TENDER DOCUMENT

TENDER NO.: DLI/C&E/WI-675/260

FOR

Tender for Design, Engineering, Supply, Supervision of Installation, Testing & Commissioning of “Flap Gates (3 nos.) & Diverter Gate (1 no.) and Associated Works” for the project of “Augmentation of Fuel and Flux Crushing Facilities (Package no. 064) of Bhilai Steel Plant (SAIL)”.

VOLUME – 4

General Technical Specification of Bhilai Steel Plant, SAIL

ENGINEERING PROJECTS (INDIA) LIMITED
(A GOVT. OF INDIA ENTERPRISE)
Core-3, Scope Complex, 7, Institutional Area, Lodhi Road, New Delhi-110003
TEL NO: 011-24361666 FAX NO. 011- 24363426
GENERAL INSTRUCTION
TO
TENDERER
(CHAPTER-01)
GENERAL TECHNICAL SPECIFICATION

INSTRUCTIONS TO TENDERER

(GS – 01)
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INTENT OF SPECIFICATION

The purpose of this general specification is to provide the Contractor with certain general information on the location and conditions existing at site and to lay down common guidelines and specifications which the Contractor shall follow in designing of the plant and during execution of work as applicable as per his scope of work.

MECON LIMITED, have been appointed by the Purchaser for rendering the detailed engineering and consultancy services for setting up the project.

The General Technical Specification has been divided into the following:

- GS 01 : General Instruction to Tenderer
- GS 02 : Fluid System
- GS 03 : Electrics
- GS 04 : Steel Structures & Auxiliary Facilities
- GS 05 : Inspection
- GS 06 : Material Handling & Hoisting
- GS 07 : Civil
- GS 08 : Air Conditioning and Ventilation System
- GS 09 : Painting
- GS 10 : Fire Fighting
- GS 11 : Architecture
- GS 12 : Information Technology
- GS 13 : Preferred Makes
- GS 14 : Hydraulics

GENERAL

The facilities envisaged, the conditions of site, etc have been described in the Technical Specification for the package.

Wherever applicable, the contractor should visit the site and satisfy himself of the site conditions and get conversant with other relevant matters.

SITE CONDITIONS AND INFRASTRUCTURE FACILITIES

Site Conditions

Location

Bhilai Steel Plant (BSP), SAIL is located at Bhilai in Durg district of the state of Chhatisgarh in the central region of India. The site lies between 21.15° North latitude and 81.22° East longitude. The nearest convenient rail head is Durg which is about 12km west of Bhilai. Bhilai/Durg stations are on the Howrah-Mumbai rail line of SEC Railway of the Indian Railways.

The location of Bhilai is as follows:
- From New Delhi, the national capital: 1359 kms
- From Kolkata: 868 kms
- From Chennai: 1269 kms
- From Mumbai: 1100 kms
The distance from State Capital Raipur to Bhilai Steel Plant is 30KM. It is well connected by rail and road network. The nearest national highways are NH 6 & NH 43 crossing through Raipur.

03.01.02 Meteorological Data

In the absence of meteorological data at Bhilai/ Durg, the data of the state capital Raipur, 30kms away, are considered. The meteorological details at Raipur are given below:

**Ambient Temperature**
- Absolute maximum: 47.7\(^{\circ}\) C
- Absolute minimum: 3.9\(^{\circ}\) C
- Highest of mean monthly: 45.2\(^{\circ}\) C

**Ambient Air**
- Ambient air quality: Industrial

**Relative Humidity**
- Maximum: 100%
- Minimum: 7%

**Climate**
- Tropical Humid

**Rainfall**
- Heaviest rainfall in 24 hours: 370.3 mm
- Annual Average: 1288.8 mm

**Wind**
- Predominant wind direction: SW to NE(Oct-Feb) and West to East (Mar-Sep)
- Mean wind speed: 6.8 kmph
- Maximum wind speed: 45 kmph

**Altitude**
- Average altitude of the land is 300 m above MSL

Temperature inside shop premises is generally taken as 5\(^{\circ}\) C above ambient, unless otherwise specified.

03.02 Infrastructure Facilities Outside the Plant

03.02.01 Railway

Bhilai Steel Plant is connected to Indian Railways network via Bhilai/Durg Stations of SEC Railway on the Howrah-Mumbai line. The track gauge of SEC Railways as well as of the plant tracks are standard broad gauge i.e. 1676 mm.

03.02.02 Road

The plant is well connected to the country by road. National Highways NH6 & NH43 both pass through Raipur.

03.02.03 Sea Port

The nearest sea port is Vishakhapattanam, approximately 550 Km away from the site by rail.

03.02.04 Air Traffic
The nearest air port connected to the national network is Mana at Raipur, 30kms away.

03.03  **Infrastructure Facilities Inside the Plant**

03.03.01  **Railway**

The track gauge for the entire plant corresponds to the Indian Railway standard broad guage i.e. 1676 mm.

03.03.02  **Road**

Main road and side roads of the Plant shall have roadways of 7.0 m and 4.0 m width respectively and the temporary roads provided during the construction stage shall be designed to cater the needs of movement of heavy construction vehicles.

04. **GENERAL RULES AND REGULATIONS AND STANDARD**

04.01  **General Rules and Regulations**

04.01.01  All plant units with respect to their location, layout, general arrangement and design of equipment, structural design, etc. shall be safe to the personnel and conform to the relevant statutory requirements issued by Chhatisgarh Government and the Government of India but not limited to the following.

- Indian Electricity Rules/Acts
- Electricity Regulatory Commission Act
- Indian Petroleum Regulations/Acts
- Indian Boiler Regulations/Acts
- Indian Explosives Acts
- Gas Cylinders Rules/Acts
- Carbide of Calcium Rules/Acts
- Static and mobile Pressure Vessels Codes (unifired) Rules/Acts
- Fire Protection Manual issued by Tariff Advisory Committee (India)
- Pollution Control Regulations/Acts

04.01.02  Pollution control measures shall be provided considering the latest norms and international standards. These should satisfy the stipulations of Central Pollution Control Board and Department of Environment and Forest, Government of India.

04.02  **Standard**

04.02.01  **Preferred Makes of Equipment & Supplies**

To restrict/minimise stock/inventory of spares, the Purchaser will limit the makes of equipment & supplies to those listed in the “preferred makes of equipment and supplies” unless other-wise expressly so agreed.

04.02.02  **Unit of Measurement**

All dimensions & weights shall be given in metric system.

04.02.03  **Language**

All drawings, documents, etc. shall be in English language.
05. SAFETY

05.01 Safety Regulations

05.01.01 The Contractor shall comply with the, relevant Safety Rules and Regulations but not limited to the following:

- Indian Electricity Rules/Acts
- Electricity Regulatory Commission Acts
- Indian Petroleum Regulations/Acts
- Indian Boiler Regulations/Acts.
- Indian Explosive Acts
- Gas Cylinder Rules/Acts
- Carbide of calcium Rules/Acts.
- Static and Mobile Pressure Vessels codes(Unfired) Rules/Acts
- Fire protection manual issued by Tariff advisory committee (India)
- Pollution Control Regulations/Acts

05.01.02 Strict attention shall be paid to all statutory regulations and safety rules for prevention of accidents.

05.01.03 The safety posters/regulations for prevention of accidents shall be displayed by the Contractor at appropriate places. Notices and warning signs shall be displayed for all sources of dangers.

05.01.04 The Contractor is not permitted to construct any temporary road crossing on the rail tracks for the sake of their convenience at work site.

05.01.05 When the work is carried out at night or in the obscure day light, adequate arrangements for flood lighting in the working area shall be made by the Contractor at his own cost and got approved by the Purchaser.

05.01.06 All handling/transport and rigging equipment including lifting tools and tackles shall be checked at regular intervals and kept in good and safe working condition.

A register is to be maintained regarding the results of periodical tests/checks and other particulars in respect of each and every such equipment.

05.01.07 The Contractor must take sufficient care in moving his construction plant and equipment from one place to another, so that those do not cause any damage to the property of the Purchaser or obstruct construction activities of other Contractors.

05.01.08 The Contractor shall depute a full time safety engineer who will exclusively look after all the jobs pertaining to safety at site and keep close liaison with Purchaser/Consultant. He will be responsible for maintaining safe working conditions at site, promoting safety consciousness among the workmen and reporting to concerned authorities in case of accident/dangerous occurrences.

05.01.09 Before execution of work in hazardous area like

- Gas contamination
- Working at height.
- Storage of inflammable materials
- Danger of electric shocks
- Explosion risks
- Excavations more than 2 m deep, etc.

A protocol should be prepared in association with the concerned agencies of the Purchaser/Consultant.

05.02 **Safety while Working with Explosives.**

05.02.01 Explosives shall not be used on the work site by the Contractor without the written permission of the Purchaser and that too only in the manner and to the extent to which it has been prescribed.

05.02.02 Explosives shall be stored in special premises approved by the Purchaser and at the cost of the Contractor who shall be liable for all damages, loss or injury to any person or property and shall be responsible for complying with all statutory obligations in these respects.

05.03 **Safety Appliances**

05.03.01 The Contractor shall provide the safety appliances conforming to the relevant Indian standards to all their workmen and supervisors engaged by them as well as by the sub contractors.

05.03.02 The Contractor shall ensure that all the workmen and supervisors, are using the safety appliances regularly during work at site.

05.03.03 Any form of compensation in lieu of safety appliances shall not be permitted. Any violation in safety provisions or failure to maintain safe working conditions will lead to serious penalty on the Contractor and finally may lead to termination of the Contract.

05.03.04 The workmen of the Contractor deployed for construction and erection in hazardous areas shall be provided with personnel protective safety appliances of special nature suitable for hazardous working conditions.

05.04 **Safety during Construction/Execution**

05.04.01 The Contractor shall be responsible for the safety of his workmen and employees. The Contractor shall ensure that safety practices are followed so as to prevent personal injury to his workmen and also to other persons working/passing by in that area.

05.04.02 The Contractor shall ensure that in case of any accidents, the same are reported without delay to the Purchaser/Statutory Authorities as per Rules. In case of any injury/accident the Contractor shall bear all the expenditure for medical treatment and shall pay the compensation in case of permanent disability or death.

05.04.03 The Contractor shall ensure that all personnel employed do not stray into other areas. Any injury caused due to this shall be the sole responsibility of the Contractor.

