists.

2.0 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of electrically operated hoist shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

3.0 CONSTRUCTION FEATURES

Electrically operated hoist shall be a complete unit with travelling trolley, hoisting motor, travel motor (if travelling trolley is motor operated), rope drum, wire rope, necessary gearing, sheaves, brakes, hook, pendent push button station, contactor panel, all wiring, conductor for travel motion (if travelling trolley is motor operated), limit switches, end stops, buffers, earthing terminals and other accessories to make the equipment complete in all respects. Electrically operated hoist shall have minimum factor of safety as five (5).

3.1 TRAVELLING TROLLEY

The travelling trolley shall be motor driven or push pull or manual geared type as specified in data sheet A. Trolley frames shall be fabricated from rolled structural steel sections. The side plates of the trolley shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalising pin. The wheels shall be machined on their treads to match the profile of the monorail.

3.2 ROPE DRUM

Rope drum shall be as per IS 3938. Rope drum shall be either cast or welded to sustain concentrated loads resulting from rope pull. Drum shall be machine grooved right and left with grooves of a proper shape for the rope used. Grooving shall be of proper length to handle entire rope required to make the specified lift plus the two dead laps at each anchor point, without overlapping.

3.3 WIRE ROPES

Wire ropes shall be extra flexible with well lubricated hemp core having six (6) strands of thirty-seven (37) or thirty-six (36) wires per strand with ultimate tensile strength of 1.6×10^6 KN/M². Wire ropes shall be of Right Hand Ordinary (RHO) lay construction. The rope shall be fastened to the drum with an attachment having strength equal to that of the rope. The rope fastening at the swinging end shall be aligned so as to prevent rope coming off its reeving. Rope shall be of sufficient length so that two (2) full laps shall remain on the drum at extreme low position of the hook. Reverse bends or cross bends and bird caging shall be avoided. The breaking loads for the hoist ropes shall not be less than the factor specified in IS 3938. The load shall include rated load on hooks, weight of the bottom block and the weight of rope.

3.4 LOAD CHAIN AND LOAD CHAIN WHEEL

In case chain is employed for lifting the load instead of wire rope, it shall be heat treated to give required ductility and toughness so that it stretches before breaking. The total length of the load chain shall exceed the minimum length required to give the specified range of lift by not less than three (3) links per fall to ensure that the slack end anchorage is not loaded. The load chain wheel shall be of adequate strength and shall be suitably designed to ensure effective operation of the chain and shall be properly secured with shaft, preferably with splines

3.5 SHEAVES

Sheaves shall be as per IS 3938. These shall be equipped with anti-friction bearings and shall be fully guarded to prevent the rope coming off. Equalising sheaves, if provided, shall also be as per IS 3938. Grooves shall be machined to proper shape for the rope used.

3.6 GEARS

Gears shall be cut from solid cast or forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one piece gear section. Pinions shall be of forged carbon or heat treated alloy steel. All gears and pinions shall be totally enclosed type upto last stage of reduction in all motions and shall be carried in fabricated steel gear boxes which shall be dust proof and firmly sealed to prevent oil leakages. For travel motion, creep speed if specified shall be achieved by one of the following methods :

(a) Planetary gear box integral with main gear box
(b) Planetary gear box independent with motor

(c) Worm reducer with clutch

However, for hoisting motion, creep speed shall be achieved only by methods (a) or (b) indicated above. Creep speed shall be generally 10 % of main speed.

3.7 BEARINGS

Bearings may be ball or roller type. All anti-friction bearings shall be of approved make, which are interchangeable with corresponding size bearings of other make. Bearing housings shall be of split type or so designed to permit easy removal of the shaft. The design shall be such that there is no ingress of dust and oil or grease does not leak out. Bearings shall have a minimum life expectancy of 20 years based on equivalent running time as per specified class.

3.8 SHAFTS AND AXLES

Shafts and axles shall be of forged steel and shall have ample strength, rigidity and adequate bearing surface for intended duties. Shafts and axles shall be accurately machined and properly supported. Shafts shall, as far as possible, be furnished straight. If shouldered, these shall be provided with fillets of ample radius or shall be tapered to avoid loss of strength and stress concentration. These shall be designed considering allowances for keys and splines.

3.9 BRAKES

All brakes shall be of ‘fail-safe’ design and shall operate automatically in case of power failure. Each of the trolley and hoisting motors shall be equipped with electrically released, spring set, friction shoe type brakes. Hoisting brake shall be designed to hold 1.5 times full load torque while trolley travel brake shall be designed to hold 1.25 times full load torque. Separate brakes shall be provided for creep motions. All brakes shall have weather-proof enclosures. Coupling halves shall not be used as brake drums.

3.10 LIFTING HOOK

The lifting hook shall be single hook type, solid, forged, heat treated, of rugged construction and provided with a standard depress type safety latch. Lifting hook shall have swivels and operate on ball or roller thrust bearings with hardened races. Lock to prevent hook from swivelling shall be provided.

3.11 BUFFERS, STOPS AND SWEEPS

3.11.1 Spring or rubber buffers shall be provided on the trolley. Suitable end stops shall be provided which shall be welded on the ends of monorail to contact the buffers mounted on the trolley.

3.11.2 Trolley wheel stops shall be provided before the end stops. These shall match to wheel radius. Stops to prevent trolley from running off the monorail shall be abutted against ends of monorail. Stops shall be welded to the monorail.

3.11.3 Sweeps shall be attached to the trolley to remove foreign material from the rails.

3.12 GUARDS

3.12.1 All exposed couplings, shafts, gear wheels, pinions, drives etc. shall be safely encased and guarded.

3.12.2 The sheaves of hook blocks shall be guarded to prevent trapping of hand between a sheave and the in-running rope.

4.0 ELECTRICAL EQUIPMENT

4.1 MOTORS

Drive motors shall be as per IS 325 and companion specification TCE.M4-203-01. Motor shall be suitable for frequent reversal, braking and acceleration. Pull-out torque shall be 2.15 times the rated torque.

4.2 PENDENT PUSH BUTTON STATION

The pendent push button station shall be supported independently, earthed separately independent of suspension and shall comprise the following push buttons and indicating lamps :

(a) ‘Start’ and ‘Stop’
(b) Trolley travel - ‘To’ and ‘Fro’
(c) Hook - ‘Hoist’ and ‘Lower’

Red lamp shall indicate supply ‘ON’

4.3 MISCELLANEOUS

Controllers and resistors, controls, electrical protective devices, cables and conductors, earthing guards etc. shall be as per IS 3938. Limit switches shall be provided for overhoisting and overlowering and for two extreme ends of trolley travel.

TCE.M4-113-54	**TCE CONSULTING ENGINEERS LIMITED**	SECTION : D7
ENQ. SPEC. NO.	**DATA SHEET A** **ELECTRICALLY OPERATED HOISTS**	SHEET : 1 OF 2

GENERAL	1. DESIGNATION: NOTE-3	DESIGN DATA (CONTD.)	23. TYPE OF TROLLEY : MOTOR DRIVEN /
			24. HOISTING SPEED : 5.0 M/min.
	2. NUMBER REQUIRED : NOTE-3		25. TROLLEY TRAVEL SPEED : 10.0 M/min.
	3. TAG NUMBERS : NOTE-3		26. CREEP SPEED REQUIRED FOR :
	4. LOCATION IN HAZARDOUS AREA: NO		26.1 HOIST AND TROLLEY : NO
	5. HAZARDOUS AREA CLASSIFICATION AS PER IS 5572 ZONE 0/1/2		27. TYPE OF DOWN SHOP LEAD : FLEXIBLE TRAILING CABLE / PVC SHROUDED BUS BAR
	6. LOCATION: INDOOR		
	7. APPLICABLE STANDARD : IS 3938		28. METHOD OF OPERATION : PENDENT PUSH BUTTON STATION
	8. DUTY CLASS : 2		
	9. HOT METALS HANDLED : NO		29. INCHING AND PLUGGING CONTROLS
	10.		29.1 INCHING CONTROL REQUIRED FOR : HOISTING AND / OR TRAVEL
	11.		
DESIGN DATA	12. TYPE : LUG OR HOOK OR TROLLEY : SUSPENDED OR BASE MOUNTED		29.2 PLUGGING CONTROL REQUIRED FOR HOISTING AND / OR TRAVEL
	13. CAPACITY: BY BIDDER T		30. MOTORS : REFER TCE.M4-203-01 AND / OR TCE.M4-203-02
	14. RANGE OF LIFTING: AS PER VENDOR REQUIREMNTS ELEVATION FROM TO M	MATERIALS AND CODES OF CONSTRUCTION	31. TROLLEY WHEELS : RIM TOUGHENED, HEAT TREATED CAST OR FORGED OR ROLLED STEEL / GRADED CAST IRON (NOTE 1)
	15. OPERATING FLOOR ELEVATION: AS PER VENDOR REQUIREMNTS		32. ROPE DRUM AND SHEAVES : IS 3938 (NOTE 1)
	16. BOTTOM OF MONORAIL ELEVATION: BY BIDDER		33. WIRE ROPE : IS 2266
	17. LENGTH OF MONORAIL: BY BIDDER M		34. CHAIN DRUM OR CHAIN WHEEL : HEAVY DUTY MALLEABLE CASTING / PRESSED SHEET STEEL (NOTE 1)
	18. MONORAIL TRACK : BIDDER TO DECIDE STRAIGHT/ CURVED		35. CHAIN : ALLOY STEEL IS 3109 / IS 6216
	19. RADIUS OF CURVATURE OF MONORAIL : BY BIDDER M		36. GEARS AND PINIONS : SPUR/ HELICAL AS PER IS 4460/ BS 436/ BS 721/ AGMA STANDARDS (NOTE 1)
	20. MONORAIL BY : PURCHASER		
	21. SIZE OF MONORAIL (IF PROVIDED BY PURCHASER) :		
	22. TYPE OF HOIST : WORM / SPUR GEAR		

REV.NO.	01		PPD.BY : DS/KS	JOB NO.	CLIENT : BORL; EPCC:BHEL
DATE	23-5-08		CHD.BY : KG	TCE. 5178A	PROJECT : 3x33 MW CPP AT BINA
REV.BY					

ISSUE NO. R5	TCE.M4-113-54	**TCE CONSULTING ENGINEERS LIMITED**	SECTION : D7
	ENQ. SPEC. NO. TCE. 5178A-C-563-015	**DATA SHEET A** **ELECTRICALLY OPERATED HOISTS**	SHEET : 2 OF 2

MATERIALS AND CODES OF CONSTRUCTION	37. BEARINGS : BALL OR ROLLER TYPE ANTI-FRICTION BEARINGS AS PER IS 5669/ IS 5692/ IS 5932/ IS 5935	TESTS AND INSPECTION	48. TCE.M4-904 AND / OR TCE.M4-185-01 AND TCE.M4-185-69 OR TCE.M4-186-11
	38. SHAFTS AND AXLES : CARBON STEEL		49. OVERLOAD TEST WITH 125 % OF SPECIFIED LOAD : YES
	39. BRAKES : ELECTROMAGNETIC / ELECTRO THRUSTORS		50. TEST LOADS : BY VENDOR /
	40. LIFTING HOOK : FORGED AND HEAT TREATED ALLOY STEEL / CARBON STEEL AS PER IS 2758 / IS 2759 / IS 3813 / IS 3815 TABLE 1 / IS 3815 TABLE 3 / IS 3822 / IS 4164 / IS 8610		51. SPEED CHECK FOR ALL MOTIONS: YES
			52. INSULATION TEST FOR ALL ELECTRICAL EQUIPMENT : YES
			53. PERFORMANCE TEST AT SITE BY VENDOR : YES / NO
	41. LUBRICATION : CENTRALISED GREASE LUBRICATION WITH HAND OPERATED GREASE PUMP		54.
			55.
	42.	LIST OF APPROVED SUB-VENDORS	56. MOTORS :
SPARES AND MAINTENANCE TOOLS AND TACKLES	43. REFER TCE.M4-907		57. BRAKES :
	44. ESSENTIAL SPARES		58. LIMIT SWITCHES :
	44.1		59. BEARINGS :
	44.2		60. MINIMUM ONE ELECTRIC HOIST FOR ILMS AND CRUSHER IN CRUSHER HOUSE AND ONE FOR SCREEN IN SCREEN HOUSE .
	44.5		
	45. FINISH PAINT : SYNTHETIC ENAMEL		

NOTES

1. BIDDER SHALL DECIDE NUMBER, CAPACITY, LIFT ETC TO SUIT HIS LAYOUT AND EQUIPMENT .
2. ALL ELECTRICAL EQUIPMENT SHALL BE SUITABLE FOR SPECIFIED HAZARDOUS ZONE AS PER IS 5572.
3. BIDDER HAS TO SPECIFY AND JUSTIFY THE REQUIREMENT.

REV.NO.	01		PPD.BY : DS/KS	JOB NO.	CLIENT : BORL; EPCC: BHEL
DATE	23-05-08		CHD.BY : KG	TCE. 5178A	PROJECT : 3 X 33 CPP AT BINA
REV.BY					

ISSUE NO. R5	SPECIFICATION NO. TCE.M4-113-54	**TCE CONSULTING ENGINEERS LIMITED** **DATA SHEET B** **ELECTRICALLY OPERATED HOISTS**	SECTION : D7 SHEET : 1 OF 3

	SL. NO.	ITEM ↓ / BIDDER →			
GENERAL	1.	DESIGNATION		ELECTRICALLY OPERATED HOIST FOR	
	2.	NUMBER OFFERED			
	3.	TAG NUMBERS			
	4.	CAPACITY	T		
HOIST	5.	MANUFACTURER			
	6.	MAKE			
	7.	MODEL NUMBER			
	8.				
	9.				
TROLLEY	10.	MANUFACTURER			
	11.	MAKE			
	12.	MODEL NUMBER			
	13.				
ELECTRICAL REQUIREMENTS	14.	HOIST MOTOR :		MAIN	CREEP
	14.1	MAKE			
	14.2	TYPE			
	14.3	RATING	KW		
	14.4	SPEED	RPM		
	15.	TROLLEY MOTOR :		MAIN	CREEP
	15.1	MAKE			
	15.2	TYPE			
	15.3	RATING	KW		
	15.4	SPEED	RPM		
	16.	LIMIT SWITCHES FOR :			
	16.1	HOISTING : MAKE, TYPE AND NUMBERS PROVIDED			
	16.2	TRAVELLING: MAKE, TYPE AND NUMBERS PROVIDED			

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

	SL. NO.	ITEM ↓ / BIDDER →		
ELECTRICAL REQUIREMENTS (CONTD.)	17.	TYPE OF DOWN SHOP LEAD		
	17.1	MAKE		
	17.2	SIZE		
	17.3	LENGTH	M	
	17.4	SUPPORTING ARRANGEMENT		
	17.5	IF CURVED MONORAIL, NUMBER OF CABLE TROLLEYS PROVIDED AND WIDTH OF EACH TROLLEY	NO./ mm	
	18.			
	19.			
	20.			
	21.			
DIMENSIONS	22.	MONORAIL IF PROVIDED BY VENDOR : INDICATE BEAM SIZE MINIMUM/ MAXIMUM SUITABLE FOR TROLLEY MOVEMENT	mm	ISMB / ISMB
	23.	MONORAIL IF PROVIDED BY PURCHASER : IS SIZE SPECIFIED IN DATA SHEET A SUITABLE FOR TROLLEY MOVEMENT		YES/ NO IF NO, INDICATE SUITABLE SIZE ISMB
	24.	DISTANCE BETWEEN HIGHEST HOOK POSITION TO BOTTOM OF MONORAIL	mm	
	25.	IF MONORAIL IS CURVED, MINIMUM RADIUS TROLLEY CAN NEGOTIATE	mm	
	26.			
MATERIALS OF CONSTRUCTION	27.	IF HOIST IS IN HAZARDOUS AREA :		
	27.1	TROLLEY WHEELS		
	27.2	ROPE DRUM AND SHEAVES		
	27.3	GEARS AND PINIONS		
	28.			
	29.			

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

	SL. NO.	ITEM ↓ / BIDDER →		
MISCELLANEOUS	30.	WIRE ROPE DIAMETER	mm	
	31.	WIRE ROPE BREAKING LOAD	KN	
	32.	WEIGHT OF COMPLETE HOIST AND TROLLEY ASSEMBLY	Kg	
	33.	WEIGHT OF HOIST	Kg	
	34.	WHEEL LOAD WITH IMPACT AND WITHOUT IMPACT	Kg	/
	35.	PRELIMINARY DIMENSIONED GENERAL ARRANGEMENT DRAWING OF ELECTRICALLY OPERATED HOIST ALONG WITH WHEEL STOP DETAILS TO BE FURNISHED		WHETHER FURNISHED YES/ NO
	36.			
	37.			
	38.			
	39.			