05.04.04 The Contractor shall ensure that skilled labours required for specific works have necessary trade certificates and adequate experience of the job. This is likely to be checked by the Purchaser. The concerned operator, mechanics, electricians, fitters, riggers, etc. must be fully conversant with the hazards associated in operation/maintenance of their relevant equipment.

05.04.05 **Safer Working Platforms**

- Contractor shall use strong and secured planks and boards of the right sizes.
These planks shall be painted at the edges brightly to warn the workers for any misuse (usually zebra paint)
Barricades should be put-up to prevent them from falling.
Contractors shall make sure that scaffolds are erected by trained scaffolders.
Supervisors must inspect scaffolds once every week.

05.04.06 Falling Objects and Debris
- No loose materials which can fall down should be kept on the working platforms.
- Overhead shelters should be provided to minimize damage from falling objects.
- Strong nets to be provided to catch these objects or debris.
- Nets must envelop all sides of the building.

05.04.07 Personal Safety Equipment
- Workers must wear approved safety helmets and shoes.
- For those working in high places safety belts shall be provided.
- The safety belts must be attached to strong anchorage points.

05.04.08 Operating Construction Machine
- Contractors shall make sure that those operating the construction machinery are well trained for their jobs.
- The keys of such machinery shall be kept with the authorized persons.
- The keys shall be removed after use of the machine.

05.04.09 Safer Electrical Installations
- Contractor shall use approved types of electrical sockets and plugs.
- Proper insulators for all electrical wirings shall be provided.
- Wiring should not be allowed to lie on the floor or on the ground.

05.05 Safety in Designing of Equipment
05.05.01 All machinery and equipment must be equipped with safety devices. The safety provisions shall conform to the recognised standards, safety codes and statutes.
05.05.02 All safety measures as required to be adopted as per the statutory regulations and the safety rules of the plant shall be strictly followed by the Contractor during the execution of the Contract.

06. DRAWINGS AND DOCUMENTS
06.01 Drawings
06.01.01 The drafting standards adopted in preparation of drawings shall be such that good clean and legible print of the drawings can be obtained.
06.01.02 For preparation of original drawings guidelines contained in Indian Standard specification IS:10164-1985 (preparation of engineering drawings and diagrams) shall be followed.
06.01.03 The Contractor shall submit the drawings in any of the following standard sizes.

<table>
<thead>
<tr>
<th>Size Code</th>
<th>Working Space (mm)</th>
<th>Cut Size (mm)</th>
<th>Uncut Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0</td>
<td>811 x 1144</td>
<td>841 x 1189</td>
<td>880 x 1230</td>
</tr>
</tbody>
</table>
However, Contractor’s standard drawings are exempted from the above size limitations. It is desirable to keep the same size for all drawings for ease of filing, reference and record keeping.

06.01.04 All drawings shall be oriented to match the plant layout drawings and shall have a key plan identifying the plant area to which they apply.

06.01.05 All drawings shall be made with the north arrow pointing to the top of the sheet.

06.01.06 There shall be sufficient reference notes and cross references on the drawings to permit identification of all related drawings and documents which are required for proper understanding.

06.01.07 When a drawing is revised by the Contractor, every change made shall be identified on the drawing by placing the revision number in a small triangle so as to be easily recognisable. In addition, a record of revisions along with the co-ordinates showing the location of revisions shall be indicated at the left hand bottom corner of the drawings as per standard practice. In case of revision of drawing, for which different number is allotted, the new drawing shall clearly indicate the number of the drawing which it supersedes.

06.01.08 Approval of drawings from the statutory authorities such as the Indian Boiler Inspectorate, Inspectorate of Explosive, Electrical Inspector, etc. is the responsibility of the Contractor.

06.01.09 Any additional drawings not specifically mentioned by the Purchaser/Consultant but is required for the approval of drawings, shall be submitted by the Contractor.

06.01.10 The title block of the drawing shall be as per the title block enclosed as Annexure 01.

06.02 Approval of Drawings.

06.02.01 Approval of Contractor’s drawings will generally be accorded within four (4) weeks of receipt.

06.02.02 Approval of Contractor’s drawings means that these will be checked for conformity with applicable specifications and general conformity with the engineering requirement for the areas covered in the scope of work. It is understood that approval by the Purchaser’s Consultant does not include checking for drafting and other errors but only reviews of basic concepts and general principles involved.

06.02.03 The Contractor shall be responsible for any discrepancy, errors and omissions in the drawings and other information furnished by them, irrespective of whether these drawings have been approved by the Purchaser/Consultants or not. The Contractor shall bear all extra cost due to alterations necessitated by reasons of any discrepancies, errors or omissions in the drawings and particulars supplied by the Contractor.

06.02.04 Drawings furnished by the Contractor shall be certified as correct for use and shall bear the signatures of responsible persons of the Contractor.

06.02.05 Approval of Contractor’s drawings shall not relieve the Contractor of his responsibility to comply with the intent of the contract, manufacture/fabrication or procurement prior to approval of drawings shall be at the Contractor’s risk.
06.02.06 The Contractor shall submit 8 sets of drawings to the Purchaser for approval by the Purchaser/Consultant.

06.02.07 If the drawing is “Approved” then one print shall be returned back to the Contractor duly stamped “Approved” by the Consultant.

06.02.08 If the drawing is “Not approved” or “Approved as Noted”, then one stamped print with appropriate comments shall be returned back to the Contractor for incorporation of comments and re-submission of revised drawings for approval in 8 sets within 7 days.

06.02.09 After approval of drawings the Contractor shall submit 10 sets of approved drawings to the Purchaser. The Contractor shall incorporate the following note on the drawing before taking additional prints for submission to Purchaser.

“For Information Only” by MECON vide their letter no. ………………dtd.……..”

06.02.10 The drawing shall become a contract drawing after approval and there after the Contractor shall not deviate from them in any way whatsoever except with the written permission of the Purchaser/Consultant.

06.02.11 All reference and information category drawings shall be submitted in 10 sets to Purchaser. These drawings shall be submitted to Purchaser before forwarding the same to the erection Contractor at site for construction/erection activities.

06.02.12 The information category drawings shall not be approved by the Consultant. However, information category drawings shall be stamped “For Information Only” and one set shall be returned back to the Contractor.

06.02.13 In case any discrepancy is observed on these drawings, same shall be informed to the Contractor by marking the comments on the drawings. The Contractor shall resubmit these drawings after incorporating the comments in 10 sets to the Purchaser.

06.02.14 After receipt of stamped “For Information Only” drawings, the Contractor shall submit 10 sets of drawings to the Purchaser. The Contractor shall incorporate the following note on the tracing before taking additional prints for submission to the Purchaser.

Stamped “For Information Only” by MECON vide their letter no. ………………dted. ……………………

06.03 Submission of Drawings, CD, Reproducible and Documents

The Contractor shall submit the following drawings/documents to the Purchaser.

06.03.01 Drawings

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<thead>
<tr>
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<th>PURCHASER</th>
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<td>6 Sets</td>
<td>2 Sets</td>
</tr>
<tr>
<td>2</td>
<td>Fabrication drawings for approval of consultants</td>
<td>6 Sets</td>
<td>-</td>
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<tr>
<td>3</td>
<td>Drawings after approval along with list of drawings (for distribution)</td>
<td>8 Sets</td>
<td>2 Sets</td>
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<tr>
<td>4</td>
<td>Information category drawings</td>
<td>8 Sets</td>
<td>2 Sets</td>
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<tr>
<td>5</td>
<td>Information category drawings after stamping “For Information Only” by consultants.</td>
<td>8 Sets</td>
<td>2 Sets</td>
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<td>6</td>
<td>Erection drawings</td>
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<td>2 Sets</td>
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<tr>
<td>7</td>
<td>As built drawings</td>
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<td>2 Sets</td>
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<td>8</td>
<td>Spare parts drawings</td>
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<td>2 Sets</td>
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</table>
9 Wearing parts drawings - 2 Sets

06.03.02 Compact Disc and Reproducibles

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<tr>
<td>2 As built drawing of information category</td>
<td>-</td>
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<tr>
<td>3 Spare parts drawings</td>
<td>-</td>
</tr>
<tr>
<td>4 Wearing parts drawings</td>
<td>-</td>
</tr>
<tr>
<td>5 All Manuals</td>
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</table>

06.03.03 Documents

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<tr>
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<tbody>
<tr>
<td>1 Erection manual</td>
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<td>2 Operating and maintenance manuals</td>
<td>1 Set</td>
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<tr>
<td>3 Storage and reconversation manuals</td>
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<td>1 Set</td>
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<td>5 List of consumables</td>
<td>1 Set</td>
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<tr>
<td>6 List of lubricants and hydraulic oil</td>
<td>1 Set</td>
</tr>
<tr>
<td>7 List of special tools and tackles</td>
<td>1 Set</td>
</tr>
<tr>
<td>8 Test certificates and inspection certificates in bound volume</td>
<td>1 Set</td>
</tr>
</tbody>
</table>

07. PROGRESS REPORT

07.01 The Contractor shall submit a detailed PERT Network showing completion time which would indicate starting and completion dates of all activities of engineering, purchasing, procurement of materials, manufacturing, inspection, dispatch, erection, testing and commissioning, etc. under his scope of work.

07.02 The Contractor shall submit the progress report in such details as may be required by the Purchaser so as to enable them to monitor the progress of work.

07.03 The Contractor shall submit the progress report every month in the proforma mutually discussed and agreed upon with Purchaser/Contractor.

07.04 The Contractor shall submit 8 sets of progress report every month as on 20th of the month so as to reach the Purchaser by 25th of month.

08. CODING SCHEME

All drawings/ documents/ equipment/ spare parts/ shipments shall have a coded number which shall be finalized with the successful tenderer.
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<th>APPROVAL</th>
<th>INFORMATION</th>
<th>REFERENCE</th>
<th>RECORD</th>
<th>CONSTRUCTION</th>
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Title Block of Drawing

STEEL AUTHORITY OF INDIA LIMITED
BHILAI STEEL PLANT

CONSULTANT
MECON LIMITED

SUPPLIER'S FORMAT
STEEL AUTHORITY OF INDIA LIMITED
BHILAI STEEL PLANT
GENERAL TECHNICAL SPECIFICATION

GENERAL SPECIFICATION
FOR
ELECTRICAL SYSTEM
(GS – 03)

MECON LIMITED
RANCHI - 834002

No. MEC/S/1901/11/38/00/00/F1889/R2

JULY, 2007

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10.0  ELECTRICAL

1.01  General

1.01.01  Standards

The design, manufacture, assembly and testing as well as performance (including safety, earthing and other essential provisions) of equipment and accessories covered under this specification shall, in general, comply with the latest issue of:

- Latest applicable Standards and Codes of Practices published by Indian Standards Institution (BIS).
- Latest IPSS (Interplant Standards for Steel Industry)
- Latest Indian Electricity Rules & statutory requirements of Central Govt. and State Govt.

In case, the tenderer is not in a position to comply fully with certain IS / IPSS specifications or in respect of certain items for which there are no IS / IPSS specifications, the tenderer may base his proposals on IEC recommendations or other reputed national or international standards subject to the approval of the Purchaser.

The components and materials used and the equipment supplied shall conform to high standards of design, engineering and workmanship and shall be suitable for efficient operation and reliable service in steel plant conditions.

All equipments supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of Govt. of India and the respective governments of state in which the plant is situated. The installation shall also confirm to Indian Electricity Act and Indian Electricity Rules.

In case of any contradiction between the data given in the Technical Specification (TS) and this General Technical specification (GTS), data given in the Technical specification (TS) shall prevail.

1.01.02  Climatic Conditions

1.01.02.01  Environmental condition

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Environmental condition</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Maximum ambient temp.</td>
<td>50 deg. C</td>
</tr>
<tr>
<td>2.0</td>
<td>Maximum Humidity</td>
<td>100 % does not occur simultaneously with maximum temperature.</td>
</tr>
<tr>
<td>3.0</td>
<td>Height</td>
<td>Less than 1000 M.</td>
</tr>
<tr>
<td>Sl.No</td>
<td>Environmental condition</td>
<td>Data</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>4.0</td>
<td>Environment</td>
<td>Dusty &amp; Corrosive</td>
</tr>
</tbody>
</table>

### 1.01.02 Ambient conditions of shop units

Generally following maximum ambient temperature shall be considered in different units of the integrated steel plant.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Area</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>A. Coke Ovens &amp; Byproduct Plant</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Battery cellar</td>
<td>+ 55 Deg. C</td>
</tr>
<tr>
<td>2.</td>
<td>Battery Top</td>
<td>+ 60 Deg. C</td>
</tr>
<tr>
<td>3.</td>
<td>Coal Tower, Intermediate &amp; End benches</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td>4.</td>
<td>Pusher Car &amp; Loco</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td>5.</td>
<td>Guide Car &amp; Charging Car</td>
<td>+ 60 Deg. C</td>
</tr>
<tr>
<td></td>
<td><strong>B. Blast furnace</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Cast house</td>
<td>+ 60 Deg. C</td>
</tr>
<tr>
<td>2.</td>
<td>Furnace proper</td>
<td>+ 55 Deg. C</td>
</tr>
<tr>
<td>3.</td>
<td>Stock house</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td>4.</td>
<td>Pump house</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td>5.</td>
<td>Stove area</td>
<td>+ 55 Deg. C</td>
</tr>
<tr>
<td>6.</td>
<td>GCP area</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td>7.</td>
<td>Other areas</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td></td>
<td><strong>C. Steel Melting Shop</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Converter Bay</td>
<td>+ 60 Deg. C</td>
</tr>
<tr>
<td>2.</td>
<td>Mixer Bay</td>
<td>+ 55 Deg. C</td>
</tr>
<tr>
<td>3.</td>
<td>Other areas</td>
<td>+ 55 Deg. C</td>
</tr>
<tr>
<td></td>
<td><strong>D. Continuous Casting Shop</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Casting bay</td>
<td>+ 60 Deg. C</td>
</tr>
<tr>
<td>2.</td>
<td>Withdrawal, straightening and gas cutting areas</td>
<td>+ 55 Deg. C</td>
</tr>
<tr>
<td>3.</td>
<td>Other areas</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td></td>
<td><strong>E. Hot rolling mills</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Generally</td>
<td>+ 55 Deg. C</td>
</tr>
<tr>
<td>2.</td>
<td>Finishing bays</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td>3.</td>
<td>Foundry</td>
<td>+ 55 Deg. C</td>
</tr>
<tr>
<td>4.</td>
<td>Auxiliary Shops</td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td></td>
<td><strong>F. Other areas</strong></td>
<td>+ 50 Deg. C</td>
</tr>
<tr>
<td></td>
<td><strong>G. Electrical rooms</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>HT/LT substation &amp; MCC rooms (ventilated)</td>
<td>+ 45 Deg. C</td>
</tr>
<tr>
<td>2.</td>
<td>Cable basements / tunnels (ventilated)</td>
<td>+ 45 Deg. C</td>
</tr>
<tr>
<td></td>
<td><strong>H. Control Rooms</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Control rooms – Air conditioned</td>
<td>+ 24 Deg. C</td>
</tr>
</tbody>
</table>

Equipment selection and de-rating shall generally be based on ambient temperature of 50 Deg.C. For specific areas and shops, the ambient temperature conditions indicated above shall be taken into consideration and equipment shall be suitably de-rated accordingly.
The equipment offered should be suitable for smooth, efficient and trouble free service in the tropical humid climate prevailing at plant site and under the ambient temperature conditions indicated above for the different shops and areas. In hot areas of higher temperature conditions, the equipment shall be adequately protected against damage from radiant heat and hot air.

The equipment shall be designed to give efficient and reliable performance under heavy steel plant conditions and shall be such that the risks of accidental short-circuits due to animals, birds or vermins are avoided.

1.01.03 **Standard Voltage levels:**

In case the standard voltage levels to be adopted in the plant are specified in the Technical specification, it shall be followed. In absence of any details indicated in the Technical Specification, the following standard voltage levels shall be adopted.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Description</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HT AC</td>
<td>11 KV / 6.6 KV, 3 phase, 50 Hz, unearthed neutral</td>
</tr>
<tr>
<td>2.</td>
<td>LT AC</td>
<td>415V, 3 Phase, 50 Hz, 4 wire, solidly earthed</td>
</tr>
<tr>
<td>3.</td>
<td>AC control and signaling voltage</td>
<td>240V, AC ± 10% obtained using suitable control transformers with auto changeover facility.</td>
</tr>
<tr>
<td>4.</td>
<td>DC supply voltage</td>
<td>220 Volts / 110 Volts</td>
</tr>
<tr>
<td>5.</td>
<td>DC control and signaling voltage</td>
<td>220 Volts / 110 Volts</td>
</tr>
<tr>
<td>6.</td>
<td>Control voltage for HT switchgear equipment</td>
<td>110 V DC from battery in HT S/S area. 220 V DC from battery in MSDS area.</td>
</tr>
<tr>
<td>7.</td>
<td>Special socket outlets for portable lamps</td>
<td>24V, single phase, 50 Hz, AC obtained through suitable transformers</td>
</tr>
<tr>
<td>8.</td>
<td>DC Electro-magnetic brakes</td>
<td>220V, DC, obtained through individual rectifiers</td>
</tr>
<tr>
<td>9.</td>
<td>Solenoid valves</td>
<td>24V DC, unearthed</td>
</tr>
<tr>
<td>10.</td>
<td>Machine tools lighting</td>
<td>24 V AC</td>
</tr>
<tr>
<td>11.</td>
<td>Sockets for Welding purposes</td>
<td>415V, 100A, 3 pin plus earth with plug interlocked switch</td>
</tr>
<tr>
<td>12.</td>
<td>Sockets for hand tools</td>
<td>240V, 15A, 2 pin plus earth with plug interlocked switch</td>
</tr>
<tr>
<td>13.</td>
<td>Illumination system</td>
<td>240 V AC for general application. 24 V AC for confined &amp; semi confined area. (as per IPSS).</td>
</tr>
<tr>
<td>14.</td>
<td>PLC power supply</td>
<td>240 V AC, 50 Hz, obtained through UPS (for processor, RIO chassis,</td>
</tr>
<tr>
<td>Sl.No</td>
<td>Description</td>
<td>Data</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>interrogation voltage and output voltage</td>
</tr>
<tr>
<td>15.</td>
<td>Monitoring and signaling in electronic installations, mimic panels</td>
<td>24V, DC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Through PLC output for PLC control boards / desks)</td>
</tr>
<tr>
<td>16.</td>
<td>PLC DI interrogation voltage</td>
<td>24 V DC</td>
</tr>
<tr>
<td>17.</td>
<td>PLC DO voltage</td>
<td>24 V DC</td>
</tr>
</tbody>
</table>

1.01.03.01 Symmetrical short circuit ratings:

The three phase symmetrical short-circuit ratings of the switchgear at the different voltage levels shall be as follows unless specifically indicated in the Technical specification:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>11 kV switchgear</td>
<td>40 kA for 3 sec.</td>
</tr>
<tr>
<td>2.</td>
<td>6.6 kV switchgear</td>
<td>40 kA for 3 sec.</td>
</tr>
<tr>
<td>3.</td>
<td>415 V switchgear</td>
<td>50 kA for 1 sec.</td>
</tr>
</tbody>
</table>

1.01.03.02 Permissible variations:

The system / unit / plant / equipment shall be designed so as to be suitable for the following variations in voltage and frequency unless specifically indicated in the Technical specification:

<table>
<thead>
<tr>
<th>Description</th>
<th>Voltage</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible variations with rated performance, rated current and control effectiveness maintained</td>
<td>For LT system: +10% &amp; -15%</td>
<td>Frequency variation for both HT &amp; LT shall be +4%, -6%</td>
</tr>
<tr>
<td>Permissible variations with changes in rated Current / torque but without any undesirable effect on performance</td>
<td>+/- 10%</td>
<td>+/- 3%</td>
</tr>
<tr>
<td>Permissible variations for control and regulation equipment</td>
<td>+/- 15%</td>
<td>+6%, -6%</td>
</tr>
</tbody>
</table>
### Description Voltage Frequency

<table>
<thead>
<tr>
<th>Description</th>
<th>Voltage</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>with rated performance and control quality maintained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permissible voltage dip at the HT and LT switch gear bus during starting of HT and LT motor</td>
<td>For LT system: -15%</td>
<td>Frequency Variation for both HT &amp; LT shall be considered as +4%, -6%.</td>
</tr>
<tr>
<td>For HT system: -10%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 1.01.04 Criteria for selection of voltage levels for motors & Power devices:

- AC squirrel cage induction motors of ratings up to 200 kW and slip ring motors up to 250 kW shall be fed at LT, 415V, 3 phase, 4 wire, 50 Hz with DOL.
- AC motors of ratings in excess of 200KW up to 1000 KW and beyond 1000 KW shall be connected to 6.6 KV U/E and 11 KV U/E power supply system respectively for DOL starting. The HT voltage level shall be as specified in the Technical specification.
- AC squirrel cage induction motors of ratings up to 200kW may be fed at LT, 415V, 3 phase 4 wire 50 Hz, with VFD where speed control is required.
- For motor rating more than 200 KW up to 1000 KW shall be provided with VFD where speed control is required , the rated voltage of the motor shall be 690 V .
- Soft starters with DOL bypass shall be provided for drives ratings ranging from 90 KW to 200 KW where full torque load starting and speed variation is not required.