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

1.0	GENERAL DESIGN DATA		
1.1	Material of all Piping Except 2.2		CAST IRON PIPES TO IS:1536, CLASS-D (OF STANDARD LENGTH)
1.2	Material of Piping for Items No. 2.6 & 2.7		MS ERW PIPES TO IS: 3589 MIN. 6 mm THICK OR MS PIPE TO IS:1239 PART-I, HEAVY CLASS
1.3	Material of Piping for Item No. 2.1,2.4,2.3		MS ERW PIPES MIN.9.3MM THICK AS PER IS : 3589 OR MS ERW PIPES OF MIN. 6.53 MM THICK AS PER IS:3589 WITH 20 MM THICK CAST BASALT LINING
1.4	Material of fittings		Ni-Cr ALLOY CAST IRON WITH MINIMUM 500 BHN – 600 BHN(AS PER IS-4771 Type-1a) OR 25 THK.BASALT LINERS
1.5	Type of Wearback for Fittings		INTEGRAL
1.6	Necessary Steel hangers, supports and inserts in concrete for Piping		BY VENDOR
1.7	Thickness of Wearbacks		MINIMUM TWICE THE PIPE WALL THICKNESS
1.8	Radius of 90^0 Bends		MINIMUM THREE TIMES NORMAL PIPE DIAMETER.
1.9	Pipe Joints		FLANGED WITH EVERY THIRD JOINTOF SLEEVE COUPLING
1.10	Deflection in Sleeve Coupling		MINIMUM 3 DEG.
1.11	Gap between ends of Pipes at Coupling		SUFFICIENT TO TAKE CARE OF EXPANSION OF PIPES
1.12	Material for Sleeve Coupling		STEEL SLEEVE WITH STEEL/C.I FLANGES AND RUBBER GASKETS.

1.13	Location		OUTDOOR
2.0	LINES INCLUDED		
2.1	Piping from silo jet pumps to ash slurry sumps.		YES
2.2	Discharge piping f drain sump pumps and B.A.overflow pumps	YES	
2.3	Piping from B.A jet pumps to slurry sump		YES
2.4	Piping from slurry pumps to slurry disposal area		YES
2.5	All other piping not specified above but required for the system envisaged.		YES
2.6	Sludge piping		YES
2.7	Ash water recovery system		YES
3.0	TESTS AND TEST CERTIFICATES		
3.1	Test certificates for materials of Construction of Piping and Fittings		YES
3.2	Hydrostatic Test at Works for Piping and Fittings		YES
4.0	NOTES		
4.1	Ni-Cr Alloy C.I Used for Fittings shall be of Ni-Hard/Ni-Resist Type as per ASME.		
4.2	All other ash slurry piping not listed here but required to make the system complete shall be included in the BIDDER's scope of supply.		

ISSUE NO.	SPECIFICATION NO.	TCE CONSULTING ENGINEERS LTD	SECTION D9
	TCE-3472-116-60	DATA SHEET - A ASH SLURRY LINE VALVES	SHEET 1 OF 1

1.0	GENERAL DATA		
			REMOTE OPERATED VALVES / MANUALLY OPERATED VALVES
1.2	Number Required		REFER FLOW DIAGRAM
1.3	Type		PLUG VALVE/ KNIFE EDGE TYPE GATE VALVE / PLUG VALVE/ KNIFE EDGE TYPE GATE VALVE
1.4	Ash Slurry Flow Through Valve	Cu.m/hr	BY BIDDER
1.5	Size of Valves		BY BIDDER
2.0	MATERIALS OF CONSTRUCTION		
2.1	Knife Gate Valves		
2.1.1	Body & Seat material and hardness		SS 304 NITRIDED TO 500 - 600 BHN
2.1.2	Plate/flap Material and Hardness		SS 304 EDGE STELLITED TO MIN. 1 MM THICK
2.1.3	Shaft Material and Hardness		SS - 316
2.1.4	Deflector Cone		Ni-HARD ALLOY CI 450 BHN
2.2	Taper Plug Valves		
2.2.1	Body material		CI
2.2.2	Plug material and hardness		CASE HARDENED CARBON STEEL WITH ANTIFRICTION PTFE COATING ON THE PLUG
3.0	NOTES		
3.1	All Parts of Valves Coming in Contact with Slurry shall be		WEAR AND CORROSION RESISTANT
3.2	The Valves shall be Provided with Operating Hand Wheel and Position Indicator		YES

1.0	**GENERAL DATA**			
1.1	Type		REMOTE / MANUALLY OPERATED	
1.2	Number required			
1.3	Type of water used in ash slurry		FRESH WATER	SEA WATER
1.4	Ash Slurry Flow Through Valve	Cu.m/hr		
2.0	**MATERIALS OF CONSTRUCTION**			
2.1	**Knife Gate Valves**			
2.1.1	Body material and hardness		SS 304 Nitrided to 500 TO 600 BHN	SS 316 Nitrided TO 500 TO 600 BHN
2.1.2	Plate/flap : Material and hardness		SS 304 edge stellited to min. 1 MM thickness	SS 316 EDGE stellited to min. 1 MM thickness
2.1.3	Shaft Material		SS 316	SS 316
2.1.4	Deflector cone		Alloy cast iron 450 BHN	Alloy cast iron 450 BHN
2.2	**Taper Plug Valves**			
2.2.1	Body material and hardness		Cast Iron FG 260	ALLOY CAST IRON, 340 BHN
2.2.2	Plug material and hardness		Case hardened carbon steel with antifriction PTFE coating	Corrosion resistant Alloy Cast Iron with PTFE coating
3.0	Type of actuation for remote operated valves		Motor/Cylinder operated	Motor/Cylinder operated
4.0	Hydrostatic Test for Valve Body and Seat Tightness		Zero leakage should be achieved	Zero leakage should be achieved
5.0	All parts of valves coming in contact with slurry shall be		Wear resistant	Wear and corrosion resistant
6.0	Painting of Ferrous surfaces by		VENDOR / PURCHASER shall be as per Section – C.	

7.0	All valves shall be provided with operating hand wheel and position indicator. Hand chain shall be provided if the wheel is not reachable from the operating platform.		
8.0	For general inspection requirements TCE.M4-185-01 shall be followed		
9.0			

ISSUE NO. R6

SPECIFICATION NO.	TCE CONSULTING ENGINEERS LIMITED	SECTION D9
TCE.M4-116-60	DATA SHEET - B ASH DISPOSAL EQUIPMENT ASH SLURRY LINE VALVES	SHEET 1 OF 1

ENQUIRY /SPECIFICATION NO.

SR.NO.	ITEM →		BIDDER →	
			KNIFE GATE VALVE	TAPER PLUG VALVE
1.0	MANUFACTURER			
2.0	NUMBER OF VALVES			
3.0	LINE SIZE	MM		
4.0	ASH SLURRY FLOW RATE THROUGH VALVE	Cu.m/hr		
5.0	VALVE BODY			
5.1	Material			
5.2	Hardness	BHN		
6.0	PLATE/PLUG			
6.1	Material			
6.2	Hardness	BHN		
7.0	SHAFT MATERIAL			
8.0	IF REMOTE OPERATED TYPE, INDICATE			
8.1	Type of Actuation			
8.2	Quantity of Compressed Air Required if any	Nm^3/hr		
8.3	Pressure of Compressed Air Required if any	$Kg/cm^2(g)$		
8.4	Motor rating incase of electrically actuated valve			
9.0	WHETHER CATALOGUES ENCLOSED?		YES/NO	

NOTE TO BIDDER
1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

DATA SHEET – C

DATA TO BE FURNISHED BY THE VENDOR AFTER AWARD OF THE CONTRACT

1.0 DRAWINGS / DOCUMENTS TO BE SUBMITTED FOR APPROVAL

1.1 Dimensional drawing indicating materials of construction and hardness of various components.

1.2 QAP

2.0 DRAWINGS / DOCUMENTS TO BE SUBMITTED FOR REFERENCE

2.1 Manufacturers' test certificates for the material supplied for various components.

2.2 Hydrostatic test certificates

2.3 Operation and maintenance manuals.

1.0	DESIGNATION			BY BIDDER
2.0	QUANTITY		No.	One (1)
3.0	LIQUID PUMPED			Bed Material Slurry
4.0	LIQUID TEMPERATURE		°C	Ambient
5.0	SPECIFIC GRAVITY			REFER SYSTEM DATA SHEET IN C-13
6.0	PERCENT OF SOLIDS		%	25%
7.0	MAXIMUM SIZE OF SOLIDS		mm	REFER SYSTEM DATA SHEET IN C-13
8.0	**PUMP AND SUMP DATA**			
8.1	Capacity		cu.m/hr	BY BIDDER
8.2	Total head		m/c	By BIDDER
8.3	Maximum speed		rpm	By BIDDER
8.4	Sump length and width		mm	REFER BHEL DWG NO. 0-381-01-00815
8.5	Depth of sump	A	mm	REFER BHEL DWG NO. 0-381-01-00815
8.6	Maximum operating level	C	mm	REFER BHEL DWG NO. 0-381-01-00815
8.7	Submergence level	N	mm	REFER BHEL DWG NO. 0-381-01-00815
8.8	Bottom clearance	D	mm	REFER BHEL DWG NO. 0-381-01-00815
8.9	Clearance from side wall	L	mm	REFER BHEL DWG NO. 0-381-01-00815
8.10	Pipe terminal point	H	mm	To ash slurry sump
9.0	**CONSTRUCTION FEATURES**			
9.1	Type of lubrication			OIL/ GREASE/
9.2	Type of impeller			SEMI-OPEN
9.3	Automatic float level switch for start/stop			YES
9.4	Suction strainer			YES
9.5	Companion flanges			YES
9.6	Discharge point			ABOVE BASE PLATE
9.7	Location			INDOOR IN TUNNEL
10.0	**MATERIALS OF CONSTRUCTION**			

10.1	Casing		Cast iron
10.2	Impeller		Cast Iron
10.3	Pump shaft		EN8
10.4	Line shaft		EN8
10.5	Shaft enclosing pipe		
10.6	Discharge pipe		
10.7	Strainer		
10.8	Cover plate		
10.9	Stuffing box		
11.0	**MOTOR BY**		VENDOR
12.0	**INSPECTIONS AND SHOP TESTS**		
12.1	Visual inspection		YES
12.2	Performance test		YES
12.3	Hydrostatic test certificate		YES
12.4	NPSH test		NO
12.5	Type and routine test certificate		YES
12.6	Material test certificates		YES
13.0	**NOTES**		
13.1	Material test certificates shall be furnished for all components		
13.2	The rating of the drive motor shall be at least 125% of the power required by the pump at duty point		
13.3	Hydrostatic test shall be conducted at twice the total head or 1.5 times the shut off head, whichever is greater.		
13.4	If cooling water for line bearings is required the same shall be drawn from the pump discharge pipe. Vendor shall provide all the		

necessary pipes and fittings for supplying water to the line bearings.

ISSUE NO. R4

SPECIFICATION NO. TCE-M4-105-12	TCE CONSULTING ENGINEERS	SECTION D-11
ENQ.SPEC.No. TCE.	DATA SHEET - B SUMP PUMPS	SHEET 1 OF 2

ENQUIRY /SPECIFICATION NO.

SR.NO.	ITEM →	BIDDER →	
1.0	MAKE		
2.0	MODEL NUMBER		
3.0	QUANTITY	no.	
4.0	**GUARANTEED PERFORMANCE**		
4.1	Capacity	cu.m/hr	
4.2	Total head	mlc	
4.3	Shut-off head	mlc	
4.4	Speed	rpm	
4.5	Efficiency	%	
4.6	Pump input	kW	
4.7	Recommended motor rating	kW	
4.8	Sealing water (if required) quantity and pressure	cu.m/hr kg/sq.cm (g)	
4.9	Maximum size of solids	mm	
5.0	TYPE OF STUFFING BOX SEAL		
6.0	TYPE OF PUMP LUBRICATION		OIL/GREASE/EXTERNAL WATER/SELF LUB
7.0	DISCHARGE PIPE	mm	
8.0	DISCHARGE PIPE END		SCREWED/FLANGED
9.0	FLANGE DRILLING STANDARD		
10.0	WEIGHTS	kg	(a) PUMP WITH COVER PLATE (b) MOTOR
11.0	**DIMENSIONS** (REFER DATA SHEET-A)		
11.1	Pump setting length 'B' FILE NO. M410512B.DOC	mm	
11.2	Minimum bottom clearance required 'D'	mm	

NOTE TO BIDDER

1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

SR.NO.	ITEM →		BIDDER →
11.3	Minimum side clearance required from centre line of pump 'E'		
11.4	Minimum submergence required from bottom of sump 'N'	mm	
11.5	Minimum clearance required for removal of pump parts and motor (including height of slings on lifting tackle used)	m	
11.6	Sump dimensions required for the offered pump (L x B x D)	mm	
11.7	Opening dimensions on cover slab	mm	

NOTE TO BIDDER

1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

DATA SHEET - C
SUMP PUMPS

DATA TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT

1.0 The Vendor shall submit the following key drawings/data having engineering information to the Purchaser/ Engineer as listed below.

1.1 Detailed dimensioned general arrangement drawing of sump pump and motor indicating important design data such as capacity, total head, efficiency, drive motor, sealing water requirement (if any), (quantity and pressure), clearance of sump required, base plate details, loads, weights of pump and motor, vertical clearance required for removal of pump and motor etc.

1.2 Cross-sectional drawing of pump with complete bill of materials.

1.3 Performance characteristics curves of pump

1.4 Foundation drawings with details of fixing, grouting, plinth size, anchor bolts etc. shown on the drawing.

1.5 Operation, erection and maintenance manuals.

ISSUE NO. R3	TCE.M4-113-50	**TCE CONSULTING ENGINEERS**	SECTION : D-12
	ENQ.SPEC.NO. TCE.	**DATA SHEET -A** **CHAIN PULLEY BLOCK**	SHEET : 1 OF 2

GENERAL	1. DESIGNATION: CHAIN PULLEY BLOCK FOR	DESIGN DATA (CONTD.)	20. TYPE OF TROLLEY: PUSH TYPE/ MANUAL GEARED
	2. NUMBER REQUIRED: BY BIDDER		21. HAND CHAINS LOCATION: THE HAND-CHAIN FOR THE HOISTING AND TRAVERSING MECHANISM SHALL BE WELL CLEAR OF THE HOOK AND BOTH CHAINS SHALL BE ON THE SAME SIDE
	3. TAG NOS.: BY BIDDER		22.
	4. LOCATION IN HAZARDOUS AREA: YES/ NO		23.
	5. HAZARDOUS AREA CLASSIFICATION : AS PER IS 5572 ZONE 0/1/2		24.
	6. LOCATION : INDOOR/ OUTDOOR	MATERIALS AND CODES OF CONSTRUCTION	25. CHAIN PULLEY BLOCK : AS PER IS 3832/ BS 3243
	7. APPLICABLE STANDARD : IS 3832/ BS 3243		26. TROLLEY FRAME : ROLLED STRUCTURAL STEEL WITH SIDE PLATES EXTENDED BEYOND WHEEL FLANGES TO PROTECT WHEELS
	8. DUTY CLASS : 1 / 2		27. TROLLEY WHEELS : HEAT TREATED CARBON STEEL/ LOW ALLOY STEEL/ GRADED CAST IRON. SINGLE FLANGED WITH TAPERED TREAD (NOTE 1)
	9.		28. LOAD CHAIN : ALLOY STEEL IS 3109/ IS 6216/ BS 1663/ BS 3114
DESIGN DATA	10. TYPE : LUG OR HOOK OR TROLLEY SUSPENDED		29. LOAD CHAIN WHEEL AND MAIN ARM : HEAVY DUTY MALLEABLE CASTING/ PRESSED SHEET STEEL (NOTE 1)
	11. CAPACITY: BIDDET TO INDICATE Kg		30. HAND CHAIN : AS PER IS 2429/ BS 6405
	12. RANGE OF LIFTING : ELEVATION FROM TO M		31. HAND CHAIN WHEEL : PRESSED SHEET STEEL (NOTE 1)
	13. OPERATING FLOOR ELEVATION: M		32. SHAFTS AND AXLES : CARBON STEEL
	14.BOTTOM OF MONORAIL ELEVATION: M		
	15. MONORAIL TRACK: STRAIGHT/CURVED		
	16. RADIUS OF CURVATURE OF MONORAIL: M		
	17. MONORAIL BY: PURCHASER/ VENDOR		
	18. SIZE OF MONORAIL (IF PROVIDED BY PURCHASER) : ISMB		
	19. TYPE OF CHAIN PULLEY BLOCK : WORM/ SPUR GEAR		

REV.NO.	00			PPD. BY DS/KS	JOB NO.	OWNER:BHEL; EPCC:BHEL
DATE				CHD. BY KG	TCE.	
REV. BY				DATE 23-05-08	5178A	PROJECT:3X33MW CPP, BINA

ISSUE NO. R3	TCE.M4-113-50	**TCE CONSULTING ENGINEERS**	SECTION : D-12
	ENQ.SPEC.NO. TCE.	**DATA SHEET -A** **CHAIN PULLEY BLOCK**	SHEET : 2 OF 2

MATERIALS AND CODES OF CONSTRUCTION (CONTD.)	33. GEARS AND PINIONS : SPUR/ HELICAL AS PER IS 4460/ BS 436/ BS 721/ AGMA ATANDARDS (NOTE 1)	PAINTING	43. FINISH PAINT : EPOXY/ SYNTHETIC ENAMEL/
	34. LIFTING HOOK : HOOK WITH STANDARD DEPRESS SAFETY LATCH AND LOCK TO PREVENT HOOK FROM SWIVELING. HOOK SHALL BE FORGED ALLOY STEEL/ CARBON STEEL AS PER IS 8610/ BS 2903		44.
	35. BEARINGS: BALL OR ROLLER AS PER IS 5669/ IS 5692/ IS 5932/ IS 5935		45.
	36. BRAKE : SCREW AND FRICTION DISC TYPE SELF ACTUATING LOAD PRESSURE BRAKE		46.
	37. LUBRICATION OF MOVING PARTS SHALL BE DONE MANUALLY BY HAND OPERATED GREASE PUMPS THROUGH RESPECTIVE GREASE NIPPLES		47.
	38.	TESTS AND INSPECTION	48. TCE.M4-904 AND TCE.M4-185-69 OR TCE. M4-186-11 (STRIKE OUT WHAT IS NOT APPLICABLE) (NOTE 2)
	39.		49. OVERLOAD TEST WITH 150 % OF SPECIFIED LOAD
	40.		50.
	41.		51.
	42.		52.
			53.
			54.
			55.
			56.
			57.
			58.
			59.
			60.
			61.
			62.