#### 1.01.05 Design criteria & reliability conditions:

#### 1.01.05.01 Power Distribution system

The power distribution system shall meet the following guide lines:

- Suitable numbers of 415V LT Substation (LTSS) shall be provided for feeding different Motor control centers and auxiliaries power distribution boards as required for the plant.
- The MCC / PDB / MLDB shall be fed from LTSS.
- Suitable numbers of 415V Motor control centers shall be provided for feeding power supply to motors of rating 90 KW and below.
- Field located Power supply panels (MCB DB / Local Starter Panels) shall be fed from MCC.
- Electronic relays with display (for motor rating of 37 KW and above) shall be considered in place of thermal overload relays as follows:
  - Electronic over load relay protection for motors below 15 KW for crane application and for reversible drives. Electronic over load relay / MPCB protection for motors below 15 KW for other application
  - EOCR for OC & EF , unbalance protection for motors rated 18.5 KW to 90 KW
  - Composite motor protection relay with OL , OC ,EF , unbalanced & locked rotor protection with digital display for motor rated 110 KW and above .
  - EOCR shall be used only for non intelligent feeders .
- Motor of rating above 90 KW shall be provided with independent Motor control Panel (MCP) which shall be fed directly from LTSS. Power devices like MCCB,
Contactors, intelligent motor control relays / microprocessor based MPR (for non intelligent controllers) etc. shall be located in independent MCPs. Each MCP shall be located in MCC room by the side of the respective group MCC.

- VFD’s shall be provided for process fans / pumps as per technological requirement.
- A dedicated MCC with two incomers (one from PCC and other from DG set or any emergency power source) and bus coupler shall be provided for catering to all emergency loads of the shop/unit.
- MCCB, contactor and overload relay rating for the low voltage general purpose induction motors shall be selected as per type-2 coordination chart of selected manufacturer. However the minimum contactor rating shall be 32A.
- All the important drives (all 6.6 KV , 11 KV & 690 V motors) should be provided with suitable CBM systems such as vibration monitoring, current signature, temperature etc. Information from CBM systems to be interfaced to HMI system as well as plant-wide CBM system.

1.01.05.02 The capacities of the transformer shall be selected as per the following guidelines:

- MD of MCC, shall be calculated as per the guidelines given in clause no. 1.01.08 of the General Technical Specifications.
- Load factor of 0.9 shall be considered for motors being fed from 415V LTSS . The load factor shall be applied on the kW rating of motors. Only working motors shall be considered.
- Load of lighting transformer shall be considered as per the kVA rating of transformer.
- Where ACDB is provided along with the LTSS, then load of ventilation system with 0.9 load factor shall be considered.
- Diversity factor of 1.1 shall be used on the summation of MDs of various MCCs, motors, lighting transformers and ACDB.
- Spare capacity of 20% shall be provided for future use.
- Each LTSS shall be fed from two identically rated transformers.
- In case of outage of any transformer, the remaining transformer shall be loaded up to 80% of their rating.
- Transformer shall be selected from standard rating of 1000/2000 KVA only
- It shall be ensured that when all the loads are in operation and the largest motor is started, the voltage drop at the motor terminals shall not be more than 15%.

1.01.05.03 The rating of outgoing feeders of LTSS shall be selected from standard circuit breakers ratings of 800A, 1000A & 1600 A only considering the load requirement and derating factors due to ambient temperature as well as for the mounting of the component in the switch board. CTs shall be selected considering the actual loads.

1.01.05.04 11kV / 6.6 kV panel mounted load break switches with earthing switches of adequate rating shall be provided before feeding the transformer. Transformer pens shall also be provided with push button station for switching ON/OFF the corresponding 11kV / 6.6 kV upstream feeding circuit breaker.

In case of transformer of rating 5 MVA and above , following arrangement shall be followed:
- LBS (isolator) shall be provided in the transformer room, when transformer is fed from remote HT switchboard.
- Lockable type PB shall be provided in transformer room when transformer is fed from HT switchboard located in the same building.
1.01.05 AC squirrel cage induction motors shall be used for drives requiring speed control. For all electrical machines wherever strip wound coils are used detail drawing is to be provided in soft copy. Use of DC motors, AC slip ring motors shall be avoided to the extent possible. Manufacturing drawing for parts – stator coils, slip ring, brush, brush holder in slipring motor’s and drawings of parts of- armature coil, commutator, brush and brush holder in DC machine shall be provided in soft copy. Sizes of conductors used in motors shall be preferred sizes as per IS. Sufficient spares of parts of all electrical machines shall be provided.

1.01.06 Cabling
Tenderer shall note the following regarding cabling:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Requirement</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Inter shop cable routing</td>
<td>Through overhead cable gallaries / structure or walkable cable tunnel.</td>
</tr>
<tr>
<td>2.0</td>
<td>Substation building</td>
<td>RCC cable basement of minimum 3.0 metres clear height.</td>
</tr>
<tr>
<td>3.0</td>
<td>MCC room</td>
<td>RCC cable trench / false floor at bottom of MCC</td>
</tr>
</tbody>
</table>
| 4.0    | Illumination system cable laying in all units. | 1. Unarmoured FRLS cables through MS black conduits in open area.  
2. Armoured FRLS without conduit in covered area.  
3. Unarmoured FRLS cables through concealed MS black conduits in buildings like control room, office building etc. |

1.01.07 Motor starting and permissible voltage dips:
- Voltage dip on starting of the largest L.T. motor shall be limited to 15% of the nominal voltage at the motor terminals.
- Maximum allowable voltage drop in any feeder under steady state condition shall be maintained as follows: -
  - Total voltage drop during running : 6 %
  - LTSS to motor : 6 %
  - LTSS to MCC/PDB/MLDB if in same building : 2%
  - MCC to motor for above case : 4%
  - LTSS to MCC/PDB/MLDB if in different building : 3%
  - MCC to motor for above case : 3%

Voltage drop at the terminal of other equipment shall be as per the minimum voltage required for proper functioning of the equipment recommended by their manufacturers.
1.01.08 Maximum Demand of MCC

Maximum demand (MD) of the MCC shall be calculated considering the following:

1. Working load of the MCC shall be calculated based on the motor kW rating.
2. The load factor shall be considered as follows:
   - For continuous drives – 0.9
   - For intermittent drives like sump pumps etc. – 0.6
   - For electrically actuated valves / dampers – 0.2
   - For maintenance loads like hoists, cranes etc. - 0.4
3. Welding and utility socket loads shall not be considered for calculation of maximum demand.
4. Load factor shall be applied on the kW rating of motor.
5. Diversity factor shall be considered as one.
6. Spare feeders shall also be considered for calculation of maximum demand as per guidelines indicated in Sl. No.2
7. Load of power supply feeders shall be corresponding to the load being fed with 0.9 load factor.
8. Cyclic load shall be converted to continuous load and shall be used for MD without load factor. (e.g. 22kW motor at 40% duty factor will have continuous load as 22 x square root of 0.4)
9. 20% spare capacity shall be included in maximum demand for future use.

1.01.09 Incomer rating selection for MCC

1. All ACB I/C shall be intelligent type having standard protocol for communication
2. Incomer of the MCC shall be ACB / MCCB having fault level of 50 kA for 1 sec. MCCB shall be provided for ratings 630A and below. Standard ratings of ACB / MCCB shall be provided.
3. Continuous current rating of the incomer shall be corresponding to MD of the MCC.
4. In case of PMCC where MCC is directly fed from transformer, Continuous current rating of Incomer shall be equal to current rating of transformer.
5. In case ACB / MCCB is rated for 40 deg.C then continuous de-rated current in enclosure and for ambient temperature shall be more than MD / transformer current rating.
6. Main bus bar rating of MCC shall be equal to incomer rating.
7. Voltage rating of the breaker shall be equal to the incomer voltage of the system with rated tolerance (as mentioned in the relevant chapter).
8. Each MCC shall be provided with manual operated, draw out two nos.of incomers and one no. of bus coupler. Incomers and bus coupler shall be ACB / MCCB. ACB / MCCB shall be provided with overload, short circuit, earth fault and under voltage releases.
9. Each incomer and bus coupler shall be provided with indicating lamps for each phase for incoming supply and digital ammeter and voltmeter for measuring current in each phase and line to line voltages of MCC bus. ON, OFF and TRIP indicating lamps shall also be provided.
10. Incomer and bus coupler shall be mechanically interlocked in such a way that at any given time only two breakers can be closed. Electrical interlocks shall be provided as follows:
When both incomer ACBs / MCCBs are ON then bus coupler ACB / MCCB can not be switched ON.

When incoming power to one of the incomer is not available then bus coupler can be switched ON manually.

When incoming power to the incomer breaker is restored then incomer can be switched on manually and bus coupler will trip automatically.

Bus coupler closing is not permitted if the incomer trips on fault.

1.01.10 Outgoing Feeder Selection for MCC

1 Motor feeders shall be provided with MCCB, contactor, electronic thermal overload relay (with indication lamp for motor rating 37 KW and above) and other auxiliary equipment like selector switch, indicating lamps, auxiliary contactors etc. as per requirement (for non intelligent MCC).

2 Overload protection device shall be electronic overload relay as indicated in specification. In case electronic overload relay is provided then MCC module shall be provided with indicating lamps.

3 Motor control panel (MCP) for motor ratings above 90 KW shall be provided with motor protection numerical relay (for non intelligent MCC) as per specification. Other components same shall be same as motor feeders of MCC.