NOTES:

1. MATERIALS OF CONSTRUCTION INDICATED ARE FOR CHAIN PULLEY BLOCKS OPERATING IN NON HAZARDOUS AREA. FOR THE CHAIN PULLEY BLOCKS OPERATING IN HAZARDOUS AREA, ALL CONTACT PARTS SHALL BE OF DISSIMILAR MATERIALS. FOR EXAMPLE : BRONZE TO STEEL, BRASS TO STEEL ETC.
2. FOLLOWING ADDITIONAL TESTS INDICATED AS ‘B’ IN TCE.M4-186-11 SHALL ALSO BE CARRIED OUT WHEN TCE.M4-186-11 IS APPLICABLE.
3. BIDDER HAS TO FILL THIS DATA SHEET A ALONG WITH DATA SHEET-B

REV.NO.	00			PPD. BY DS\KS	JOB NO.	OWNER:BHEL; EPCC:BHEL
DATE				CHD. BY KG	TCE.	
REV. BY				DATE 23-05-08	5178A	PROJECT:3X33MW CPP, BINA

1.0 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's works, delivery at site and performance testing at site of chain pulley block.

2.0 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of chain pulley block shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

3.0 FEATURES OF CONSTRUCTION

Chain pulley block shall be complete with load chain, load chain wheel, hand chain, hand chain wheel, necessary gearing, brakes for hoisting, hooks and other accessories to make the equipment complete in all respects.

3.1 Load Chain And Load Chain Wheel

The total length of the load chain shall exceed the minimum length required to give the prescribed range of lift by not less than three links per fall to ensure that the slack end anchorage is not loaded. The load chain wheel shall be of adequate strength and shall be suitably designed to ensure effective operation of the chain and should be properly secured with shaft, preferably with splines.

3.2 Hand Chain And Hand Chain Wheel

The length of the hand chain shall be such that the lowest point of the suspended loop shall hang 400 mm above the operating level. Hand chain wheels shall be provided with flanges and designed to ensure effective operation with hand chain.

3.3 Shafts And Axles

Shafts and axles shall have ample strength and rigidity and adequate bearing surface for the intended duties.

3.4 Gears

Gears shall be cut from solid cast or forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one piece gear section.

3.5 Brakes

Brakes shall be of automatic type that will stop and hold the load when hand-chain pull is released and shall permit controlled lowering of the load when hand-chain pull is applied in the lowering direction.

3.6 Pawls

Pawls shall be of sufficient strength to arrest the full load from lowering due to gravity. The pawl and ratchet wheel shall be of steel, hardened and tempered so as to attain required wear resistance and toughness.

3.7 Lifting Hook

Lifting hook shall be solid, forged, heat treated alloy or carbon steel of rugged construction and provided with a standard depress type safety latch. Lifting hook shall have swivels and operate on ball or roller thrust bearings with hardened races. Lock to prevent the hook from swivelling shall be provided.

DATA SHEET - C

DATA TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT

1. Detailed dimensioned general arrangement drawing indicating various clearances, lifts etc. Drawing shall also indicate all design data and information furnished in data sheets A & B.

2. Part list of the chain pulley block and trolley along with materials and codes of construction.

3. Calculations indicating effort required to lift the load.

4. Operation and maintenance manual with lubrication schedule.

Documents indicated at 1, 2 & 3 above shall be reviewed and approved, while document indicated at 4 above shall be for information only.

ISSUE R0

ISSUE NO. R4	SPECIFICATION NO. TCE.M4-113-50	**TCE CONSULTING ENGINEERS** **DATA SHEET - B** **CHAIN PULLEY BLOCK**	SECTION : D12 SHEET : 1 OF 2

ENQUIRY/ SPECIFICATION NO. TCE.

	SL. NO.	ITEM ↓ / BIDDER →		
GENERAL	1.	DESIGNATION		CHAIN PULLEY BLOCK FOR
	2.	NUMBER OFFERED		
	3.	TAG NOS.		
	4.	CAPACITY	Kg	
	5.			
CHAIN PULLEY BLOCK	6.	MANUFACTURER		
	7.	MAKE		
	8.	MODEL NO.		
	9.			
	10.			
TROLLEY	11.	MANUFACTURER		
	12.	MAKE		
	13.	MODEL NO.		
	14.			
DIMENSIONS	15.	MONORAIL IF PROVIDED BY VENDOR : INDICATE BEAM SIZE MINIMUM/ MAXIMUM SUITABLE FOR TROLLEY MOVEMENT	mm	ISMB / ISMB
	16.	MONORAIL IF PROVIDED BY PURCHASER : IS SIZE SPECIFIED IN DATA SHEET A SUITABLE FOR TROLLEY MOVEMENT		YES/ NO IF NO INDICATE SUITABLE SIZE ISMB
	17.	DISTANCE BETWEEN HIGHEST HOOK POSITION TO BOTTOM OF MONORAIL	mm	
	18.	IF MONORAIL IS CURVED, MINIMUM RADIUS TROLLEY CAN NEGOTIATE	mm	
	19.			
	20.			
	21.			

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

ISSUE NO. R4	SPECIFICATION NO. TCE.M4-113-50	**TCE CONSULTING ENGINEERS** **DATA SHEET - B** **CHAIN PULLEY BLOCK**	SECTION : D12 SHEET : 2 OF 2

ENQUIRY/ SPECIFICATION NO. TCE.

	SL. NO.	ITEM ↓ / BIDDER →		
MATERIALS OF CONSTRUCTION	22.	IF CHAIN PULLEY BLOCK IS IN HAZARDOUS AREA :		
	22.1	TROLLEY WHEELS		
	22.2	LOAD CHAIN WHEEL AND MAIN ARM		
	22.3	HAND CHAIN WHEEL		
	22.4	GEARS AND PINIONS		
	23.			
MISCELLANEOUS	24.	WEIGHT OF COMPLETE CHAIN PULLEY BLOCK AND TROLLEY ASSEMBLY	Kg	
	25.	WEIGHT OF CHAIN PULLEY BLOCK	Kg	
	26.	EFFORT REQUIRED TO LIFT THE LOAD	Kg	
	27.	WHEEL LOAD WITH IMPACT AND WITHOUT IMPACT	Kg	/
	28.	PRELIMINARY DIMENSIONED GENERAL ARRANGEMENT DRAWING OF CHAIN PULLEY BLOCK AND TROLLEY TO BE FURNISHED ALONG WITH WHEEL STOP DETAILS		WHETHER FURNISHED YES/ NO
	29.			
	30.			

NOTES TO BIDDER

1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A.
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

1.0	TYPE OF CONSTRUCTION :		
1.1	ASH SLURRY SUMP		RCC, PARTIALLY UNDER GROUND
2.0	DETAILED DESIGN AND CONSTRUCTION OF ALL CIVIL WORKS OF		
2.1	ASH SLURRY SUMP		BY VENDOR
3.0	CAPACITY OF SUMP REQUIRED :		
3.1	ASH SLURRY SUMP CAPACITY	cu.m	TO CATER FOR 10 MIN. SLURRY GENERATION OF BOTH FLY ASH & BED ASH
3.2	Complete Set of Sump Level Switches		YES (BY VENDOR)
3.3	Overflow Connection Sleeve		YES (BY VENDOR)
3.4	Drain Connection Sleeve		YES (BY VENDOR)
4.0	ASH SLURRY SUMP		
4.1	Alloy Cast Iron Plates Having a Minimum Hardness of 340 BHN together with Fixtures to be Fixed at Bottom of Ash Slurry Sump		YES
4.2	Alloy Cast Iron wear plates having a minimum hardness of 340 BHN together with fixtures to be fixed on sump face which comes in contact with ash slurry including collecting channels.		YES (BY VENDOR)
4.3	Complete set of Bubbler Type/ Float Operated Type sump level control		YES (BY VENDOR)
5.0			
6.0			

7.0

8.0

9.0 NOTES

9.1 Alloy CI Used for Liners and Ni-HARD WITH 2.5% NICKEL and piping shall conform to 340 BHN HARDNESS

9.2 Ash Slurry Sump and Ash Water Tank Covered with Suitable Gratings.

1.0	DESIGNATION		**
2.0	NUMBER OF PUMPS		** 1 WORKING + 1 STANDBY
3.0	TYPE OF PUMP		SUBMERSIBLE PUMP
4.0	LOCATION OF PUMPS		AHEH ROOM
5.0	LIQUID PUMPED		SLURRY
6.0	LIQUID TEMPERATURE		AMBIENT
7.0	SPECIFIC GRAVITY		BY BIDDER
8.0	PERCENT OF SOLIDS	%	25% (ESTIMATED)
9.0	MAXIMUM SIZE OF SOLIDS	mm	25
10.0	PUMP AND SUMP DATA		
10.1	Capacity	m3/hr	BY BIDDER
10.2	Total Head	mlc	BY BIDDER
10.3	Maximum Speed	rpm	BY BIDDER
10.4	Sump Length and Width	m	BY BIDDER
10.5	Depth of Sump	m	BY BIDDER
10.6	Motor Mounting Height	m	(MIN.) 1000 MM FROM FLOOR LEVEL
10.7	Sump Arrangement		TWIN-PIT ARRANGEMENT
11.0	CONSTRUCTION FEATURES		
11.1	Type of Lubrication		GREASE
11.2	Stuffing Box		YES
11.3	Type of Impeller		NON-CLOG, OPEN
11.4	Automatic Float Level Switch for Start/Stop		YES
11.5	Suction Strainer		YES
11.6	Sump Cover Plate		YES

11.7	Companion Flanges	YES
11.8	Discharge Point	REFER ATTACHED DRAWINGS
11.9	Seal Water	NO
11.10	Location	INDOOR
12.0	MATERIALS OF CONSTRUCTION	
12.1	Casing	C.I (210 BHN)
12.2	Impeller	ALLOY C.I
12.3	Pump Shaft	EN-8
12.4	Line Shaft	EN-8
12.5	Shaft Enclosing Tube	STEEL
12.6	Discharge Pipe	STEEL
12.7	Strainer	C.I
12.8	Cover Plate	M.S
12.9	Stuffing Box	MFG. STD.
13.0	MOTOR BY	VENDOR
14.0	STARTER BY	VENDOR

15.0 NOTES

15.1 Material test certificates shall be furnished for all components.

15.2 The rating of the drive motor shall be at least 125% of the power required by the pump at duty point.

15.3 Hydrostatic test shall be conducted at twice the total head or 1.5 times the shut off head whichever is greater. The duration of test shall be minimum 30 minutes.

15.4 The strainer openings should be compatible with the size of solids that can be handled by the pump impeller.

15.5 Sump pump motors shall be designed for frequent start-stops.

15.6 Out of two pumps, one pump will be operating normally while the other pump will be a standby and will be operated during emergency.

15.7 The total discharge head of each pump shall be selected by considering ash disposal piping length of 1200mm, with a static lift of 6m to handle the ash with a characteristics as indicated in System Data Sheet A-1 of this specification.

1.0	SERVICE	ALL WATER SERVICES INDICATED IN THE FLOW DIAGRAM LIKE ASH WATER,SEAL WATER, COOLING WATER,FLUSHING WATER,ETC.
2.0	FLANGE FACING	SERRATED FINISH
3.0	LIMITS OF PRESSURE, NOMINAL SIZE AND THICKNESS	* BIDDER TO DECIDE
4.0	LINE JOINTS	
	a) For pipe sizes less than or equal to 50 mm	SOCKET WELDED AS PER ANSI B 16.11 UNLESS OTHER-WISE INDICATED. FLANGED CONNECTION SHALL BE PROVIDED AT EQUIPMENT
	b) For pipe sizes greater than 50 mm size	BUTT WELDED ENDS WITH SPLIT PACKING RINGS UNLESS OTHERWISE SPECIFIED. FLANGED CONNECTIONS SHALL BE PROVIDED AT VALVES AND EQUIPMENT.
5.0	PIPES TO CONFORM	IS 1239, HEAVY CLASS/ IS-3589
6.0	FLANGES TO CONFORM	ANSI 150 lbs FORGED STEEL ASTM 105 TO B 16.5, FLAT FACE
7.0	BOLTS & NUTS TO CONFORM	FORGED STEEL BOLTS, NUTS & STUDS TO IS 1367 CLAUSE 4.6 OR EQUAL.
8.0	GASKETS	MIN. 3 MM THK. RED RUBBER TO SUIT.
9.0	FITTINGS	NB 15 TO NB 50 : 300 lbs RATING FORGED CARBON STEEL TO ASTM 105 OR) IS-

			1875 CLASS II WITH SCREW ENDS DIMENSIONAL STANDARD : ANSI B 16.11 NB 65 & ABOVE : A 234 Gr WPB MATERIAL WITH FLANGED ENDS DIMENSIONAL STANDARD : ANSI B 16.9
10.0	VALVES		REFER VALVES DATA SHEET
11.0	NOTES		
11.1	Piping system after installation shall be hydro-statically tested at pressure of 1.5 times the maximum working pressure.		
11.2	Test certificates as required for relevant standards shall be furnished		
1.0	SERVICE		CONVEYING AIR FOR FLY ASH CONVEYING AND COMPRESSED AIR FOR INSTRUMENTS & CONTROL SERVICES UPTO VALVES, OTHER SERVICES.
2.0	LIMIT OF TEMPERATURE		AMBIENT
3.0	FLANGE FACING		SERRATED FINISH
4.0	LIMITS OF PRESSURE	kg/cm2(g)	9.0
5.0	NORMAL PIPE SIZE AND THICKNESS		BIDDER TO DECIDE
6.0	LINE JOINTS		
	a) For Pipe Sizes Less Than 65 mm		SCREWED
	b) For Pipe Sizes of 65 mm and Above.		FLANGED

7.0	PIPES TO CONFORM	IS 1239, HEAVY CLASS/IS-3589 ERW GALVANISED PIPE
8.0	FLANGES TO CONFORM	ASA 150 lbs FORGED STEEL ASTM A 105 TO ASA B 16.5
9.0	BOLTS & NUTS TO CONFORM	FORGED STEEL BOLTS, NUTS & STUDS TO SUIT IS 1367, CLAUSE 4.6 OR EQUAL.
10.0	GASKETS	RED RUBBER/ASA B 16.21, 3 MM THK.
11.0	FITTINGS	ASA 3000 lbs RATING FORGED STEEL TO IS 1875, CLASS 2. FITTINGS TO ANSI B 16.9 MATERIAL ASTM A 234 Gr NPB WITH SCREWED ENDS FOR PIPES LESS THAN OR EQUAL TO 50 MM AND FLANGED CONNECTIONS FOR PIPES EQUAL TO OR GREATER THAN 65 mm.
12.0	NOTES	
12.1	Piping system after installation shall be hydro-statically tested at pressure of 1.5 times the maximum working pressure.	
12.2	Test certificates as required for relevant standards shall be furnished	

1.0	SERVICE		COMPRESSED AIR FOR INSTRUMENTS AND CONTROL (PNEUMATIC SIGNAL LINE)
2.0	LIMIT OF TEMPERATURE		AMBIENT
3.0	LIMIT OF PRESSURE	kg/cm2(g)	9.0
4.0	NORMAL PIPE SIZE AND THICKNESS		BIDDER TO DECIDE
5.0	LINE JOINTS		
6.0	PIPES		
6.1	Normal Pipe Size Range		LESS THAN 50 MM
6.2	MATERIAL SPECIFICATION		SEAMLESS COPPER TUBING TO ASTM 875 WITH PLAIN ENDS
7.0	FLANGES		COPPER ALLOY AS PER B 62 OR EQUIVALENT
8.0	BOLTS & NUTS		FORGED STEEL BOLTS, NUTS & STUDS TO SUIT IS 1367, CLAUSE 4.6 OR EQUIVALENT
9.0	FITTINGS		COPPER ALLOY AS PER B 62 OR EQUIVALENT WITH THREE PIECES FLANGED ENDS.
10.0	GASKETS		RED RUBBER/ASA B 16.21, 3 MM THICK WIRE INSERTED TYPE
12.0	NOTES		
12.1	Piping system after installation shall be hydro-statically tested at a pressure of 1.5 times the maximum working pressure.		
12.2	Test certificates as required for relevant standards shall be furnished		

1.0 SCOPE

This specification covers the technical requirements and essential particulars for the design (as applicable), supply, shop fabrication, inspection, testing, cleaning, commissioning assistance and protection of the piping systems as covered in the tender specification documents and drawings. The CONTRACTOR shall demonstrate that the piping satisfies the requirements of the specification and applicable codes. To the extent design and engineering of piping systems are specified to be in the CONTRACTOR scope in Section C of the tender documents and hereunder, all references to the PURCHASER drawings and documents in the subsequent clauses of this section shall be understood to imply the CONTRACTOR's drawings and documents.