4 Power supply feeders shall be provided with MCCB and ammeter.

5 All PDB feeding non-critical loads shall be single fed system

1.01.11 Power Factor Compensation

In case power factor correction at LT level is specified in specification then APFC shall be provided in PMCC / LTPDB. The capacitor bank shall be so designed that the overall power factor of the system shall be 0.95.

1.01.12 Cable selection

 .01 Incomers of MCC / PDB / MLDB

- Cable size for incomer of MCC & PDB shall be selected on the basis of current rating corresponding to MD and voltage drop.
- Cable size for incomer of MLDB shall be selected on the basis of current rating corresponding to lighting transformer and voltage drop.
- The standard size of the cable shall be 3.5 x 240sq.mm. of type AYFY as per IS:1554 (A2XFaY for XLPE insulated cables as per IS : 7098 Part-1).
- For calculating the current rating of power cables de-rating factor of 0.65 shall be used.

 .02 Motors

- Cable size for LT motors shall be selected on the basis of rated nameplate current and starting & running voltage drop as per specification.
- Cable size for HT motors shall be selected on the basis of rated nameplate current, starting & running voltage drop as per specification and short circuit capacity of the system. The cable size shall be calculated based on the breaker opening time of 0.35 seconds.
- Minimum size of cable for LT motors shall be 4x6sq.mm. of type AYRY as per IS:1554 and maximum size of cable shall be 3.5 x 185 sq.mm. of type AYFY as per
IS:1554. In case copper conductor cables are used then the maximum & minimum size of cable shall be one size lower than as indicated above for aluminium cables.

- For motors rated up to 2.2 kW and actuators of motors of valves and dampers cable size of 4x2.5sq.mm. of type YRY as per IS:1554 shall be used.
- For calculating the current rating of power cables de-rating factor of 0.65 shall be used.

.03 Illumination System
- The minimum size of the cable for feeding power to SLDB or MCBDB having 32A incomer shall be 4x25sq.mm of type AYFY/AYY as per IS:1554.
- Cable size for MCBDB to light fittings shall be 2x2.5sq.mm. or 4x2.5sq.mm as per the configuration of fittings. The cable type shall be YRY/YY as per IS: 1554.
- In case of concealed wiring, single core, PVC insulated, stranded copper conductor wire of size 1.5sq.mm in MS conduit shall be used. For utility sockets, cable size shall be 4sq.mm.
- Laying of cables shall be decided as per details indicated in the specification.
- Energy efficient smart lighting fixtures and controls to be used for buildings.

.04 Automation System
- All control cables connecting I/Os from field to marshalling panel of PLC or remote I/O panel shall be of stranded copper conductor of type YRY as per IS: 1554 and of size 1.5 sq. mm. minimum for PLC I/O or as suitable.
- Communication bus shall be laid in GI pipe. The route for redundant communication bus shall be different.

.05 General
- Minimum size of the cables used in LT power circuits shall be 6sq.mm per core if with aluminium conductor or 4sq.mm per core if with copper conductor. Maximum cable size shall be 240sq.mm for incomers to MCCs, PCCs etc. The minimum cable size selected for applications in the power circuits of cranes and other moving mechanisms shall be 6sq.mm per core copper. All power cables shall be 3.5 / 4 cores.
- For power supply to moving mechanisms subject to vibrations, flexible copper cables preferably of single core should be used. In these cases, a separate core should be provided for earthing. For hoists with flexible / festoon cable system, power supply shall be through butyl rubber / EPR insulated PCP/CSP sheathed flexible cables. Cables used for circuits of tacho generators, brakes, solenoids, field windings and secondary windings of measuring transformers shall be copper conductor with cross-sectional area not less than 2.5sq.mm per core.
- For control circuits, PVC insulated and PVC sheathed multicore cables with copper conductors having a minimum cross-sectional area of 2.5sq.mm per core shall be used. The number of cores may be standardized as 3, 5, 7, 10, 14, 19, and 24.
Each core of control cable with 7 core and above shall be numbered at every 1-
meter interval.

- For signals like mA and mV, special screened/shielded cables shall be used.
- 20% spare cores shall be provided with minimum 1 spare core in multi-core control
  and signal cables.

1.01.13 Ventilation and Air Conditioning

The various electrical rooms of the plant shall be provided with ventilation and air
conditioning facilities, as indicated below. Air dryer units to be provided wherever air is
being used for purging / cleaning purposes.

.01 Substation building, MCC Rooms and Cable Cellar

All HT/LT substations, switch gear rooms and MCC rooms, cable basement/cellars
which do not house any electronic equipment but contain only electrical equipment,
shall be pressurized up to 2-3mm water column with cooled air washer system to
maintain the room temperature at 45 deg.C irrespective of ambient temperature.
Suitable capacity fan and pumps (1W+1S) shall be provided for each unit.

.02 Electrical rooms with electronic equipment / Central Control rooms

The electrical rooms housing electronic equipment like PLC, computers, Servers,
Level –II systems, Remote I/Os, AC and DC variable speed drives, soft starters, UPS,
electronic weighing panels, telephone exchange equipment etc. shall be installed in
air-conditioned environment with pressurization to maintain the following conditions:

- Room temperature : Shall not be more than 35deg.
- Relative humidity : 50 to 60%
- Pressurization : 2-3 mm WC
- Temperature gradient : 2 Deg. C/h

For central control rooms standby air conditioners shall also be provided.
Separate room, as part of control room shall be provided with window AC units.

.03 Small local Control Rooms/pulpits

The small control rooms/pulpits shall be air-conditioned to maintain the following
conditions:

- Room temperature : 24Deg. C
- Relative humidity : 50-60%
- Pressurization : 2-3 mm WC

.04 Cable tunnels
These shall be ventilated with fresh filtered air to maintain exit air temperature at 40deg.C.

Cable tunnel ventilation shall be sectionalized to maximum length of 150 m.

Temperature rise shall be limited to 3-5 deg.C above atmospheric dry bulb temperature subject to a maximum of 40deg.C at the exit of air from these premises.

Partition door between basement and the cable tunnel shall be air tight and of fire retardant material.

All cable tunnels shall be properly ventilated.

.05 General

- Necessary ducting with air diffuser shall be provided.
- Ventilation and air conditioning system shall be interlocked with fire detection system for safety.
- Airtight double door arrangement shall be provided for electrical rooms, control rooms and basement.

1.01.14 Variable Speed AC Drives.

1. Continuous current of AC drives shall be decided as indicated below:
   - For continuous duty drives (variable torque drives) like pumps fans etc. :- 115% of motor full load rated current.
   - For motion control drives and intermittent duty drives : 150% of motor full load current.
   - For constant torque drives and multi motor drives like moving machines, hoisting etc. :- 150% of the summation of rated motor current for multi motor drives and rated motor current for hoisting drives.

2. All AC drives shall be rated for 380 – 480V, three phase with voltage variation as specified.

3. Isolation transformer shall be provided for drive more than 75 KW and line reactor shall be provided for drive less than 75 KW in incoming (line) side .

4. For 4 quadrant operation applications active front end, low harmonics, regenerative AC drive shall be provided for main drives , process cranes and major auxiliary drives..

5. For crane applications in hot areas where ambient is more than 50 deg.C thyristor converters (ASTAT or SIMOTRAS) shall be used .

6. Current rating of AC drive as innumerated above shall be calculated after de-rating to specified ambient temperature.

1.01.15 Control Philosophy

.01 General

Adequate and appropriate automation systems shall be designed and engineered using state-of-art and field proven technology to facilitate monitoring, control and all other functions associated with operation of all the plant/shop units through user-friendly human-machine interfaces.

The Automation system shall be designed with geographical & functional distribution of hardware in a multi-level hierarchy, viz. Level-0, Level-1, level-2, level-3 etc, as
applicable, to meet specific plant requirements for monitoring, control, process visualization & optimization of all the plants/ shop units.

The automation system shall be structured in general, considering the following hierarchical levels:

- **Level - 0**
  
  This level, also called field level, is functionally responsible for generation, transmission & conversion of signals for the process parameters compatible to the higher level equipment as well as signal based activation for the final control elements.

  This level is realized based on the primary sensing elements, proximity switches, converters, microprocessor based intelligent systems and final control elements. The components of this level shall be grouped and distributed geographically around the plant as per main process equipment location.

- **Level-1**
  
  This level, also called supervisory level, is functionally responsible for supervision of the individual process equipment & functions, monitoring, control, visualization and regulation of process parameters to the desired level based on the signals generated from the field level. This level is also responsible for processing of signals for generating compatible control commands to control the process parameters by activation of the final control elements.

  This level is realized based on the controllers & systems, input & output systems, data base units, data communication, visualization system (HMI stations) and interface units for connectivity to the other levels of the automation system. In addition to routine PID functions, advanced process optimization functions comprising special control algorithms, mathematical computations etc. will be able to permit distribution of control and data acquisition functions throughout the entire plant.

- **Level-2**
  
  This level is functionally responsible for the process control functions through the Level-1 automation system by process guidance & optimization and control of process parameters to the desired level of perfection based on the available signals from the supervisory level. This level is also called process control level and is responsible for generating set points / control commands to the Level-1 equipment based on the pre-loaded process specific mathematical models. This level is realized based on the process computer & its own data base units, input & output systems, data communication systems, visualization system (HMI stations) and interface units for connectivity to the other levels of the automation system. Level-2 automation system has been covered under a separate General Specification.

The Level-1 automation shall basically comprise:

- A Programmable Logic Controller (PLC) based automation system

.02 Modes of operation
The following modes of operation shall be provided, it shall be in line with changes suggested in respective TS.

A. Local

Local Control Station (LCS) shall be provided for all motor and actuator drives. LCS shall have required numbers of push buttons for operation of drive.

In Local Mode, operation of single drive / equipment from LCS shall be provided. This mode of operation will generally be for test and repair purposes. To enable the testing of individual equipment all the interlocks shall be bypassed in this mode. However all critical equipment / drives shall be provided with hard-wired interlocking in MCC.

However for failsafe operation, potential free contact of Push Button from LCS and a potential free contact of field safety sensor shall be hard wired to MCC for safety reasons.

Drive can not be started from any place if the selector switch is in OFF position.

B. Remote

In Remote mode, the equipment can be started from control room only. This remote mode is further divided into following three modes:

- Operator mode
- Auto mode
- Computer mode (Level-2 system)

Once the remote mode of operation is selected then from HMI with help of key board / mouse / soft keys above three modes of operation can be selected.