2.0 CODES AND STANDARDS

2.1 All piping systems including subcontracted items shall comply with all currently applicable statutes, regulations and safety codes in the locality where the system will be installed. The piping shall also conform to the latest editions of the codes and standards listed under Clause 2.2 below. Nothing in this specification shall be constructed to relieve the CONTRACTOR of this responsibility.

2.2 The system and work under this contract shall conform to the following standards/codes:

(a) Indian Boiler Regulations

(b) Indian Regulations of Inspector of Explosives

(c) ASME Code ‘Power Piping’ - ASME B 31.1 and all other associated ANSI/ASME standards.

(d) Manufacturer's Standardisation Society (MSS), USA, Standard Practices.

(e) American Society for Testing and Materials (ASTM) Specifications.

(f) Pipe Fabrication Institute (PFI), USA, Standards

2.3 In case of conflict between the codes and standards referred to herein and the requirements of this specification, the more stringent requirement shall govern.

3.0 SCOPE OF WORK

3.1 The scope of supply of the CONTRACTOR under this contract shall be as defined in Section C of this specification. For all the piping systems included in this scope of supply, the CONTRACTOR shall supply all materials except those items specifically excluded from his scope in Section C, and render the piping systems complete as applicable. The CONTRACTOR's scope of supply shall include but not be limited to the following:

(a) Pipes, tubes, headers, manifolds, etc.

(b) Bends, elbows, returns, tees, laterals, crosses, reducers, caps and closures, full and half couplings, plugs, sleeves and saddles, stubs and bosses, unions and other similar fittings.

(c) Flanges

(d) Gaskets and fasteners

(e) Complete assemblies of hangers, supports, anchors, guides, restraints, snubbers, shock absorbers, etc., including welded attachments, springs and spring gauges, beam clamps, clips, shoes, rollers, trapezes, trunnions, etc.

(f) Auxiliary steel, concrete foundations, pedestals, etc., as required for hangers, supports, guides, restraints, anchors, snubbers, shock absorbers, etc.

(g) All materials as required for providing anti-corrosive treatment to buried pipes

(h) All paints, varnishes, primers, thinners and other painting materials.

(i) Weather hoods for bare pipes crossing ceilings and walls.

3.2 Unless otherwise specified in Section C, the CONTRACTOR's scope of supply includes all instrument impulse piping and fittings upto the last root valve. In the case of temperature measurement points, the CONTRACTOR's scope includes supply of thermowell stubs.

3.3 The CONTRACTOR shall supply all necessary drains and vents including anti flash funnels as required for the safe and effective draining/venting of the piping systems. It must be noted that the flow diagrams may not indicate all the drains and vents that would be required. As stated elsewhere, it is the CONTRACTOR's responsibility to identify the requirements of drains and vents whether the same have been shown in the flow diagrams or not and supply the necessary pipe work, fittings, hangers, supports, etc. The drains and vents indicated on the flow diagrams shall however be regarded as minimum requirements. The drains and vents shall be led upto the nearest floor drain in case of cold water systems and upto the flash tank in case of steam and hot water systems, as directed by the PURCHASER.

3.4 In the case of pipes laid in trenches or on pipe racks, the CONTRACTOR shall supply necessary steel members, cross beams and other supporting accessories such as stools, saddles, base plates, clamps, U-bolts, angles, clips, etc.

3.5 All concrete pedestals and foundations other then those specifically indicated as excluded from the CONTRACTOR's scope in Section C shall be supplied by the CONTRACTOR.

3.6 Wherever uninsulated pipes cross walls or roofs, the necessary weather hoods shall be designed, fabricated and supplied by the CONTRACTOR as directed by the PURCHASER.

3.7 The CONTRACTOR shall design, fabricate and supply all hangers and supports, anchors, guides, restraints, etc., including necessary welded attachments and auxiliary steel based on data furnished by the PURCHASER/ENGINEER. The data to be furnished by the PURCHASER / ENGINEER would be from the systems point of view and would typically include the overall configuration of the support system, operating and design loads, cold to hot movements of pipe, desired hanger/support spring constant, type of spring support, viz., constant load type or variable load type, etc. It is the CONTRACTOR's responsibility to design, engineer and select the individual components of the hangers, supports, restraints, guides or anchors based on the

PURCHASER's data and in accordance with the requirements of this specification.

3.8 The loads indicated in the PURCHASER's hanger/support sketches do not include the weights of hanger components such as clamps, turnbuckles, trapezes, spring cage assemblies, etc. The weights of these components shall be considered by the CONTRACTOR in the design and settings of hangers and supports under advice to the PURCHASER/ENGINEER.

3.9 The CONTRACTOR shall perform necessary internal machining of pipes for installing orifices, flow nozzles, straightening vanes, etc.

3.10 At all intersection joints, it is the CONTRACTOR's responsibility to design and provide suitable reinforcements as per the applicable codes and standards taking into account the pressure, temperature and dead weight loads.

3.11 Welding, nondestructive examination of welded joints and repair of weld defect areas shall conform to TCE specification no. TCE.M4-134-04.

3.12 The CONTRACTOR shall prepare fabrication isometric drawings and bills of material for piping NB 65 mm and larger based on the PURCHASER's piping drawings except for Low Pressure (LP) piping systems such as water and air. The PURCHASER/ ENGINEER will review, prior to release for fabrication, all piping isometric drawings. The PURCHASER/ENGINEER may request changes, if the PURCHASER/ENGINEER's stress analysis or other considerations require it. As the CONTRACTOR is responsible for the design and adequacy of hanger components, no comments or approval may be given by the PURCHASER/ENGINEER except in those instances where it may appear that the CONTRACTOR's work does not meet the standard desired by the PURCHASER/ ENGINEER. In such cases, the CONTRACTOR shall be guided by the PURCHASER / ENGINEER's comments and the CONTRACTOR shall comply to the requirements at no extra cost.

3.13 The CONTRACTOR's fabrication drawings shall take into account the requirements of this specification as also all applicable codes and standards including statutory regulations such as the Indian Boiler Regulations. The CONTRACTOR's fabrication drawings shall carry all details of fabrication, welding, etc., as may be required for obtaining

necessary statutory clearances. It is the CONTRACTOR's responsibility to obtain all such clearances, and fabrication shall commence only after the necessary clearances have been obtained from the appropriate authorities. All expenses incurred in obtaining these clearances shall be to the CONTRACTOR's account.

4.0 MATERIALS AND WALL THICKNESS

4.1 All piping materials to be supplied by the CONTRACTOR shall be in accordance with the PURCHASER's piping material specification and/or piping bill of materials.

4.2 The BIDDERs may offer if they so desire, alternate materials equal or superior to those specified. However, no credit would be given to offers containing materials superior to those specified. The responsibility for establishing equality or superiority of the alternate materials offered to those specified rests entirely with the BIDDER. The PURCHASER / ENGINEER reserves the right to reject such alternate materials and insist upon only those specified.

4.3 The BIDDERs shall note that equality or superiority of the materials offered by them vis-a-vis those specified would be judged not only based on a comparison of the material standards but also on the ease of fabrication, shop and field welding, heat treatment, service record and any other characteristic considered important by the ENGINEER.

4.4 BIDDERs shall indicate in their offer, reasons and justification for their wishing to deviate from the materials specified.

4.5 Materials inferior to those specified will not be acceptable.

4.6 Where bending and forming allowances are excluded from the wall thicknesses specified in the specification documents, the specified wall thicknesses shall be increased in accordance with the CONTRACTOR's standards to allow for the manufacturing process for bends and fittings. In no case shall the wall thicknesses of fittings be less than those specified for straight pipes.

4.7 For steam piping systems, all materials shall be procured directly from the manufacturers. Materials procured from traders and stockists are not acceptable. For LP piping systems, these can be procured from reputed and approved traders or stockists.

4.8 All materials procured shall be new and specifically for the subject contract.

4.9 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper identification number or other acceptable references to enable identification of the certificate with the material it purports to certify. The heat number shall also be indicated on the material certified.

5.0 FABRICATION

5.1 Unless otherwise specified in Section C, all steam piping systems of size NB 65 mm and larger shall be supplied fully prefabricated at works as per the piping drawings. All piping, NB 50 mm size and smaller, shall be supplied in straight lengths, with the pipe ends cut square to the axis.

5.2 Unless otherwise specified in piping drawings or piping materials specification data sheets, all pipeline joints shall have welded construction. Butt-welded joints shall be used for pipes NB 65 mm and larger. Socket welded joints shall be used for pipes NB 50 mm and smaller. The use of companion flanges to connect two pieces of pipe or the use of odd or short pieces of pipes in making up long runs is prohibited, except as noted on the PURCHASER's piping drawings.

5.3 Where welded pipes or fittings are used, longitudinal welds in adjoining sections shall be staggered by minimum of 90^{o} during fabrication. All piping shall be fabricated true to lines and elevations as indicated in the piping drawings.

5.4 Neither butt nor branch joints shall be closer than twice the pipe diameter to any other joint in the same pipeline except where 'weldolet' type fittings are used, in which case the branch weld will be made to the 'weldolet'.

5.5 The number of joints for field welding shall be kept as a minimum as practicable and limited to accessible circumferential butt welds.

5.6 All pipe bends shall have a bend radius of five nominal pipe diameters unless otherwise specified in the PURCHASER’s piping drawings. The pipe bends shall be true to angle and radius and shall maintain a true

circular cross section of pipe without deformity or undue stretching. Crimping of pipes to form bends is not acceptable.

5.7 All pipe flanges and contact surfaces shall be concentric with the axis of the piping. All flanges and fittings shall be accurately machined and drilled true to template.

5.8 All threads on piping components shall be taper pipe threads as per applicable standards. Threaded connections for insertion type fluid temperature sensing and sampling devices shall be seal welded when the service temperature exceeds 495^{o}C or the service pressure exceeds 103.5 bar (g). The threads shall be entirely covered by the seal weld and only qualified welders shall carry out such seal welding.

5.9 The CONTRACTOR shall cut the pipe short for cold spring for all hot lines in accordance with the data furnished by the PURCHASER. In addition to the cut for cold spring, a length of pipe must be cut to attain slope when the line is in the cold or hot position. The additional cut must not add to the cold spring in the system. In order not to add to the cold spring, the pipe must be detailed and fabricated so that the affected horizontal runs will be sloped to the proper angle when installed in the field before the final weld is made. At the point of closure, the two pipe ends should be separated by the required amount of cold spring only.

5.10 All welded attachments such as lugs, shoes, trunnions, etc., as required for supporting, restraining or anchoring a pipe shall be welded to the pipe at works and stress relieved as required. All welded attachments and thermocouple pads shall be of the same material as the parent pipeline and shall be subjected to the same fabrication and welding procedures as the associated piping.

5.11 All welds between dissimilar materials shall be carried out at works. Field welding of joints involving dissimilar materials shall be avoided.

5.12 The first circumferential weld joint after a pipe bend shall as far as possible be after a minimum straight length of two times the pipe diameter or 500 mm whichever is less.

5.13 All pipelines shall be pitched to low point(s) where drainage is indicated on the PURCHASER's drawings. The pitch shall be sufficient to prevent pockets of moisture collecting at low points between supports.

5.14 The CONTRACTOR shall fabricate the pipe assemblies in such a way as to avoid any difficulty during field erection.

5.15 All branch connections shall be realised through the use of tees, crosses and laterals to the extent such standards fittings are available as per ANSI standards. Where intersection welds are employed due to non-availability of a standard fitting, they shall be of suitable structural adequacy by virtue of intrinsic weld connection, reinforcing pads or rings or materials inherent in the branch. It is the CONTRACTOR's responsibility to provide reinforcement, wherever necessary for branch connections.

5.16 The CONTRACTOR shall machine welding ends of all pipes, bends and fittings, to make sound welds. The welding rod shall be compatible with the parent material.

5.17 The CONTRACTOR shall be responsible for determining the proper bending procedure, including bending temperature, as well as the heat treatment or stress relieving procedures to produce the desired end product.

5.18 Cold bending may be performed on carbon steel, carbon molybdenum and chromium molybdenum steel pipes with chromium content less than 1 % in a stress relieved, normalised and tempered or fully annealed condition. Bending performed at temperatures below 900^{o}C shall be considered "cold bending".

5.19 Only hot bending at 900^{o}C to 1200^{o}C shall be performed on chromium - molybdenum steel regardless of its heat treatment by full annealing. The pipes shall be filled with free running, sulphur free silica sand or other dry solid inert material, firmly tapped for the hot bending operations. Optical pyrometry or other approved methods shall be used for temperature control of these operations.

5.20 Oxyacetylene torches shall not be used for heating purposes during bending operations.

5.21 Carbon steel, carbon molybdenum and chromium molybdenum piping shall be bent hot if cold bends, free of cracks or buckles, cannot be made.

SECTION: D14 **VALVES DATA SHEET** **sh 1 of 2**

GATE / GLOBE / CHECK VALVES

Sl. No.	Description	Water service		Air service (Globe & Check valves only)	
		15 TO 50 NB	65 NB& ABOVE	15 TO 50 NB	65 NB& ABOVE
1.0	BODY / BONNET	Bronze as per ASTM B62 / IS 318 LTB2	CI as per IS 210 –FG200	Bronze as per ASTM B62 / IS 318 LTB2	Cast steel, as per ASTM A216 Gr.WCB
	DISC	-----do----	CI as per IS 210 –FG200	-----do----	-----do----
	STEM (not applicable for check valves)	Manganese bronze IS320 Gr.HT-2	Manganese bronze IS320 Gr.HT-2	Manganese bronze IS320 Gr.HT-2	Alloy Steel as per ASTM A 479 Type 410-2
	BODY SEAT / DISC SEAT	Bronze as per ASTM B62 / IS 318 LTB2	Bronze as per IS 318 Gr. LTB2	Bronze as per ASTM B62 / IS 318 LTB2	-----do----
	END CONNECTION	Screwed as per IS554 – tapered	Flat faced flanged to ANSI B16.1	Screwed as per IS554 – tappered	Raised flange as per ANSIB16.5
	VALVE RATING	150 lb	125lb	150 lb	150lb

BALL VALVE

Sl. No.	Description	Water service		Air service	
		15 TO 50 NB	65 NB& ABOVE	15 TO 50 NB	65 NB& ABOVE
1.0	BODY / BONNET	Bronze as per ASTM B62 / IS 318 LTB2	CI as per IS 210 –FG200	Bronze as per ASTM B62 / IS 318 LTB2	Cast steel, as per ASTM A216 Gr.WCB
	DISC	“ “	CI as per IS 210 –FG200	“ “	“ “
	STEM	Manganese bronze IS320 gr.HT-2 or ASTM B312 Gr. A	Manganese bronze IS320 gr.HT-2 or ASTM B312 Gr. A	Manganese bronze IS320 gr.HT-2 or ASTM B312 Gr. A	Alloy Steel as per ASTM A 479 Type 410-2
	BODY SEAT / DISC SEAT	Bronze as per ASTM B62 / IS 318 LTB2	Bronze as per IS 318 Gr. LTB2	Bronze as per ASTM B62 / IS 318 LTB2	-----do----
	END CONNECTION	Screwed as per IS554 – tappered	Flat faced fanged to ANSIB16.1	Screwed as per IS554 – tapered	Raised flanged as per ANSI B 16.5
	VALVE RATING	150 lb	125lb	150 lb	150lb

General **sh 2 of 2**

1.0 For carbon steel valves Bolts and Nuts: ASTM A 193 Gr. B7, ASTM A 194 Gr.2H

2.0 Hand wheel / Lever (for all valves) : Malleable Iron ASTM A 47 Gr.3251

3.0 For Bolts & nuts (for CI & bronze valves) : ASTM A 307 Gr. B

BUTTER FLY VALVES

Body = CI, IS210 –FG260

Disc = ------do-------

Shaft = SS410

Disc seal rings = neoprene rubber

Internal hardware = SS304

Pipes and fittings

SL. NO	Description	Water line		Air line		Ash line		
		15 – 50NB	65NB & above	15 – 50NB	65NB & above	15 – 50NB	65NB & above	
1.0	LINE JOINTS	Plain end as per ANSI B 16.11. Flanged connection for eqpt.	Butt welded ends. Flanged joints for equpt.	Screwd	Flanged			
2.0	Pipes to confirm	IS1239 / IS 3589		IS1239 / IS 3589		IS 1239 / 3589		
3.0	Flanges	ANSI 150lb forged steel ASTM 105 to B16.5 flat face.		ANSI 150lb forged steel ASTM 105 to B16.5 flat face.		Sleeve type with steel sleeve or CI flanges		
4.0	Fittings	3000lb-forged carbon steel to ASTM105 as per ANSI B16.11	A234 Gr.WPB with Butt welded to ANSI B16.9	3000lb-forged carbon steel to ASTM105 as per ANSI B16.11	A234 Gr.WPB with Butt welded to ANSI B16.9	Ni-Cr alloy CI as per IS 4771 Type 1a –550 bhn hardness		
5.0	MOC of piping	ERW	ERW	GI pipe				
						MS ERW – 9.5mm thk. For I & II nd field and 7mm for other fieds		

ISSUE NO.	SPECIFICATION NO.	TCE CONSULTING ENGINEERS LIMITED	SECTION : D34
	TCE-M4-203-01	DATA SHEET - B INDUCTION MOTORS	SHEET 1 OF 2

ENQUIRY / SPECIFICATION NO.

SR.NO.	ITEM → ↓ BIDDER →	UNIT	GUARANTEED PARTICULARS
1.0	Application		
2.0	Manufacturer		
3.0	Applicable Standards		
4.0	Rated		
	(a) Output	kW	
	(b) Speed	RPM	
	(c) Frame size		
5.0	Type of Duty (IS 325 or equivalent)		
6.0	Supply Conditions		
	(a) i) Rated Voltage	V	
	ii) No. of Phases		
	iii) Frequency	Hz	
	(b) Allowable Variations in		
	i) Voltage	%	
	ii) Frequency	%	
	iii) Combined	%	
7.0	Current		
	(a) Full Load	Amps	
	(b) Starting	% FL	
8.0	Method of Starting		
9.0	Class of Insulation		
10.0	(a) Ref. Ambient Temp.	deg.C	
	(b) Temp. rise of windings by Res. Method		
	i) Stator	deg.C	
	ii) Rotor	deg.C	
	(c) Temp. rise of bearings	deg.C	
11.0	Degree of Protection (IS 4691 or equivalent)		
12.0	Suitable for Outdoor Operation	Yes/No	
13.0	Normal winding connection	Star/Delta	
	(i) Stator		
	(ii) Rotor		

NOTE TO BIDDER

1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

SR.NO.	ITEM → ↓ BIDDER ➔	UNIT	GUARANTEED PARTICULARS
14.0	Winding Suitable for 24V		
	Space Heating	Yes/No	
	Space heater Rating 1 No.		
15.0	Terminal box		
	i) Type & No. of Terminals		
	brought Out		
	ii) Fault withstand capacity		
	at rated voltage &		
	duration		
17.0	Dimensional Dwg. Enclosed	Yes/No	

NOTE TO BIDDER
1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.

SIGNATURE OF BIDDER	
DATE	

1.0 SCOPE

1.1 The specification covers the design, material, constructional features, manufacture, inspection and testing at the VENDOR'S/his SUB-VENDOR'S works, delivery to site and performance testing of induction motors.

1.2 For motors of rated above 500 V, a separate specification (TCE.M4-203-02 - Additional requirements for HV motors) covers the additional requirements, any or all of which shall be complied with for motors rated 415V if specified in Data Sheet-A.

2.0 CODES AND STANDARDS

2.1 The design, material, construction, manufacture, inspection, testing and performance of induction motors shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the applicable standards specified in data sheet A1 latest revision as on the date of offer Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. In case of conflict between the standards and this specification, this specification shall govern.

3.0 DRIVEN EQUIPMENT

3.1 When this specification forms part of the driven equipment specification, information not given in the Data Sheet-A will be governed by the driven equipment specification.

3.2 Motors shall be capable of satisfactory operation for the application and duty as specified in the motor Data Sheet-A and as specified for the driven equipment.

4.0 PERFORMANCE AND CHARACTERISTICS

4.1 Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under either of the following supply conditions as specified in Data Sheet-A.

	Supply Condition I	Supply Condition II
(a) Variation in supply voltage from rated voltage	±6%	±10%
(b) Variation in supply frequency from rated frequency	±3%	±5%

Supply Condition (contd.)

		I	II
(c)	Combined voltage and frequency variation	9%	10%

4.2 Motors shall be suitable for the method of starting specified in the Data Sheet-A.

4.3 The minimum permissible voltage shall be 85% of the rated voltage during motor starting

4.3.1 Motors shall be capable of starting and accelerating the load with the applicable method of starting, without winding temperatures reaching injurious levels, when the supply voltage is in the range of 85% of the rated motor voltage to maximum permissible voltage specified in Data Sheet-A.

4.4 The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerances as per the applicable standard) unless otherwise specified.

4.5 Motors shall be capable of developing the rated full load torque even if the supply voltage drops to 70% of the rated voltage. If such operation is envisaged for a period of one second, the pull out torque of the motor shall be atleast 205% of full load torque.

4.6 Motors when started with the driven equipment coupled shall be capable of withstanding atleast two successive starts from cold conditions & one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.

5.0 INSULATION

5.1 The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate.

6.0 TEMPERATURE RISE

6.1 The temperature rises shall not exceed the values given in IS 12802. Under extremes of supply condition (clause 4.1 above), the temperature rise shall not exceed the value indicated in IS by 10^{o}C.

6.2 For motors specified for outdoor installation heating due to direct exposure to solar radiation shall be considered.

7.0 CONSTRUCTIONAL FEATURES

7.1 Motors weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

8.0 BEARINGS

8.1 Unless otherwise specified in data sheet-A, motor bearings shall not be subjected to any external thrust load.

8.2 Unless otherwise specified, motor bearings shall have an estimated life of atleast 40,000 hrs.

8.3 The bearings shall permit running of the motor in either direction of rotation.

8.4 When forced oil lubrication or water-cooling is required, prior approval from the purchaser shall be obtained.

8.5 When forced oil lubrication or water cooling is required, the machine shall be suitable for starting & continuous operation for atleast 10 minutes, without the availability of lubrication or cooling system

8.6 If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil & an oil level sight gauge shall be provided to show the precise oil level required for stand still and running conditions.

8.7 It shall be possible to lubricate the bearings without dismantling any part of the motor.

9.0 TERMINAL BOX

9.1 Terminal boxes shall have a degree of protection of atleast IP 55 for out door applicable

9.2 Unless otherwise approved, the terminal box shall be capable of being turned through 360^{o} in steps of 90^{o}.

9.3 Terminals shall be of stud type & the terminal box shall be complete with necessary lugs, nuts, washers.

9.4 When single core cables are to be used the gland plates shall be of non-magnetic material.

9.5 Sizes of terminal boxes and lugs shall be as given in Table-I, unless specified otherwise in data sheet A or Section C.

TABLE-I

415 V MOTORS - SIZES OF CABLES, STUDS, TERMINAL LUGS & TERMINAL BOXES

(TO BE PROVIDED ON MOTORS BY VENDOR)

SL. NO	MOTOR RATING (kW)	1100V Al. Conductor armoured PVC cable Cores x mm^2	Stud size	Terminal lug size of DOWELL MAKE equivalent to DOWELL's CAT NO.	Minimum Terminal Box Size HXWXD mm X mm X mm
1.	Upto 3	3x4	M6	CUS/06	100 x 100 x 60
2.	3.1 - 7.5	3x6	M6	CUS/07	100 x 100 x 60
3.	7.6 - 15	3x16	M6	CUS/09	100 x 100 x 60
4.	16 - 25	3x35	M8	CUS/12	150 x 150 x 75
5.	26 - 40	3x70	M10	CUS/17	200 x 200 x 100
6.	41 - 55	3x120	M12	CUS/22	400 x 400 x 125
7.	56 - 70	3x185	M16	CUS/28	450 x 450 x 150
8.	71 - 85	3x240	M20	CUS/30	500 x 500 x 200
9.	86 - 110	3x400	M20	CUS/33	600 x 600 x 200
10.	111 - 175	3x1Cx500	M20	CUS/34	600 x 200 x 200 (3 separate cable boxes for the 3 single core cables)

10.0 PAINT AND FINISH

10.1 All motor parts exposed directly to atmosphere shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint.

11.0 HEATING DURING IDLE PERIODS

11.1 For motors rated 30 kW and below, during idle periods, the stator winding will be connected to a 24 V single phase, 50 Hz, AC supply for heating and elimination of moisture. The supply will be connected between any two terminals.

11.2 Motors rated above 30 kW shall have space heaters suitable for 240V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

12.0 **ACCESSORIES**

12.1 Two independent earthing points shall be provided on opposite sides of the motor, for bolted connection of the PURCHASER'S earthing conductors as specified in data sheet-A. These earthing points shall be in addition to earthing stud provided in the terminal box.

12.2 Except when otherwise specified, the motors shall be provided with a bare shaft extension having a key slot and a key at the driving end.

13.0 **TESTS**

13.1 Motor shall be subjected to all the routine tests as per applicable standard in the presence of the PURCHASER'S representative. Copies of test certificates of type and routine tests shall be furnished as specified in the distribution schedule, for the PURCHASER'S approval. The VENDOR shall ensure to use calibrated test equipment/instruments having valid calibration test certificates from standard laboratories traceable to national/international standards.

1.0 SCOPE

1.1 This specification covers requirements of HV induction motors. These are in addition to the requirements of specification No.TCE.M4-203-01. Clauses of this specification which are not applicable for any motor are mentioned in Data Sheet-A of TCE.M4-203-01.

1.2 In case of conflict between TCE.M4-203-01 or applicable standard and this specification, this specification shall govern.

2.0 PERFORMANCE AND CHARACTERISTICS

2.1 Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 80% of the rated voltage.

2.2 Motors shall be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage for 5 minutes, commencing from hot condition.

2.3 Motors shall withstand the voltage and torque stresses developed due to the vector difference between the motor residual voltage and the incoming supply voltage equal to 150% of the rated voltage, during fast change over of buses. The duration of this condition is envisaged for a period of one second.

2.4 The locked rotor current of the motors shall not exceed the following values which are inclusive of 20% tolerance.

2.4.1 600% of full load current for motors up to and including 1500 kW.

2.4.2 450% of full load current for motors above 1500 kW.

2.5 The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage (clause 2.1 above) by at least three seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible. In case the speed switch is required, it shall be indicated out by the bidder in his offer.

When a speed switch is mounted on the motor shaft , the same shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% over speed in either direction of rotation. If the speed switch requires any auxiliary voltage, it shall be suitable for the auxiliary voltage specified in Section-B - Project Information of the specification

3.0 **INSULATION TREATMENT**

3.1 Motors shall be given power house treatment. Additional treatments to withstand heavily salt polluted or similar atmospheric conditions shall be given based on the location indicated in Data Sheet-A.

4.0 **ACCESSORIES**

4.1 EMBEDDED TEMPERATURE DETECTORS (ETD'S)

Atleast six resistance type temperature detectors for the stator winding each having D.C. resistance of 100 ohms at 0^{o}C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum. One ETD shall be provided for each of the motor bearing & shall be wired up to the terminal box. The temperature detectors shall be of 3 wire , duplex type.

4.2 BEARING THERMOMETERS

4.2.1 Each bearing shall be provided with a dial type thermometer. Each thermometer shall consist of two potential free contacts. They shall be designed to close independently at two different temperatures - one for 'Alarm' and another for 'Trip'.

4.2.2 The contact rating of the potential free contacts shall be 1A at 240V AC & 0.1A at 110V DC. Any auxiliary supply, if required shall be indicated by the bidder.

4.2.3 The thermometers shall be located at a convenient height for easy reading and handling.

4.2.4 One bearing shall be insulated to prevent shaft currents.

4.3 **DRAIN PLUGS**

Motors shall be provided with drain plugs, so located to drain water, resulting from condensation or due to other causes, from all pockets in the motor casing.

4.4 **FLOW SWITCHES**

Flow switches shall be provided for monitoring cooling water flow if CACW motors are specified.

4.5 **VIBRATION PADS**

Vibration pads shall be provided when called for in the specification.

5.0 **TERMINAL BOX**

5.1 Separate terminal boxes shall be provided for each of the following:

5.1.1 Stator Leads

5.1.2 Rotor leads (wound motors)

5.1.3 Space Heaters

5.1.4 Temperature Detectors

5.2 The three phases shall be segregated by barriers of metal or fibre glass.

5.3 The cable box design shall be suitable for any type of cable termination kits available.

6.0 **EARTHING PAD**

The earthing pads shall be of non-corrodible metal welded or brazed at two locations on opposite sides complete with suitable bolt and washers for connecting the PURCHASER'S earthing flat.

7.0 **RATING PLATE**

7.1 The following details, in addition to those specified in applicable standards shall be included on the rating plate.

7.1.1 Temperature rise of windings in degree centigrade at rated load, rated voltage, frequency and ambient conditions and the method of measuring temperature rise. (Thermometer/ Winding resistance).

7.1.2 Type of bearings, recommended lubricant, lubricating interval & re-lubricating quantity.

8.0 **TESTS**

8.1 Type test certificates for similar motors shall be furnished with the Bid.

8.2 Extra price for performing type tests on the motor as per applicable standard shall be quoted.

8.3 If specified in data sheet-A, for motors rated 3.3 kV and above, the induced shaft voltage shall be measured at the manufacturer's works during shop testing. The maximum value of induced voltage in the motor shaft shall not exceed 250mV.

8.4 The polarisation index test shall be carried out on all motors rated at 3.3 kV and above. The minimum value of the polarisation index shall be 2 when determined as per IS-7816.

8.5 Coils of HV motors shall be tested as per IEC-34-15.

8.6 Loss tangent measurement of coils for motors rated 6.6 kV & above shall be done as per IS-13508.

8.7 All other routine tests shall be carried out as per applicable standards.

ISSUE
R8

SL.NO.	DESCRIPTION	UNIT	TECHNICAL PARTICULARS
1.0	GENERAL		
1.1	APPLICATION		
1.2	NUMBER OF UNITS		
1.3	TYPE OF MOTOR		SQUIRREL CAGE/ WOUND ROTOR
1.4	SUPPLY SYSTEM FAULT LEVEL	MVA	
1.5	SUPPLY NEUTRAL TYPE OF EARTHING		
1.6	COMPLIANCE WITH TCE.M4-203-02 IS REQUIRED		YES/NO
1.7	IF YES CLAUSES OF TCE.M4-203-02 WHICH ARE NOT APPLICABLE :		
2.0	RATING		
2.1	RATED OUTPUT :	kW	
2.2	RATED VOLTAGE : (415V for 132kW & below motors & 6.6kV for above 132kW motors)	V	
2.3	NUMBER OF PHASES & FREQUENCY		
2.4	SUPPLY CONDITION (REF. CL.NO.4.1 OF TCE.M4-203-01)		I/II
2.5	SYNCHRONOUS SPEED	RPM	
3.0	DUTY		
3.1	TYPE OF DUTY (CLAUSE 9.2 OF IS:325 OR EQUIVALENT)		
3.2	POWER REQUIRED BY LOAD	kW	

SL.NO.	DESCRIPTION	UNIT	TECHNICAL PARTICULARS
4.0	METHOD OF STARTING		D.O.L./STAR DELTA/ OTHER
5.0	INSULATION		
5.1	CLASS OF INSULATION		
5.2	REF. AMBIENT TEMPERATURE	deg.C	
5.3	TEMPERATURE RISE OF WINDING		
5.3.1	BY THERMOMETER METHOD	deg.C	
5.3.2	BY WDG RESISTANCE METHOD	deg.C	
6.0	INSTALLATION		
6.1	LOCATION		Indoor/Outdoor
6.2	HAZARDOUS AREA DIVISION (IS:5572 OR EQUIVALENT)		
6.3	ATMOSPHERE		CHEMICAL/DUSTY/SALT LADEN
7.0	ENCLOSURE		
7.1	TYPE OF COOLING (IS 6362)		
7.2	DESIGNATION FOR DEGREE OF PROTECTION (IS 4691)		
8.0	MAIN TERMINAL BOX		
8.1	LOCATION AS SEEN FROM NON-DRIVE END:		RIGHT/LEFT
8.2	RATINGS		
	(a) SHORT TIME i. CURRENT : ii. DURATION :	 kA(RMS) SECS.	 0.25
	(b) DYNAMIC :	kA(PEAK)	