Operator Mode

Under this mode it shall be possible to monitor & control the plant based on set points / commands given by operator through keyboard and the control, sequential operation of various mechanisms in the required sequence shall be executed by PLC with all interlocks. In this case all the changes / operations are operator initiated.

Auto Mode
This is the normal mode of operation of the plant. In this mode, the desired values (set point) of the parameters of process control loop will be set via keyboard of the HMI and sequencing and logic functions will remain operative through the PLC as per application software.

There shall be a provision for group start of drives in individual section with the required interlocks, logic and sequencing between the individual drives.

Computer Mode

In this mode the entire plant will be controlled through level-2 system. All the required set points will be generated by level-2 computer as per the mathematical model calculations based on the inputs received from the field. In case of failure of the level – 2 system all the set points will be automatically shift to operator mode of operation.

1.01.16   Spares Philosophy

The spare philosophy for various equipment shall be as follows:

1. LTSS, MCC, PDB and MLDB shall be provided with 20% spare feeders or one of each type whichever is higher with minimum of two numbers in each section.
2. LDB, MCBDB for lighting and MCB DB for utility sockets shall be provided with minimum 9 nos. of spare feeders.
3. DC MCB DB shall be provided with 8 nos. of spare feeders.
4. ACDB of UPS shall be provided with 40% spare feeders.
5. 20% spare terminals shall be provided in each module of MCC, MCP and each ACB panel.
6. 20% spare terminals shall be provided in all junction boxes, LCS and local control panels / local starters.
7. Control desk and control cabinet shall be provided with 30% spare terminals.
8. Marshalling panel of MCC and PLC shall be provided with 30% spare terminals.
9. Relay panels / relay modules shall have 20% spare relays of each type fully wired up to the terminal blocks.
10. 20% spare interposing relays fully wired up to the terminal blocks shall be provided in PLC panels.
11. 10% spare components of each type shall be provided in each control desk / control cabinet / signaling panel.
12. Spare I/O philosophy for PLC shall be as follows:

   ➢ Min. of 20 % of I/O modules used (with at least one module of each type) for input and output shall be offered as spare for each programmable controller and the same shall be mounted and wired to the terminal block in the cubicle suitably.
   ➢ No. of spare Channel per card shall be 20 %.
   ➢ Provision shall be provided with empty slots for future expansion for 20% I/O modules.
   ➢ Minimum 50 % spare memory capacity shall be available in the system for Purchaser's use after loading of application and system software.
01 nos. of DI & DO card per PLC shall be provided as spare.

1.01.17 Uninterrupted Power Supply (UPS)

UPS shall meet the following requirements:

1. Hot standby dual redundant UPS system shall be provided. Each UPS shall be rated for full capacity and under normal condition one UPS shall be sharing the total load. In case of failure of any UPS second UPS shall take the full load.
2. Spare capacity of UPS shall be 60%.
3. Load factor or diversity factor shall not be considered while calculating the load on UPS.
4. Two separate power supply from different sources shall be provided to UPS – one for UPS and the other for Bypass.
5. Bypass supply to equipment shall be through constant voltage transformer.
6. UPS and SMF batteries shall be located in air conditioned room.

1.01.18 Colour coding of equipment.

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>DESCRIPTION OF EQUIPMENT</th>
<th>COLOUR</th>
<th>PAINT SHADE NO. AS PER IS 5 : 1991</th>
<th>EQUIVALENT RAL CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I. MOTORS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>11 kV/6.6 kV motors</td>
<td>Traffic Grey A</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>2.</td>
<td>415 V LT AC motors</td>
<td>Silver Grey</td>
<td>631</td>
<td>7030</td>
</tr>
<tr>
<td></td>
<td>II. MOUNTED ELECTRICS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Equipment installed on or along with motors viz. Tacho generators, brake etc.</td>
<td>Same as that of motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Equipment installed on mechanism but separate from motor viz. Limit switches, pull chord switches, belt sway switches, speed switches, load cells, photo electric relays etc.</td>
<td>Traffic Grey A</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td></td>
<td>III. CONTROL GEAR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Drive panels, soft starter panels, UPS panels, PLC, Relay panels, MCC, PDB, MLDB, LDB, etc. including crane control panels</td>
<td>Light grey</td>
<td>631</td>
<td>7035</td>
</tr>
<tr>
<td>2.</td>
<td>Lighting distribution and power distribution board</td>
<td>Light grey</td>
<td>631</td>
<td>7035</td>
</tr>
<tr>
<td>3.</td>
<td>Fire fighting panel</td>
<td>Post office red</td>
<td>538</td>
<td>3002</td>
</tr>
<tr>
<td>4.</td>
<td>Local control box, Junction box</td>
<td>Light grey</td>
<td>631</td>
<td>7035</td>
</tr>
<tr>
<td>5.</td>
<td>Control desk</td>
<td>Light grey</td>
<td>631</td>
<td>7035</td>
</tr>
<tr>
<td>6.</td>
<td>Pulpit equipment</td>
<td>Light grey</td>
<td>631</td>
<td>7035</td>
</tr>
<tr>
<td>7.</td>
<td>Telecommunication panel</td>
<td>Smoke gray</td>
<td>692</td>
<td>7014</td>
</tr>
<tr>
<td>IV.</td>
<td>MISCELLANEOUS EQUIPMENT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Junction boxes</td>
<td>Light grey</td>
<td>631</td>
<td>7035</td>
</tr>
<tr>
<td>2.</td>
<td>Conduit/pipe pull boxes</td>
<td>Light grey</td>
<td>631</td>
<td>7035</td>
</tr>
<tr>
<td>3.</td>
<td>Light fittings</td>
<td>Light grey</td>
<td>631</td>
<td>7035</td>
</tr>
</tbody>
</table>
1.01.19 Drawings and documents :-

All the electrical drawings shall be prepared on CAE (computer aided engineering) packages e.g. Si–Graph or any equivalent software package . The package shall have the facility to connect all the relevant drawings with ERP / SAP package . It must be OODB(Object Oriented Data Based) type.

The package shall have the facility to interface the most different systems in the plant establishment and operational process. It shall have the facility to accommodate the mechanical, civil, structural drawings also.

1.02 EQUIPMENTS
1.02.01 DRY TYPE TRANSFORMER

.1 Standards
Transformers shall comply with the following Indian Standards.

IS: 2026 (1977/1981) - Power Transformers
Parts (I, II, III & IV)

IS: 11171(1985) - Dry Type Transformers

IEC : 60726 - Dry Type Transformers

.2 Mechanical Design

.01 Transformer enclosure shall be welded/ bolted sheet steel construction, free standing, with suitable size of louvers backed with wire mesh. Base shall be suitably reinforced to prevent any distortion during lifting. Base channels shall be provided with flat wheels with pulling eyes and lifting hooks to facilitate handling.

.02 All fasteners and bolts etc. shall be galvanised or zinc passivated. All surfaces to be painted shall be thoroughly cleaned, made free from rust and given a primary coat of rust resisting paint followed by two finishing coats of approved shade. Paint shall be suitable to withstand specific climatic conditions.

.03 The transformer shall be provided with separate weatherproof HV/LV terminal boxes and disconnecting links on the side of transformer so as to facilitate withdrawal of transformer without disturbing the HT and LT cables connected to transformer.

.04 Tank shall be suitably designed to withstand harmonics available in the system as well as generated by the transformer.
.3 ELECTRICAL DESIGN

i) The transformer shall be cast resin dry type transformer, AN cooled suitable for indoor installation (in a covered room).

ii) Generally as per IS 2026 – Part 1, 2 & 4 of 1977 and Part 3 of 1981.

iii) 3 phase, core type, cast resin.

iv) Rated output, voltage ratio, vector group shall be as specified in technical particulars for design.

v) Rated frequency 50 Hz, ± 6%.

vi) Insulation level shall be designed according to the voltages specified below.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>11 kV System</th>
<th>6.6 kV System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nominal system voltage (kV)</td>
<td>11</td>
<td>6.6</td>
</tr>
<tr>
<td>2.</td>
<td>Max. system voltage (kV)</td>
<td>12</td>
<td>7.2</td>
</tr>
<tr>
<td>3.</td>
<td>One minute power frequency withstand voltage (kV)</td>
<td>35</td>
<td>28</td>
</tr>
<tr>
<td>4.</td>
<td>Peak impulse test withstand voltage (kV)</td>
<td>75</td>
<td>60</td>
</tr>
</tbody>
</table>

vi) Transformers shall be capable of delivering rated current at an applied voltage up to 105% of rated voltage without exceeding the temperature limits.

vii) Overload capacity of the transformer shall be as per IS 6600 - 1972 unless otherwise specified.

viii) Shall be operable at its rated capacity at any voltage within ± 10% of rated voltage of the particular tap.

ix) Permissible maximum temperature at rated output and principal tap at the ambient temperature of 50°C

| Windings (by resistance method) | 110°C |
| Core and other adjacent parts of winding | 110°C |
| Core and other parts not adjacent of winding | Within safe limits of core and adjacent materials |

x) Transformers shall be designed to withstand the thermal and dynamic stresses due to short circuits at its terminals or symmetrical/ asymmetrical fault on any winding. Short circuit withstand capacity for the bolted fault at the terminals shall not be less than 5 second duration with respect to fault level specified.
xii) The maximum temperature at the end of the short circuit duration shall not be more than 250°C with the temperature prior to short circuit corresponding to maximum permissible overload.

xiii) Transformer shall be designed for minimum no-load and load losses within the economic limit.

xiii) Designed for suppression of harmonics, especially 3rd and 5th.

01. MAGNETIC CIRCUIT

i) Low loss CRGO silicon steel shall be used.

ii) Laminations shall be annealed in a non-oxidizing atmosphere to relieve stresses and restore the original magnetic properties of CRGO sheets after the cutting and punching operations.

iii) CRGO sheets shall be coated with insulation varnish compatible with the sealing liquid.

iv) Insulation to withstand annealing temperature as high as 850 Deg. C and shall reduce eddy current to minimum.

v) Ducts to be provided to ensure adequate cooling.

vi) Core, framework and clamps arranged and tightened to securely hold laminations in order to prevent any settling or displacement in case of heavy shocks during transport, handling or short circuits.

vii) Flux density under specified over voltage or frequency conditions shall be within the maximum permissible for the laminations. However it shall not exceed 1.6 tesla.

viii) Transformers shall be designed to withstand 110% over fluxing corresponding to rated voltage.

ix) Magnetising current shall be maximum 1% of the rated current.