SL.NO.	DESCRIPTION	UNIT	TECHNICAL PARTICULARS
8.3	EXTERNAL CABLE DETAILS		
8.3.1	TYPE		
8.3. 2	SIZE & NO OF CORES		
8.4	EARTHING CONDUCTORS		
8.4.1	MATERIAL		
8.4.2	SIZE		
9.0	MISCELLANEOUS REQUIREMENTS		TO BE FILLED IF MOTORS ARE BOUGHT SEPERATELY
9.1	SHAFT ORIENTATION		HORIZONTAL/VERTICAL/ HOLLOW VERTICAL
9.2	MOUNTING SYMBOL (IS:2253 OR EQUIVALENT)		
9.5	ROTATION AS SEEN FROM NON-DRIVE END		CLOCKWISE/ANTI-CLOCKWISE
9.6	TYPE OF BEARING		
9.6.1	DRIVE END		
9.6.2	NON DRIVE END		
9.7	WHETHER BED PLATE REQUIRED		YES/NO
9.9	COLOUR SHADES OF PAINT		
9.10	WHETHER CTs FOR DIFFEREN-TIAL PROTECTION REQUIRED FOR MOTORS >1000 kW		YES/NO

SL.NO.	DESCRIPTION	UNIT	TECHNICAL PARTICULARS
9.10.1	C.T. PARTICULARS :		
	a) 3 CTs, ONE IN THE NEUTRAL LEAD OF EACH PHASE		
	b) RATIO		
	c) CLASS	PS	
	d) KNEE POINT VOLTAGE	KPV	
	e) MAX. R.C.T. SECONDARY WINDING RESISTANCE	OHMS	
	f) MAX. EXCITING CURRENT AT 1/2 KPV		
	g) CLASS OF INSULATION		
9.11	WHETHER VIBRATION PADS REQUIRED		YES/NO
9.12	TEMPERATURE DETECTORS/ INDICATORS		
9.12.1	EMBEDDED TEMPERATURE DETECTORS FOR WINDING REQUIRED		YES/NO
9.12.2	EMBEDDED TEMPERATURE DETECTORS FOR BEARINGS REQUIRED		YES/NO
9.12.3	BEARING THERMOMETERS FOR DRIVING END & NON DRIVING ENDS REQUIRED		YES/NO
9.13	SPACE HEATERS FOR MOTORS REQUIRED		YES/NO

NOTES

DRAWINGS SHOULD BE SUBMITTED FOR REVIEW AS FOLLOWS:

1) GENERAL ARRANGEMENT WITHIN ___ WEEKS AFTER AWARD OF CONTRACT

2) DETAILS MARKED THUS (*) WILL BE DECIDED AND INTIMATED BY THE BIDDER BASED ON DRIVEN EQUIPMENT CHARACTERISTICS.

SL.NO.	BRIEF TITLE		REFERENCE NUMBER OF STANDARDS		
1.	THREE PHASE INDUCTION MOTORS		☐IS-325	☐ BS-4999	☐ IEC-34
2.	ROTATING ELECTRICAL MACHINES		☐IS-4722	☐ BS	☐IEC
3.	SINGLE PHASE INDUCTION MOTORS		☐IS-996	☐ BS	☐IEC
4.	CODE OF PRACTICE FOR CLIMATE PROOFING		☐IS	☐ BS-6751	☐IEC
5.	DESIGNATIONS FOR TYPES OF CONSTRUCTION AND MOUNTING ARRANGEMENT OF ROTATING ELECTRICAL MACHINES		☐IS-2253	☐ BS	☐IEC-34-7
6.	TERMINAL MARKING & DIRECTION OF ROTATION FOR ROTATING ELECTRICAL MACHINERY		☐IS-4728	☐ BS-4999 -108	☐ IEC-34-8
7.	DESIGNATION OF METHODS OF COOLING FOR ROTATING ELECTRICAL MACHINES		☐IS-6362	☐ BSEN 60034 -6-1994	☐ IEC-34-6
8.	DEGREES OF PROTECTION PROVI-DED BY ENCLOSURE FOR ROTATING ELECTRICAL MACHINERY		☐IS-4691	☐ BS-4999 -105	☐IEC-34-5
9.	GUIDE FOR TESTING THREE PHASE INDUCTION MOTORS		☐IS-4029	☐ BS	☐IEC-34
10.	MEASUREMENT AND EVALUATION OF VIBRATION OF ROTATING ELECTRICAL MACHINES		☐IS-12075	☐ BS-4999 142	☐IEC-34-14
11.	CLASSIFICATION OF HAZARDOUS AREAS FOR ELECTRICAL INSTALLATION		☐IS-5572	☐ BS	☐ IEC-79
12.	DIMENSIONS OF SLIDE RAILS FOR ELECTRIC MOTORS		☐IS-2968	☐ BS-4999 -141	☐ IEC
13.	PERMISSIBLE LIMITS OF NOISE LEVEL FOR ROTATING ELECTRICAL MACHINES		☐IS-12065	☐ BSEN 60034 -9-1994	☐ IEC
14.	GUIDE FOR TESTING INSULATION RESISTANCE OF ROTATING MACHINES		☐IS-7816	☐ BS	☐IEC

SL.NO.	BRIEF TITLE	REFERENCE NUMBER OF STANDARDS
15.	TANGENT DELTA & DELTA TANGENT DELTA TEST	☐IS-13508 ☐ BS ☐IEC
16.	IMPULSE VOLTAGE WITHSTAND TEST	☐IS ☐ BS ☐IEC-34-15
17.	TEMPERATURE RISE MEASUREMENT OF ROTATING ELECTRICAL MACHINES	☐IS-12802 ☐ BS ☐IEC
18.	TYPE OF DUTY AND CLASSES OF RATING ASSIGNED TO ROTATING ELECTRICAL MACHINES	☐IS 12824 ☐ BS ☐ IEC
19.	CBIP RECOMMENDATION FOR MOTORS	

NOTES

1. EQUIPMENT, ASSOCIATED ACCESSORIES, COMPONENTS/PARTS, RAW MATERIAL AND TESTS SHALL IN GENERAL CONFORM TO ☐IS ☐BS ☐IEC

2. OFFERS CONFORMING TO OTHER AUTHORITATIVE STANDARDS MAY ALSO BE CONSIDERED/ MAY NOT BE CONSIDERED.

REV. 0	TCE.M4 - 109 - PLC	TCE CONSULTING ENGINEERS LTD.	SECTION D35
	SPECIFICATION NUMBER TCE - M4 - 126 - IC - 01	PROGRAMMABLE LOGIC CONTROLLER DATA SHEET	SH 1 OF 15

GENERAL FEATURES	1	MANUFACTURER : SIEMENS LTD	✓
	2	MODEL NUMBER/SYSTEM TYPE	*
	3	MICRO PROCESSOR BASED PROGRAMMABLE LOGIC CONTROLLER (PLC)	✓
	4	CONFIGURATION : AS PER ENCLOSED DRAWING TCE - M4 - 126 - IC - 01	✓
	5	FUNCTIONS : AS PER ENCLOSED LOGIC ☐	
	6	AS PER SECTION - C WRITEUP ◣ } (ALSO REFER NOTE 1)	✓
	7	AS PER I/O LISTS ENCLOSED ☐ }	
	8	CAPACITY : BASED ON I/O LIST OF BIDDER ◣ }	✓
	9	ADEQUATE TO MEET REQUIREMENTS AS PER LOGIC DRG. ENCLOSED ☐ }	
	10	TYPE OF INPUTS AND OUTPUTS : AS PER I/O LIST ENCLOSED ☐ AS PER LOGIC DWG. ENCLOSED ☐	
	11	HARDWARE REQUIREMENTS : REFER NOTE 1	✓
	12	SOFTWARE REQUIREMENTS : REFER NOTE 1	✓
	13		
	14		
	15		
EQUIPMENT TO BE SUPPLIED	16	PLC COMPLETE WITH PROCESSOR, I/O CARDS, MEMORY MODULES, RACKS, MOUNTING ACCESSORIES, }	✓
	17	COMPLETELY WIRED & TESTED }	
	18	POWER SUPPLY MODULES YES ■ NO ☐ (REF. SHEET NO. 5)	✓
	19	HAND HELD PROGRAMMER YES ☐ NO ☐ (REF. SHEET NO. 7)	
	20	PC BASED PROGRAMMER YES ■ NO ☐ (REF. SHEET NO. 7)	✓
	21	PRINTER WITH THE PLC YES ■ NO ☐ (REF. SECTION D)	✓
	22	OPERATING TILE YES ☐ NO ■ (REF. SECTION D)	✓
	23	ILLUMINATED PUSH BUTTON YES ■ NO ☐ (REF. SECTION D)	✓
	24	INTERPOSING RELAY YES ■ NO ☐ (REF. SHEET NO. 7)	✓
	25	SYSTEM CABINET YES ■ NO ☐ (REF. SECTION D)	✓
	26	SIGNAL DISTRIBUTION HARDWARE YES ■ NO ☐ (REF. SHEET NO. 4)	✓
	27	CONTROL OPERATION PC ■ PANEL ☐	✓
	28		
	29		

NOTES

1 THE PLC SHALL MEET ALL THE FUNCTIONS LISTED HEREIN BUT NEED NOT BE LIMITED TO THE FOLLOWING. ALL HARDWARES/SOFTWARES NECESSARY TO MEET THESE FUNCTIONS SHALL BE PROVIDED.

a) TO PROCESS THE FIELD SIGNALS/GENERATED SIGNALS AND DISTRIBUTE THE SIGNALS AS PER ENCLOSED I/O LIST/LOGIC DRAWINGS

b) TO PERFORM PROTECTION, LOGIC, INTERLOCK AND SEQUENTIAL CONTROL FUNCTIONS AS SPECIFIED AND GUARANTEE THE FUNCTIONAL REQUIREMENTS AS SPECIFIED UNDER GUARANTEE CLAUSES. THE CONTROL FUNCTIONS OF PLC SHALL BE SUCH AS BINARY LOGIC OPERATIONS, SET/ RESET OPERATION, TIMERS, COUNTERS, JUMP INSTRUCTION COMPARISON BLOCK, LOGICAL BLOCKS, MATH FUNCTIONS, BOOLEAN FUNCTIONS, TIMER FUNCTIONS (ON & OFF DELAY TIMERS), COUNTER FUNCTIONS.

c) FAILURE OF ONE LOGIC SHALL NOT RESULT IN FAILURE OF OTHER LOGICS.

d) OTHER FUNCTIONS AS REQUIRED

2. EACH LOOP IS A SUBSYSTEM AND CONSISTS OF PRIMARY SENSOR/INITIATING DEVICE, FUNCTION MODULES, POWER SUPPLY CIRCUIT, LOGIC CIRCUIT MONITORING AND DETECTION.

3 EXECUTION TIME INCLUDES THE TIME FOR SCANNING ALL INPUTS AND OUTPUTS AND EXECUTION OF ALL STEP/LADDER LOGICS WITH ALL INPUTS AND OUTPUTS CONNECTED TOGETHER. IF THE PLC OFFERED CANNOT MEET THIS REQUIREMENT, BIDDER MAY DISTRIBUTE THE CONTROLS TO MORE THAN 1 PLC IN HIS OFFER TO MEET THE REQUIRED RESPONSE TIME.

REV. NO.				PPD. BY : CS	JOB NO. TCE 5178 A	OWNER : BORL	EPCC : BHEL
DATE				CKD. BY : KG		PROJECT : 3X33 MW CPP, BINA	
REV. BY				DATE			

REV. 0

TCE.M4 - 109 - PLC	TCE CONSULTING ENGINEERS LTD.	SECTION D35
SPECIFICATION NUMBER TCE - M4 - 126 - IC - 01	DIGITAL DISTRIBUTION & SIGNAL CONDITIONING MODULES DATA SHEET	SHEET 10 OF 15

C. DIGITAL DISTRIBUTION AND SIGNAL CONDITIONING MODULE (REF. NOTE 7)*

SL. No.	SYSTEMS	TYPE OF SIGNALS	NO. OF INPUTS ENVISAGED	DISTRIBUTION MODULES				SIGNAL CONDITIONING MODULES			
				NO. OF INPUT SIGNALS PER MODULE	NO. OF MODULES PROVIDED	MFR/ TYPE OF MODULE		NO. OF INPUT SIGNALS PER MODULE	NO. OF MODULES PROVIDED	MFR/ TYPE OF MODULE	

REV. NO.				PPD. BY : CS	JOB NO. TCE 5178 A	OWNER : BORL	EPCC : BHEL
DATE				CKD. BY : KG		PROJECT : 3 X 33 MW CPP, BINA	
REV.BY				DATE			

REV. 0

TCE.M4 - 109 - PLC

SPECIFICATION NUMBER
TCE - M4 - 126 - IC - 01

TCE CONSULTING ENGINEERS LTD.

DIGITAL INPUT/OUTPUT MODULES
DATA SHEET

SECTION D35

SHEET 11 OF 15

D. DIGITAL INPUT / OUTPUT MODULE (REF. NOTE 7) *

SL. No.	SYSTEMS	INPUT MODULE					OUTPUT MODULE					IPR	
		NO. OF DIGITAL INPUTS ENVISAGED	MAX. NO. OF INPUTS/ MODULE	NO. OF MODULES PROVIDED	MFR. TYPE & MOD. NO.		NO. OF DIGITAL OUTPUTS ENVISAGED	MAX. NO. OF OUTPUTS/ MODULE	NO. OF MODULES PROVIDED	MFR. TYPE & MOD. NO.		NO. OF IPR PROVIDED (REF. NOTE 10)	NO. OF IPR CABINETS PROVIDED

REV. NO.				PPD. BY : CS	JOB NO. TCE 5178 A	OWNER : BORL
DATE				CKD. BY : KG		EPCC : BHEL
REV.BY				DATE		PROJECT : 3 X 33 MW CPP, BINA

P - PLC11

JAN. 1994

E. PROCESSORS (SEE NOTES 3 & 7) *

LINE No.	SYSTEMS	TOTAL NO. OF INPUT SIGNALS	TOTAL NO. OF OUTPUT SIGNALS	TOTAL NO. OF INPUT & OUTPUT SIGNALS	TOTAL NO. OF SIGNALS ONE PROCESSOR CAN HANDLE	NO. OF PROCESSORS PROVIDED & TYPE	CAPACITY AVAILABLE (REF. NOTE 3)

REV. 0

F. RACKS AND CABINETS (SEE NOTES 2 & 7)*

LINE No.	SYSTEMS	MAIN RACKS					EXTENDED RACKS				CABINTES		
		NO. OF PROCESSORS	NO. OF POWER SUPPLY MODULES*	NO. OF I/O MODULES*	NO. OF BUS INTERF. MODULES*	NO. OF MAIN RACKS*	NO. OF POWER SUPPLY MODULES*	NO. OF BALANCE I/O MODULES*	NO. OF COMMUNICATION CARDS*	NO. OF EXTENDED RACKS *	TOTAL NO. OF MAIN & EXTD. RACKS *	NO. OF RACKS PER CABINET *	TOTAL NO. OF CABINETS *

REV. NO.	DATE	REV.BY

PPD. BY : CS
CKD. BY : KG
DATE

JOB NO. TCE 5178 A

OWNER : BORL
EPCC : BHEL
PROJECT : 3 X 33 MW CPP, BINA

TCE.M4-109-PLC
SPECIFICATION NUMBER TCE-M4-126-IC-01

TCE CONSULTING ENGINEERS LTD.

RACKS & CABINET
DATA SHEET

SECTION D35
SHEET 13 OF 15

P-PLC13
JAN. 1994

REV. 0

TCE.M4 - 109 - PLC

SPECIFICATION NUMBER
TCE - M4 - 126 - IC - 01

TCE CONSULTING ENGINEERS LTD.

PROGRAMMABLE LOGIC CONTROLLER GENERAL NOTES
DATA SHEET

SECTION D35

SHEET 14 OF 15

NOTES: -

1. THE DISTRIBUTION OF THE SIGNALS WHEREVER REQUIRED IS INDICATED. ANY CHANGES ON THE NUMBER OF DISTRIBUTION OF SINGALS CALLING FOR ANY HARDWARE CHANGES SHALL NOT BE CONSIDERED AS SCOPE CHANGE.
2. THE RACKS IN SYSTEM CABINETS SHALL HAVE SPARE SLOT PROVISION ALONGWITH PLUGIN SOCKETS/ BACKPLANE TO HOUSE ATLEAST 10% ADDITION CARD OF EACH TYPE TO ACCOMODATE FOR ENGINEERING FLEXIBILITY OR FUTURE EXPANSION. THESE SPARE SLOTS SHALL BE DISTRIBUTED TO DIFFERENT RACKS AND CABINETS.
3. THE PROCESSOR SHALL BE DESIGNED TO HAVE A MINIMUM OF 20% SPARE CAPACITY OVER AND ABOVE THAT REQUIRED CONSIDERING HOT SPARE I/O MODULES (FUTURE) TO BE LOCATED AT SPARE SLOTS.

*4. BIDDER TO SUBMIT TYPICAL LOGIC SCHEMES (LOOP DRAWINGS) SHOWING THE SIGNAL PATH FROM SENSOR TO LOCAL/CUBICLE BUS AND IDENTIFYING THE VARIOUS HARDWARES LIKE DISTRIBUTOR MODULES, SIGNAL CONDITIOING MODULES, INPUT MODULES, OUTPUT MODULES, PROCESSOR MODULES, COMMUNICATION CARDS, BUS INTERFACING CARDS, POWER SUPPLY MODULES, LIMIT VALUE MONITORS ETC., CLEARLY BRINGING OUT THE REDUNDANT FEATURES.

*5. BIDDER SHALL SUBMIT A SCHEMATIC DRAWING TO SHOW THE POWER SUPPLY DISTRIBUTION TO VARIOUS MODULES IN DIFFERENT RACKS IN A CABINET AND TO OTHER CABINETS.

6. BIDDER SHALL SUBMIT A SCHEMATIC DRAWING TO SHOW THE POWER SUPPLY DISTRIBUTION TO VARIOUS MODULES VIZ POWER SUPPLY MODULES, SINGAL DISTRIBUTOR MODULES, SIGNAL CONDITIONING MODULES, INPUT MODULES, OUTPUT MODULES, PROCESSORS INTERFACING CARDS ETC., IN THE RACKS AND CABINETS.
7. BIDDER SHALL USE AS MANY SHEETS AS THEY NEED TO LIST OUT THE DETAILS CALLED FOR IN DATA SHEETS FOR PROCESS MODULES, PROCESSORS AND RACKS AND CABINETS. HOWEVER, THE INFORMATION SHALL BE PRESENTED IN THE SAME FORMAT.
8. CONCEPT FOR I/O ASSIGNMENT (GROUPING)

(i) NO TWO IDENTICAL/ SIMILAR EQUIPMENT SHALL BE GROUPED IN THE SAME INPUT MODULE/ OUTPUT MODULE.

(ii) ANY ONE CARD SHALL HAVE I/O RELATED TO ONLY ONE EQUIPMENT AND ASSOCIATED AUXIUARIES, IF ANY EQUIPMENT AND AUXILIARY REQUIRES MORE THAN ONE CARD, I/O RELATED AUXILIARIES (EG. LOP-`A' & LOP-`B') SHALL BE IN DIFFERENT CARDS.

(iii) INPUTS AND OUTPUTS CANNOT BE COMBINED IN SINGLE MODULE.

(iv) WHENEVER, 2/3 LOGIC IS INVOLVED, EACH OF THESE INPUTS WILL BE CONNECTED TO DIFFERENT INPUT CARD AND THE ALL THE CORRESPONDING CONDITIONED OUTPUTS WILL BE TAKEN TO ONE PROCESSOR OR MORE THAN ONE PROCESSOR DEPENDING ON THE GROUPING FOR PERFORMING 2/3 LOGIC IN THE PROCESSORS.

REV. NO.	DATE	REV.BY

PPD. BY : CS
CKD. BY : KG
DATE

JOB NO.
TCE
5178 A

OWNER : BORL
EPCC : BHEL
PROJECT : 3 X 33 MW CPP, BINA

(v) ALL COMMON INPUTS TO IDENTICAL EQUIPMENT (SAY 3 BFP) SHALL BE INDIVIDUALLY CONNECTED TO THE RESPECTIVE PROCESSORS OF THE EQUIPMENT THROUGH INDIVIDUAL INPUT MODULES. ALL SUCH INPUTS ARE INDICATED WITHIN BRACKET.

(vi) I/O ASSIGNMENT SHALL BE IDENTICAL FOR SIMILAR/ REDUNDANT EQUIPMENT. FOR EXAMPLE IF ID FAN `A' RUN IS ASSIGNED CHANNEL 4 OF A CARD, ID FAN `B' RUN SHALL ALSO BE ASSIGNED CHANNEL 4 OF ANOTHER CARD. ALSO THESE CARDS SHALL BE LOCATED IN IDENTICAL SLOTS OF DIFFERENT RACKS.

(vii) I/O MODULES OF ONE EQUIPMENT AND ASSOCIATED AUXILIARIES SHALL BE LOCATED IN THE SAME RACK. IN DIFFERENT RACKS OR EVEN AT DIFFERENT CABINETS TO INCREASE THE AVAILABITY

9. * BIDDER TO FUNISH DETAILS.

10. TWO NOS. OF INTERPOSING RELAYS SHALL BE PROVIDED FOR EACH DRIVE

SYSTEM FEATURES	1	SUB SYSTEM - REF. NOTE No. 2	✓
	2	WATCH DOG TIMER	✓
	3	SCAN TIME FOR DIGITAL INPUTS : ≯ 60 mSEC.	✓
	4	SCAN TIME FOR PULSE INPUTS : ≯ 60 mSEC.	✓
	5	SCAN TIME FOR ALL ANALOG INPUTS : ≯ 500 mSEC.	✓
	6	EXECUTION TIME : ≯ 120 mSEC. (REF. NOTE 3)	✓
	7	SYSTEM LOADING : MAX. 60% UNDER WORST LOADING CONDITIONS	✓
	8	MEASUREMENT CIRCUIT : INDEPENDENT FOR EACH MEASUREMENT	✓
	9	GROUPING OF SIGNALS IN CARDS : REFER NOTE 14	✓
	10	GROUPING OF CONTROL LOGICS : REFER NOTE 15	✓
	11	OVERALL ACCURACY OF MEASUREMENT SIGNALS : ± 0.5% S T	*
	12	SYSTEM DESIGN : ENERGISE TO COMMAND BASIS AND ON FAULTS TO DEENERGISE CONDITION	✓
	13	IMPLEMENTATION OF FUNCTIONAL REQUIREMENTS TO BE INDEPENDENT FOR EACH PROTECTION	✓
	14	INTERLOCK AND SEQUENTIAL CONTROLS	
	15		
	16		
SYSTEM REDUNDANCIES	17	PROCESSOR REDUNDANCY :- 1:1 :- YES ■ NO □	✓
	18	POWER SUPPLY REDUNDANCY :- 1:1 YES ■ NO □	✓
	19	COMMUNICATION MODULES :- 1:1 :- YES ■ NO □	✓
	20	INPUT MODULES :- 1:1 :- YES □ NO □	*
	21	OUTPUT MODULE :- 1:1 :- YES □ NO □	*
	22		
	23		
SYSTEM MONITORING	24	EACH SUBSYSTEM FAILURE ALARM	✓
	25	EARTH FAULT ALARM FOR EACH SUBSYSTEM	✓
	26	POWER SUPPLY FAILURE ALARM	✓
	27	ISOLATION FACILITY FOR GROUND DETECTION AT SUB SYSTEM WITHOUT REMOVING ANY HARDWARE	✓
	28	(POWER SUPPLY ISOLATION)	
	29	ISOLATION FACILITY FOR GROUND DETECTION OF INDIVIDUAL SIGNAL WITHOUT REMOVING FIELD	✓
	30	WIRING (ISOLATION OF SIGNAL AT BOTH TERMINALS)	
	31	MTBF (BIDDER TO FURNISH SUPPORTING DATA FOR CALCULATIONS)	*
	32	MTTR (BIDDER TO FURNISH SUPPORTING DATA FOR CALCULATIONS)	*
	33	POWER SUPPLY MONITORING : REQD.	✓
	34	LEDS FOR FAULT INDICATION ON EACH TYPE OF CARD	✓
	35	LED FOR WATCH DOG TIMER FAILURE	✓
	36	AUTO OPERATION TO BE MONITORED AND ALARMING OF AUTO FAILURE.	✓
	37	FUSE PROTECTION AND FUSE FAILURE	✓
	38	COMMUNICATION MONITORING	✓
	39	SELF CHECKING FEATURES	✓
	40	CRITICAL FAULTS TO FREEZE THE FINAL CONTROL ELEMENT TO CHANGE TO MANUAL POSITION WITH ALARM	✓
	41		
	42		

NOTES

4. THE INTERFACING REQUIREMENT WITH SYSTEMS SUPPLIED BY OTHERS, SHALL BE THROUGH A (i) POTENTIAL FREE CONTACT WITH 220 V DC, 0.2 A RATING FOR DIGITAL SIGNALS AND (ii) 4-20 mA AT 24 V DC FOR ANALOG SIGNALS.

5. ALL FUNCTIONAL CARDS INCLUDING POWER SUPPLY SHALL BE MOUNTED IN CABINETS AND PRE-WIRED.

DESIGN FEATURES OF HARDWARE	1	OPTICAL ISOLATION OF ALL DIGITAL INPUTS AND OUTPUTS	✓
	2	GALVANIC ISOLATION/OPTICAL ISOLATION FOR ALL ANALOG INPUTS AND OUTPUTS	✓
	3	POWER SUPPLY TO SENSOR TRANSMITTER AT â 24 V DC	✓
	4	FROM STATION BATTERY ☐ FROM INTERNAL POWER PACK ◥	
	5	INRUSH CURRENT LIMITER TO DRIVING CIRCUIT	✓
	6	CIRCUITS : SHORT CIRCUIT PROOF AND VOLTAGE SURGE PROOF	✓
	7	PROTECTION AGAINST CONTINUOUS PRESENCE OF POWER SUPPLY OR SIGNAL	✓
	8	MODULAR TYPE OF CARDS	✓
	9	PCB : EPOXY FIBRE GLASS	✓
	10	PLUG IN TYPE PCB WITH GOLD PLATED CONTACTS (BOTH AT PLUG & SOCKET)	✓
	11	RELIABILITY AND AVAILABILITY	*
	12	I/O MODULE LOCATION IN SYSTEM CABINETS ◥	✓
	13	CARD TYPE OR FUNCTION DESIGNATION TO BE INSCRIBED ON EACH CARD	✓
	14	CARD PROTECTION : TROPICALISATION	✓
	15	CONSTRUCTIONAL DETAILS AND SPECIAL FEATURES OF CARDS	*
	16	LOGIC DEVICES : INTEGRATED CIRCUITS	
	17	MAXIMUM RESISTANCE OF FIELD CABLE PER INPUT/OUTPUT	*
	18	RECOMMENDED FIELD CABLE SPECIFICATION	*
	19	STATUS (CHANNEL HEALTHY) INDICATING LEDS FOR EACH INPUT AND OUTPUT	✓
	20	FILTERS FOR NOISE REJECTION	✓
	21	POWER SUPPLY HEALTHY LED IN MODULES	✓
	22		
	23		
ENVIRONMENT	24	MAXIMUM TEMPERATURE 50ÂC	✓
	25	RELATIVE HUMIDITY 95%	✓
	26		
	27		
	28		
DIGITAL INPUTS/OUTPUTS	29	TYPE OF INPUT CONTACT : NO/NC - FIELD SELECTABLE ☐ CHANGE OVER CONTACT ☐	*
	30	TIME DELAY OF 5-10 mSEC. FOR CONTACT DEBOUNCE TIME	✓
	31	OUTPUTS - RELAY OUTPUTS FOR DRIVING MCC STARTER COILS, DRIVING SOLENOID VALVES	✓
	32	(REF. NOTE 12)	
	33	SIGNAL DISTRIBUTION (REF. NOTE 6)	✓
	34	COMMON MODE NOISE REJECTION	✓
	35		
	36		

NOTES

6. SIGNAL DISTRIBUTION OF INPUT SIGNALS TO VARIOUS DEVICES WITHIN THE VENDOR'S SYSTEM SHALL BE THROUGH SOLID STATE DEVICES WITHOUT ANY SOFTWARE BEING USED FOR THE SAME.
7. NON VOLATILE MEMORY IS REQUIRED TO STORE PROGRAMMES, STANDARD SOFTWARE TO PERFORM LOGIC FUNCTIONS, DATA ACQUISITION AND DIAGNOSTIC FUNCTIONS.
8. THE INTERNAL POWER PACK SHALL BE REDUNDANT AND ACCEPT TWO (2) NUMBERS OF FEEDERS OF _ _ _ _ FROM UPS. THE INTERNAL POWER PACKS GENERATE ALL DIFFERENT VOLTAGES REQUIRED BY THE SYSTEM AND A BUS WILL BE FORMED FOR EACH OF THESE VOLTAGES WITH DIODE AUCTIONEERING AT THE OUTLET OF THE INTERNAL POWER PACK. EACH POWER PACK SHALL BE RATED FOR 110% OF MAXIMUM REQUIREMENTS. IN CASE THESE VOLTAGES ARE PROVIDED AT INDIVIDUAL CARD, THEN POWER PACK ARE NOT APPLICABLE. HOWEVER THE SYSTEM SHALL BE DESIGNED TO ACCEPT SUPPLY FROM TWO FEEDERS.

DIGITAL SIGNAL MONITORING FUNCTIONS	1	CONTACT MONITORING	✓
	2	FIELD CABLE MONITORING	✓
	3	POWER SUPPLY FAILURE	✓
	4	FUSE PROTECTION AND FUSE FAILURE	✓
	5	COMMUNICATION MONITORING	✓
	6	SELF CHECKING FEATURES FOR DETECTING FAULTY OPERATIONS	✓
	7		
	8		
ANALOGUE SIGNAL CONDITIONING FUNCTIONS	9	GALVANIC ISOLATION OF INPUT AND OUTPUT SIGNALS	✓
	10	INPUT FILTERING FOR NOISE LEVEL	✓
	11	NON LINEAR FILTERING FOR ATTENUATION OF NOISE LEVEL	✓
	12	AMPLIFICATION OF LOW LEVEL SIGNALS	✓
	13	SIGNAL DISTRIBUTION : REFER NOTE No. 6	✓
	14	TRANSMITTER POWER SUPPLY	✓
	15	COLD JUNCTION COMPENSATION FOR THERMOCOUPLES	✓
	16	20% OVER RANGE PROTECTION	✓
	17	CAPABILITY TO WITHSTAND CUSTOMER POWER SUPPLY VARIATION SPECIFIED UNDER POWER	✓
	18	SUPPLY SPECIFICATION	
ANALOGUE SIGNAL MONITORING FUNCTIONS	19	POWER SUPPLY FAILURE DUE TO LOOSE PLUG CONNECTION, SHORT CIRCUIT, WIRE BREAK AND	✓
	20	VOLTAGE INTERRUPTION	
	21	TRANSMITTER MONITORING FOR PARITY, WIRE BREAK, LINE ZERO AND END LIMIT VALUES	
	22	MONITORING OF A/D CONVERSION	✓
	23	CABLE MONITORING FOR OPEN CIRCUIT	✓
	24	FUSE PROTECTION AND FUSE FAILURE DETECTION	✓
	25	COMMUNICATION MONITORING	✓
	26	WIDE DEVIATIONS BETWEEN ADJACENT SCANS	✓
	27	SELF CHECKING FEATURES FOR DETECTING FAULTY OPERATION	✓
	28	DETECTION OF OPEN CIRCUIT OF THERMOCOUPLES	✓
	29		
	30		
	31		

NOTES

9. THE I/OS FOR IDENTICAL SERVICES/EQUIPMENTS LIKE FD-A AND FD-B SHALL BE LOCATED ON DIFFEREDNT RACKS.
10. PLC SHALL SUPPORT THE ADDITION/DELETION OF INPUTS FROM SCANNING/PROCESSING, ALARM INHIBIT.
11. THE PURCHASER RESERVES THE RIGHT TO RE-GROUP THE INPUTS TO PLC AFTER AWARD OF CONTRACT. ANY INCREASE IN PROCESSORS ON ACCOUNT OF THE ABOVE, UPTO 10% SHALL NOT HAVE ANY PRICE IMPLICATION TO PURCHASER.
12. PLC OUTPUTS SHALL BE TRANSISTOR OUTPUT OR TRIAC OUTPUTS ONLY AND THESE SHALL DRIVE THE INTERPOSING RELAYS. PCB MOUNTED RELAYS ARE NOT ACCEPTABLE. RELAYS SHALL BE SUPPLIED ALONGWITH PLC.
13. THE POWER SUPPLY AND OTHER HARDWARE SHALL ALSO BE PROVIDED WITH EXCESS CAPACITY TO ADD ON THESE ADDITIONAL MODULES. ALL SPARE MODULES SUPPLIED SHALL BE MOUNTED WIRED & KEPT WITH POWER SUPPLY ON AT ALL TIMES. THE POWER SUPPLY SHALL BE DESIGNED TO MEET THE REQUIREMENT OF ADDITIONAL I/O MODULES FOR WHICH THE SPARE LOTS ARE MADE AVAILABLE.
14. GROUPING OF SIGNALS IN EACH CARD IS SUBJECT TO PURCHASER'S APPROVAL AT THE TIME OF DETAILED ENGG. ANY CHANGE RESULTING IN INCREASE OF CARDS UPTO 5% WILL NOT BE CONSIDERED AS SCOPE CHANGE.