02. WINDINGS

i) Material shall be electrolytic grade copper.

ii) Shall be subjected to shrinkage treatment.

iii) Completed core and winding to be vacuum dried in full vacuum, impregnated immediately, then dried before casting in resin.

iv) Shall be braced to withstand shocks due to rough handling and forces due to short circuit, switching or other transients.

v) Permanent current carrying joints in winding and leads shall be brazed.

vi) Coils shall be supported using dried and high-pressure compressed wedge type insulation spacers.

vii) Insulating materials shall be compatible with transformer liquid under all service conditions.

viii) Leads to the terminal board and bushings shall be rigidly supported.
03. **INSULATION**
   
i) Inter-turn and inter-coil insulation shall be designed such that di-electric stress is uniformly distributed throughout the windings under all operating conditions.

   ii) The winding shall be provided with class F insulation or better (as applicable to dry type transformer as per IS: 2026 part – II). However, temperature rise in winding and core shall be limited to class B insulation.

04. **OFF CIRCUIT TAP SWITCH**
   
i) Bolted link type within enclosure, with easy accessibility.

   ii) Designed for sustained over current of at least 150% of the rated current of the winding

   iii) Capable of repeated operation and withstanding short circuit forces

   iv) Tap position configuration diagram shall be provided.

   v) Inspection/operation / or repair shall not require removal of transformer core from its enclosure.

   vi) Shall not occupy any intermediate position between clearly marked tap position.

05. **TERMINATIONS**
   
It shall be possible to withdraw the transformer easily after disconnecting the connections without disturbing the cable terminations. Cable termination box shall be bolted type and supported from bottom so that after withdrawing the transformer, it remains at its same position.

Winding shall be brought out and terminated on external /cable boxes as specified in the Technical Particulars.

i) **Cable termination**

   a) Air insulated cable end box suitable for the type and number of cables specified.

   b) Air insulated disconnection chamber with inspection opening

   c) Compression type brass cable glands with finned copper lugs of non soldering crimped type.

   d) Bolted type gland plated (non magnetic material wherever specified).

   e) Sealing kits with associated accessories like stress reliving , insulating type, bi-fercating boot, HT insulating tape etc.

ii) **Bus duct termination**
a) When bus duct termination is specified, flanged throat shall be provided to suit the bus duct. Flange ends and inspection openings shall have weather proof gaskets.

06. Bushings
ii) Minimum rated current of line end bushings shall be 1.5 times rated current of the corresponding windings.
iii) Clamps and fittings made of steel or malleable iron shall be hot dip galvanized.
iv) Bushings rated 400 amps and above shall have non- magnetic clamps and fittings only.
v) Bushing shall be solid porcelain type.
vi) Neutral bushings shall be provided as required for earthing of neutral point. This shall be connected to brass/tinned copper bar and brought to outside the body through porcelain insulator.

07. NEUTRAL CURRENT TRANSFORMERS
i) Removable at site without opening transformer enclosure cover/active part.
ii) Secondary leads shall be brought to a weatherproof terminal box and from there to the Marshalling box with 4 sq.mm copper armoured cable.

08. WINDING TEMPERATURE INDICATOR
i) Local winding temperature indicator (WTI) shall have a 150-mm diameter dial type indicator with a manual reset maximum reading pointer. There shall be two potential free contacts for alarm and trip signals. The settings for closing/opening of each contact shall be independently adjustable. Contact rating at DC11, 110V DC shall be minimum 5 Amps. The device shall be complete with lamp temperature sensing element, image coil, calibration device, aux. CTs etc. as required and shall be operated by RTD element.
ii) Temperature indicator dials shall have linear gradations to clearly read atleast every 2°C. Accuracy shall be better than ±1.5%.

09. MARSHALLING BOX
i) All outgoing connections from the transformer viz temperature indicators, level indicators CT secondaries, fault contacts for annunciation, etc. shall be wired to a Marshalling Box.
ii) Degree of protection of enclosure shall be IP52 for indoor and IP55 for outdoor type respectively.
.10 RATING PLATE
Each transformer shall be provided with a rating plate giving the details as per IS:2026 (Part-I). The marking shall be indelible and the rating plate shall be located on the front side. Exact value of transformer % impedance, as determined by tests shall be engraved on it and also on the final submission of name plate drawing.

.11 NOISE
Noise level shall be low and shall be within limit depending on the rating of the transformer as per IEEE-141.

.12 Earthing
i) All metal parts of the transformer with the exception of individual core lamination core bolts and clamping plates shall be maintained of fixed by earthing.
ii) Two nos. of tinned copper earthing terminals shall be provided.
iii) One end of bushing CTs shall be earthed.

.13 List of Fittings and Accessories
i) Off-circuit tap switch as specified.
ii) Dial type winding temperature indicators operated by RTD elements.
iii) Bushing CTs as specified.
iv) Bi-directional rollers/flanged wheels with loading arrangement.
v) Lifting lugs and jacking pads
vi) Rating and diagram plates.
vii) Earthing terminals.
viii) Inspection cover
ix) Identification plate
x) Pockets for thermometer for winding temperature indicator.
xii) HV, LV and Neutral bushings
xii) Marshalling box.

.4 TESTS
The equipment shall be subjected to all the routine tests at the manufacturer works in accordance with latest version of IS2026 Part I and III or, the relevant IPSS (where specified), in presence of purchaser or his representative.

Test of all equipment shall be conducted as per latest BIS. Test shall also confirm to International Standards IEC/VDE/DIN/BS.

The tenderer shall submit type test certificates for similar equipment supplied by him elsewhere. In case type test certificates for similar equipment is not available, the same
shall be conducted in presence of Purchaser or his representative if Purchaser so desires, without any financial implications to purchaser.

The transformer should pass the non-hygrosopic test according to DIN VDE-0532 and confirm to class E2 to prevent formation of moisture creepage path and resulting in failure of transformer.

The transformer should withstand the extreme load variation without any cracking of the casting. For this test certificate according to DIN VDE 0532 is to be furnished.

All the equipment shall be tested at site to know their condition and to prove suitability for required performance. The site tests and acceptance tests to be performed by manufacturer are detailed below.

The manufacturer shall be responsible for satisfactorily working of complete integrated system and guaranteed performance.

**Acceptance tests to be conducted at site :**

i) Assembly inspection/ Painting check  
ii) Measurement of winding resistance  
iii) Measurement of voltage ratio and check of voltage vector relationship  
iv) Measurement of no-load current.  
v) Measurement of insulation resistance/ polarizatation index.  
vi) Certification for on-load/ off-load tap changer  
vii) Final documentation check

.5 **DRAWINGS & DOCUMENTS**

The suppliers shall supply the following drawings / documents and manuals.

i) List of drawings  
   a) Overall General arrangement drawing  
   b) Rating and diagram plate  
   c) GA of Marshalling box  
   d) Wiring drawing of Marshalling box  
   e) H.V. cable box assembly  
   f) L.V. busduct assembly  
   g) QAP, Internal Test Certificates and Inspection Certificates

ii) Instruction manuals for erection, testing and commissioning.  
   a) Instruction manual shall give step by step procedure for:  
      - Erection, testing and commissioning  
      - Operation  
      - Maintenance and  
      - Repair  
   b) Operation and Maintenance Manual
- Recommended procedure for routine maintenance
- Tests for checking of proper functioning
- Diagnostic trouble shooting/ fault location charts
c) Storage, conservation and re-commissioning Manual
d) Safety Manual

Note : - Instruction manuals shall contain:

a) Manufacturer’s catalogues with ordering specification for all items
b) List of consumables with specifications, brand names and annual consumption figures
c) Procedure for ordering spares.
d) Drawings relevant for erection, operation, maintenance and repair of the equipments.

iii) List of special tools and tackles

.6 TECHNICAL PARTICULARS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>1000/ 2000 kVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Type</td>
<td>Three phase, core type, cast resin dry type</td>
</tr>
<tr>
<td>3.</td>
<td>Duty</td>
<td>Indoor, installed in room</td>
</tr>
<tr>
<td>5.</td>
<td>Voltage HV/LV</td>
<td>6.6 or11 / 0.433 kV</td>
</tr>
<tr>
<td>6.</td>
<td>Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>7.</td>
<td>No. of phase</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>Continuous rating</td>
<td>1000/2000 kVA</td>
</tr>
<tr>
<td>9.</td>
<td>Conductor</td>
<td>Copper</td>
</tr>
<tr>
<td>10.</td>
<td>Insulation class</td>
<td>Class F or better</td>
</tr>
<tr>
<td>11.</td>
<td>Cooling</td>
<td>AN</td>
</tr>
<tr>
<td>12.</td>
<td>Winding connection</td>
<td>Delta / Star</td>
</tr>
<tr>
<td>13.</td>
<td>Vector group</td>
<td>DYn 11</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Particulars</td>
<td>1000/ 2000 kVA</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>14.</td>
<td>Neutral grounding</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>15.</td>
<td>System earthing</td>
<td>HV Unearthed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LV Effectively earthed</td>
</tr>
<tr>
<td>16.</td>
<td>Percentage impedance</td>
<td>5% or 6.25% (as applicable)</td>
</tr>
<tr>
<td>17.</td>
<td>Termination</td>
<td>HV Cable end box suitable for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>termination of XLPE aluminium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cables, with air insulated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>disconnecting chamber</td>
</tr>
<tr>
<td></td>
<td>Percentage impedance</td>
<td>LV Suitable for termination of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bus duct with disconnecting chamber</td>
</tr>
<tr>
<td>18.</td>
<td>Temperature rise over 50°C ambient</td>
<td>80°C</td>
</tr>
<tr>
<td></td>
<td>temp</td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>In winding (measured by Resistance method)</td>
<td>80°C</td>
</tr>
<tr>
<td>b)</td>
<td>Core and other adjacent parts of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>winding</td>
<td>80°C</td>
</tr>
<tr>
<td>c)</td>
<td>Core and other parts not adjacent of</td>
<td>Within safe limit of core and</td>
</tr>
<tr>
<td></td>
<td>windings</td>
<td>adjacent materials.</td>
</tr>
<tr>
<td>19.</td>
<td>Bushing mounted CT’s</td>
<td>CT in LV Neutral bushing for standby</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E/F protection</td>
</tr>
<tr>
<td></td>
<td>Ratio: 500/5 A</td>
<td>Class: 10P15</td>
</tr>
<tr>
<td>20.</td>
<td>Off circuit tap changer</td>
<td>Bolted Link type</td>
</tr>
<tr>
<td>a)</td>
<td>Range</td>
<td>±5%</td>
</tr>
<tr>
<td>b)</td>
<td>Total tap positions</td>
<td>5</td>
</tr>
<tr>
<td>c)</td>
<td>Taps above nominal voltage</td>
<td>2</td>
</tr>
<tr>
<td>d)</td>
<td>Taps below nominal voltage</td>
<td>2</td>
</tr>
<tr>
<td>e)</td>
<td>Voltage per step variation</td>
<td>2.5%</td>
</tr>
<tr>
<td>f)</td>
<td>Tap change controls</td>
<td>Manual</td>
</tr>
<tr>
<td>21.</td>
<td>Impulse test withstand voltage</td>
<td>As per IS 2026, Part III – 1981</td>
</tr>
<tr>
<td>22.</td>
<td>One minute dry and wet power</td>
<td>- do -</td>
</tr>
<tr>
<td></td>
<td>frequency withstand voltage</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Short circuit level on HV side</td>
<td>40 kA for 3 Seconds</td>
</tr>
<tr>
<td>24.</td>
<td>Time duration to withstand 3 phase</td>
<td>5 Secs.</td>
</tr>
<tr>
<td></td>
<td>short circuit at secondary terminals, without any injury.</td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>Auxiliary supply voltage</td>
<td>240 V AC</td>
</tr>
<tr>
<td>26.</td>
<td>Parallel operation</td>
<td>Suitable for parallel operation with transformers of similar ratings</td>
</tr>
<tr>
<td>27.</td>
<td>Overload capacity</td>
<td>As per IS 6600 –1972</td>
</tr>
<tr>
<td>28.</td>
<td>Paint &amp; Paint shade</td>
<td>Epoxy based (Shade 632 as</td>
</tr>
</tbody>
</table>
### 1.02.01 6.6/ 11 kV CIRCUIT BREAKER (WITHOUT PROTECTION & METERING) PANEL