PROCESSOR FUNCTIONS AND CAPABILITY	1	DATA ACQUISITION	✓
	2	PROVISION OF TIME SYNCHRONISATION WITH MASTER CLOCK (REF. NOTE No. 18)	✓
	3	LOGIC FUNCTIONS	✓
	4	GENERATION OF BOOLEAN FUNCTIONS.	✓
	5	DIAGNOSTIC FUNCTIONS PERFORMANCE : REQD.	✓
	6	MONITORING ADC/DAC PERFORMANCE AND ALARMING (FOR ANALOG INPUTS)	✓
	7	DIGITAL FILTERING	✓
	8	VALIDATION OF ALL INPUTS AND OUTPUTS	✓
	9	POINT IDENTIFICATION : BY TAGS, UPTO 8 CHARACTERS LONG : REQD.	✓
	10	POINT DESCRIPTION : MINIMUM 24 CHARACTERS	✓
	11	FACILITY TO DELETE OR RETURN OF ANY POINT FROM SCAN/PROCESSING (REF. NOTE No. 10)	✓
	12	COMMUNICATION WITH I/O MODULES	✓
	13	COMMUNICATION CONTROL AND MONITORING	✓
	14	BATTERY BACKUP OF NOT LESS THAN 72 HRS.	✓
	15	PROCESSOR 32 BIT WITH FLOATING POINT CAPABILITY	✓
	16	PROCESSOR CAPABILITY :- REF. NOTE 3 OF I/O LIST	✓
	17	CAPACITY OF VOLATILE MEMORY OF EACH PROCESSOR (REF. NOTE 7)	✓
	18	VOLATILE MEMORY TO STORE DYNAMIC PLANT DATA, CONTROL PROGRAMMES AND SELF DIAGNOSTIC ROUTINES	✓
	19		
	20		
	21		
POWER SUPPLIES (REF. NOTE 13)	22	POWER SUPPLY VARIATION:	*
	23	POWER SUPPLY SCHEME : REF.. DWG. No. TCE. -580-SK-	✓
	24	INTERNAL POWER PACK : REF. NOTE 8	✓
	25	SEPERATE FUSES AND CIRCUITS FOR EACH SUBSYSTEM	✓
	26	POWER REQUIREMENTS	*
	27	HEAT DISSIPATION	*✓
	28		
	29		
	30		
ARRANGEMENT (REF. NOTE 5)	31	SYSTEM CABINETS	✓
	32		
	33	PREFABRICATED PLUG IN CABLES WITH IN PLC EX. RACK TO RACK, RACK TO POWER SUPPLIES ETC. AND	✓
	34	BETWEEN OTHER CABINETS SUPPLIED BY VENDOR	
	35	ARRANGEMENT OF CARDS/PROCESSOR CARDS IN SYSTEM CABINET (REF. NOTE 9)	✓
	36	PROTECTION CLASS : IP-55 (FOR NON A/C AREA) □ IP-32 FOR A/C AREA. ◥	✓
	37		
	38		
	39		

NOTES

15. THE PURCHASER RESERVES THE RIGHT TO RE-GROUP ANY OF THE CONTROL LOGICS IN A PLC AFTER THE AWARD OF CONTRACT. ANY INCREASE IN NUMBER OF PLCS UPTO 10% SHALL NOT HAVE ANY COST IMPLICATION. FOR ANY REDUCTION IN THE NUMBER OF PLCS THE COST REDUCTION SHALL APPLY BASED ON THE UNIT PRICE.
16. BIDDER SHALL FURNISH IN HIS PROPOSAL THE TEST FACILITY AND DETAILS OF SIMULATION TEST AVAILABLE IN THEIR FACTORY INCLUDING THEIR PREVIOUS EXPERIENCE.
17. ALL TESTS SHALL BE WITNESSED BY PURCHASER/PURCHASER'S REPRESENTATIVE.

REV. 0	TCE.M4 - 109 - PLC	TCE CONSULTING ENGINEERS LTD.	SECTION D35
	SPECIFICATION NUMBER TCE - M4 - 126 - IC - 01	PROGRAMMABLE LOGIC CONTROLLER DATA SHEET	SH 6 OF 15

MAINTAINABILITY	1	ALL CARD REPLACEMENTS ON POWER ON CONDITIONS	✓
	2	ISOLATION FACILITY FOR EACH SUBSYSTEM WITHOUT AFFECTING OTHER SYSTEMS	✓
	3	ALL CARD MOUNTED INTEGRATED CIRCUIT CHIPS SHALL BE MOUNTED THROUGH IC SOCKETS FOR	✓
	4	EASE OF MAINTENANCE	
	5	PROGRAMMING DEVICE	✓
	6		
	7		
CODES/STDS	8	ISA	✓
	9	IEEE	✓
	10	ANSI	✓
	11	BS	✓
	12	NEMA	✓
	13		
	14		
SPARES	15		
	16	SPARE CHANNELS - 10% OF THE I/O MODULES SUPPLIED. (WIRED TO THE CABINET TERMINALS)	✓
	17	SPARE MODULES - 10% OF EACH TYPE OF MODULE OR 1 MUNBER MIN. (WIRED TO THE CABINET	✓
	18	TERMINALS)	
	19	WIRED SPARE SLOT - 10% FOR FUTURE EXPANSION (WIRED TO THE CABINET TERMINALS)	✓
	20		
	21		
	22		
TESTS FACILITY	23	FACILITY FOR INJECTING INPUT SIGNALS - ON LINE SIMILATION	✓
	24	FACILITY FOR BLOCKING OUTPUT DURING TESTING	✓
	25	FACILITY FOR FORCING ON/OFF OF INPUTS.	✓
	26	EXTENSION CARDS FOR CHECKING/TESTING OF CARDS ON LINE	✓
	27		
	28		
TESTS	29	FUNCTIONAL TESTS (SIMULATED) FOR COMPLETE SYSTEM	✓
	30	SYSTEM PERFORMANCE & TESTS FOR MONITORING FUNCTIONS	✓
	31	DAMP HEAT CYCLING TEST AS PER IS-2106 PART-II 1962 OR EQUIVALENT.	✓
	32	DIELECTRIC STRENGTH TESTS (HIGH POT TEST) AS PER NEMA ICSI PART-I ICS-109/ANSI 39.51/	✓
	33	UL 508	
	34	RFI TEST AS PER SAMA PMC 33.1	✓
	35	IMMUNITY TO NOISE TEST AS PER IEEE SWC TEST 587	✓
	36	BURN IN TEST & TEMPERATURE RISE TEST FOR 120 HRS.	✓
	37	UNDER VOLTAGE TEST & SHORT CIRCUIT TEST (AT à 10% OF RATED VOLTAGE)	✓
	38	SURGE WITHSTAND CAPABILITY TEST AS PER ANSI C 37.9A/IEEE 4721 BE MMA 219	✓
	39	CONTINUITY TEST AND SHORT CIRCUIT TEST	✓
	40	FACTORY ACCEPTANCE TEST (REF. NOTE 17)	✓
	41	SIMULATION TEST FOR ALL LOGICS/LOOPS (REF. NOTE 16 & 17))	✓
	42	VENDOR TO SUBMIT ALL TEST CERTIFICATES FOR PURCHASER/CONSULTANT'S REVIEW	✓
	43		
	44		
NOTES	18	TIME SYNCRONISATION SHALL BE PROVIDED WHERE PLC IS PROVIDED WITH A PRINTER OR PLC IS A	
		PART OF DCS i.e PLC IS PROVIDED ALONG WITH DEVICES HAVING REAL TIME CLOCK.	

REV. NO.				PPD. BY : CS	JOB NO. TCE 5178 A	OWNER : BORL	EPCC : BHEL
DATE				CKD. BY : KG		PROJECT : 3X33 MW CPP, BINA	
REV. BY				DATE			

PROGRAMMING UNIT	1	HAND HELD PROGRAMMER UNIT WITH LED/LCD DISPLAY ☐ PC BASED PROGRAMMER ■	✓
	2	PROGRAMMING IN LADDER LOGIC	✓
	3	KEY PAD WITH DISPLAY FOR CHANGING TIMING SETTINGS, COUNTER SETTINGS, JUMPING/BYPASSING	✓
	4	SEQUENCES WITH LOCK FACILITY	
	5		
	6		
DRAWING TO BE FURNISHED	7	DATA SHEET FOR VARIOUS MODULES : I/O LIST INDICATING GROUPING OF VARIOUS SIGNALS IN	
	8	EACH MODULE, CONFIGURATION DWG.; TRANSMISSION SCHEME, IDENTIFYING VARIOUS HARDWARES	
	9	INDICATING FLOW OF SIGNAL PATH, INTERNAL AND EXTERNAL WIRING DIAGRAMS, POWER SUPPLY	
	10	SCHEME - TO VARIOUS PANELS/CUBICLES AND DISTRIBUTION OF SENSORS AND OTHER HARDWARES	✓
	11	IN SIGNAL PATH INCLUDING POWER SUPPLY, TERMINAL NUMBER, PIN NUMBER AT THE VARIOUS	
	12	CARD LEVEL, RACK NUMBER, CABINET NUMBER, ETC., EARTHING DIAGRAMS, LAYOUT OF VARIOUS	
	13	MODULES ON RACKS AND DETAILED WRITE UP OF CONTROL SYSTEMS FOR PURCHASER/	
	14	CONSULTANTS APPROVAL.	
	15	DETAILED INSTRUCTION MANUAL	✓
	16		
SYSTEM SECURITY	17	NO SPURIOUS OPERATION OR UNSAFE PLANT CONDITION DUE TO FAILURE/CHANGE OVER - ON	
	18	RESTORATION OF POWER SUPPLY AND/OR MALFUNCTION OF COMPONENTS/LOOPS AND/OR THE RELATED	✓
	19	EQUIPMENT SHALL TAKE PLACE	
	20	PLC SOFTWARE CHANGE : SHALL BE POSSIBLE THROUGH KEYBOARD LOCK	✓
	21		
	22		
GENERAL DESIGN FEATURES	23	FOLLOWING DESIGN AND CONSTRUCTION REQUIREMENT SHALL BE FULFILLED.	✓
	24	a) PROVEN DESIGN	✓
	25	b) REPUTED MAKE	✓
	26	c) SHOCK PROOF DESIGN	✓
	27	d) VIBRATION PROOF DESIGN	✓
	28	e) MAXIMUM INTERCHANGEABILITY OF PARTS	✓
	29	f) USE OF COMPONENTS WHICH HAVE HIGHER RATING THAN REQUIRED FOR OPERATING CONDITIONS	✓
	30	g) DESIGN OF EQUIPMENT TO AVOID OVERHEATING OF ELECTRONIC COMPONENTS	✓
	31	h) RUGGEDNESS OF EQUIPMENT/COMPONENTS	✓
	32	i) MINIMUM USE OF ELECTROLYTIC CAPACITORS	✓
	33		
	34		
	35		
	36		
	37		
	38		
	39		
	40		
	41		
	42		
	44		

NOTES

19. LEGEND : ✓ INDICATES THE SPEC CLAUSE IS REQUIRED AND APPLICABLE.

* INDICATES BIDDER TO FILL IN DATA/DETAILS

✓* INDICATED SPEC CLAUSE IS APPLICABLE; HOWEVER BIDDER SHALL INDICATE HIS SYSTEM'S PERFORMANCE/SPEC DATA AGAINST THE CLAUSE

REV. NO.				PPD. BY : CS	JOB NO. TCE 5178 A	OWNER : BORL	EPCC : BHEL
DATE				CKD. BY : KG		PROJECT : 3X33 MW CPP, BINA	
REV. BY				DATE			

REV. 0

A. ANALOG DISTRIBUTION AND SIGNAL CONDITIONING MODULES. (REF. NOTE 7) *

SL. No.	SYSTEMS	TYPE OF SIGNALS			NO. OF INPUT ENVISAGED			DISTRIBUTION MODULES							SIGNAL CONDITIONING MODULES						
								NO OF INPUT SIGNALS PER MODULE			NO. OF MODULES PROVIDED			MFR/ MOD. TYPE	NO OF INPUT SIGNALS PER MODULE			NO. OF MODULES PROVIDED			MFR/ MOD. TYPE
		4-20MA	RTD	T/C	4-20MA	RTD	T/C	4-20MA	RTD	T/C	4-20MA	RTD	T/C		4-20MA	RTD	T/C	4-20MA	RTD	T/C	

REV.BY | DATE | REV. NO.

DATE | CKD. BY : KG | PPD. BY : CS

JOB NO. TCE 5178 A

OWNER : BROL

PROJECT : 3X33 MW CPP, BINA

EPCC : BHEL

TCE.M4-109-PLC

SPECIFICATION NUMBER TCE-M4-126-IC-01

TCE CONSULTING ENGINEERS LTD.

ANALOG DISTRIBUTION & SIGNAL CONDITIONING MODULES DATA SHEET

SECTION D35

SHEET 8 OF 15

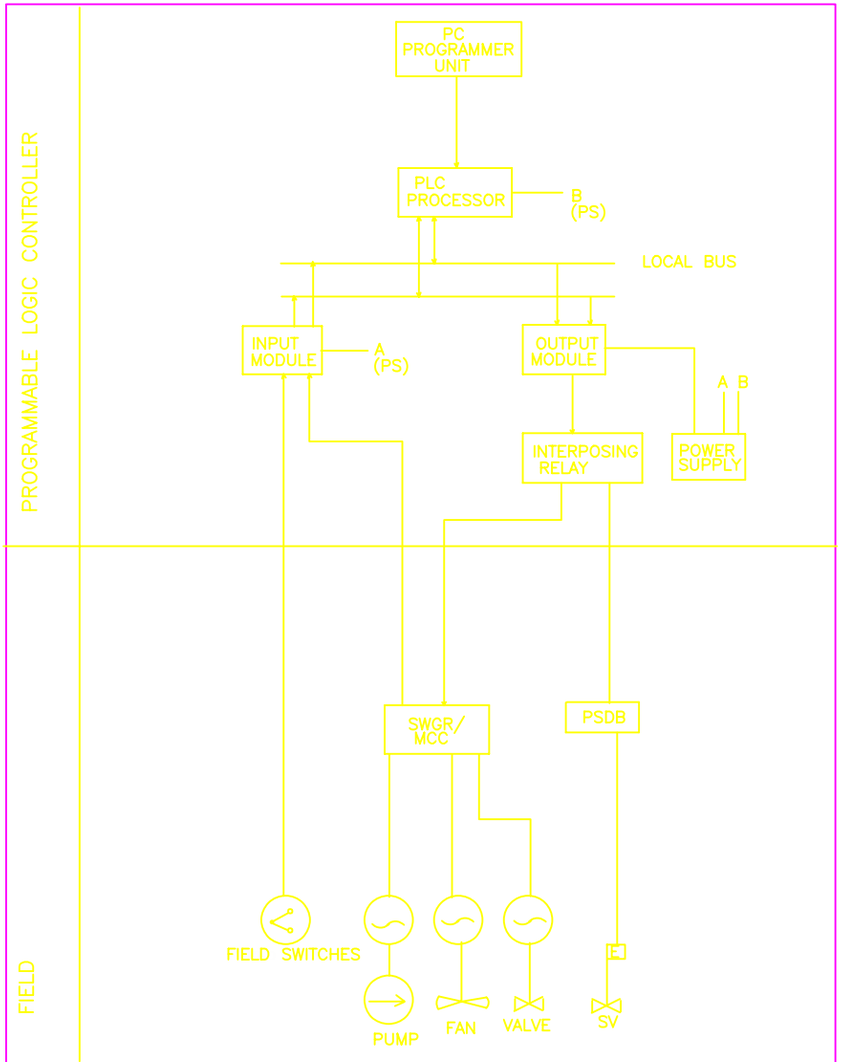
P-PLC8 JAN. 1994

B. ANALOG INPUT/OUTPUT MODULES. (REF. NOTE 7) *

SL. NO.	SYSTEMS	INPUT MODULES. NO. OF INPUTS ENVISAGED: 4 - 20MA	RTD	T/C	INPUT MODULES. MAX. NO. OF INPUT MODULES: 4 - 20MA	RTD	T/C	INPUT MODULES. NO. OF MODULES PROVIDED: 4 - 20MA	RTD	T/C	INPUT MODULES. MFR/ TYPE OF MODULE	OUT PUT MODULES. NO. OF OUTPUTS ENVISAGED: 4 - 20MA	DIGITAL	OUT PUT MODULES. MAX. NO. OF OUTPUT/MODULE: 4 - 20MA	DIGITAL	OUT PUT MODULES. NO. OF MODULES PROVIDED: 4 - 20MA	DIGITAL	OUT PUT MODULES. MFR/ TYPE OF MODULE

REV. NO.				PPD. BY : CS	JOB NO. TCE 5178 A	OWNER : BORL
DATE				CKD. BY : KG		PROJECT : 3 X 33 MW CPP, BINA
REV.BY				DATE		

EPCC : BHEL



REV	DR	CH	DT

TCE CONSULTING ENGINEERS
MUMBAI

OWNER BORL EPCC : BHEL

PROJECT : 3 X 33 MW CPP, BINA

DO NOT SCALE

PLC CONFIGURATION

SCALE

APPROVED

DIV

DR

CH

TCE FORM 034