The 6.6/ 11kV circuit breaker panel shall be totally enclosed dust and vermin proof, sheet metal clad, floor mounted, free standing, indoor type and shall house circuit breakers, bus bars, control equipment, heat shrinkable cable termination, current transformers, potential transformers, instruments, relays, annunciation system and other accessories. This factory assembled HT circuit breaker panel shall be with fully draw out type breaker carriage, compartmentalised design with pressed sheet steel (thickness not less than 2.0 mm) and with IP-4X class of enclosure. All doors other than cable chamber shall be of hinged and lockable type with neoprene gaskets at all joints and the cable chamber shall be fixed with nuts and bolts. Additional wire mesh guards and gaskets shall be provided for cable chamber. Two separate earthing terminals shall be provided for cable chamber. Two separate earthing terminals shall be provided for HT panels. The HT panel shall be provided with metallic automatic safety shutters or those made of fibre glass of suitable insulation, which cover automatically the isolating contacts when circuit breaker is withdrawn from service position. Ventilation openings shall be provided where essential and shall have suitable screen protection.

Salient technical parameters to which the Circuit breaker panel shall conform are as follows:

<table>
<thead>
<tr>
<th>Particulars</th>
<th>1000/ 2000 kVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service voltage</td>
<td>6.6/ 11 kV +6%, -9%</td>
</tr>
<tr>
<td>System Frequency</td>
<td>50 Hz +4%, -6%</td>
</tr>
<tr>
<td>Degree of enclosure protection</td>
<td>IP 4X</td>
</tr>
<tr>
<td>Fault level in MVA</td>
<td>450/ 750MVA for 3 seconds</td>
</tr>
<tr>
<td>Type of CB</td>
<td>Sulphur hexa fluoride (SF6)/ Vacuum Circuit Breaker(VCB)</td>
</tr>
<tr>
<td>Rating</td>
<td>1250A</td>
</tr>
<tr>
<td>No. of poles</td>
<td>3</td>
</tr>
</tbody>
</table>
General Features of 6.6/11kV Circuit Breakers

1) 6.6/11kV circuit breakers envisaged in the specification shall be designed to control and protect the power distribution system. The circuit breaker shall conform to IS:13118-1991 and IEC publication 56.

2) The circuit breaker shall be maintenance free and shall have adequate capacity, insulation and mechanical strength to withstand:
   a) In-rush magnetising currents of transformers
   b) Starting currents of drives
   c) Transient surges developed during various abnormal operating conditions
   d) All electrodynamic stresses developed during abnormalities like faults in the system.
   e) Frequent start/stop duty of the industrial load. Normally, 2 (two) quick succession cold starts and one restart from hot condition or 3 starts per hour shall be considered for design duty.

3) Circuit breakers shall have three operational positions, such as "Service" "Test" and "Draw-out" position. It will be possible to achieve all the above three positions with cassettes front door closed. Mechanical indicators for all three positions shall be provided. The circuit breakers shall carry a single break per pole which shall be identical with the other 2 pole chambers of the breaker. Simultaneous closing of the three poles
of a breaker on a single closing command shall be ensured. All circuit breakers shall preferably be interchangeable.

4) The 6.6/11kV breaker shall be provided with electrical and mechanical trip free features and an emergency mechanical push to trip the breaker. All the features of the equipment shall ensure complete safety of the operation and shall be complete with approved safety devices to protect against potential hazards to operating personnel or to the equipment around. The design shall include all reasonable precautions and provisions for the safety.

5) All 6.6/11kV breakers shall be provided with at least 4 potential free Aux. contacts to be used by Employer for their interlocking/signaling purposes. Contact arrangement may be 2 NO + 2 NC and these shall be rated for 10 amp current duty on the control and auxiliary voltages (both AC & DC). Further, the following features shall be ensured in each 6.6/11kV breaker panel:
   a) Control plugs provided shall be mounted in horizontal fashion.
   b) Mini bus earthing with proper interlocks.
   c) All supporting insulators shall have increased creepage distance as per IS and shall suit highly polluted atmosphere of steel industry.

.2 Bus Bars
1) The Power Bus Bars of 6.6/11kV breaker panel shall be made of high conductivity, electrolytic copper of purity 99.9% as per IS:613-1984 in rectangular sections.
2) Horizontal and vertical bus bar shall be designed manufactured and supported to withstand thermal and dynamic stress corresponding to rated short time and peak withstand current as specified above.
3) Bus bar arrangement shall be as per IS:5578-1985 & IS:11353-1995. Bus bar shall be sleeved with proper grade of insulating sleeves and of proper colour code for each phase. Care shall be taken to obviate corona formation at the joints and connections. All joints and connecting terminals shall be tinned.
4) Bus bar shall be housed in a separate bus bar chamber with adequate air clearance and bushing. The insulators/ bushing shall be cast resin type to offer higher mechanical strength, during short circuit fault.

5) The clearance between bus bars shall be maintained as per standard. The bus bar chamber shall be provided with detachable side covers for regular maintenance and inspection and have provision of extension on both sides.

.3 Cable Chambers
The cable end termination chamber for each panel shall have adequate space for the termination of required number, type and size of cables and shall be provided with suitable bracings to support the weight of the cables without undue stress on the terminals. These chambers shall be complete with all accessories and shall form integral part of the cubicle and shall be freely accessible for cable connection.

.4 Earthing of 6.6/ 11kV Breaker panel
The following norms shall be adopted for earthing of HT breaker panel:

1) The 6.6/ 11kV outgoing cable shall be accessible to provide external earthing on opening the backside lower cover of the panel.

2) Continuous copper earth bus bar shall be provided. However, the cross section shall be checked to carry the peak short circuit and short time fault current of the system.

3) Earthing bus bar shall be positively connected/ welded with 6.6/ 11kV breaker panel, individual functional units and non current carrying metallic units.

4) Hinged door shall be earthed through stranded copper galvanized earthing braid.

5) For positive earthing of withdrawable units, silver plated copper strapping earthing contacts of "make before" / "break after" type shall be used ensuring earth continuity from "service" to "test" position of draw-out type breakers on both the sides.

1.02.03 415V Switchgear

1.02.03.01 General
• The 415V switchboard shall comprise air circuit breakers & shall be metal clad, indoor type floor mounted (in fully drawout execution). Switchboard shall be in single tier execution for incomers & buscouplers & two tiers for outgoing feeders.
• Relative position of incomers shall be as per the equipment layout requirement.
• Sheet steel shall be CRCA of minimum 2.0 mm thickness.
• Circuit breaker shall be mounted on fully drawout truck with service, test and isolated positions and complete with following safety interlocks and safety shutters with padlock facility:
  ⇒ It shall not be possible to move the truck in or out of cubicle when the breaker is closed.
  ⇒ CB compartment door shall be mechanically interlocked so that it will not be possible to close the CB in plug position when the door is open.
  ⇒ It shall not be possible to push the truck in close position if either of the safety shutter is not free and not in close position.
• The position of various control switches, push buttons, levers etc. requiring manual operation, shall be at a height not less than 450mm and shall not exceed 1850mm from the finished floor level.
• Name plate for each incoming bus coupler, and outgoing feeder at front and back, both on the fixed portion of the panel.
• All panels shall have space heater with switch and cubicle illumination lamp with door switch
• All breakers of similar rating shall be interchangeable.

1.02.03.02 Insulation Level
• Rated insulation voltage 1100 V
• One minute power frequency withstand voltage:
  ⇒ 2.5 kV for power circuits
  ⇒ 2 kV for control circuits
• Clearance in air (minimum):
  ⇒ Phase to phase - 25.4 mm
  ⇒ Phase to earth - 19.0 mm

1.02.03.03 Short Circuit Strength
• Rated short time withstand current not less than the system short circuit level specified for 1sec.
• Rated peak withstand current not less than 2.1 times the system short circuit level.

1.02.03.04 Busbars
• Busbars made of EC grade aluminium alloy equivalent to E91E WP as per IS 5082, 1981, size adequate for specified rated continuous and SC current.
• Jaw contact to be mounted on ACB and fixed contact to be mounted on the bus side (as per the manufacturer’s standard).
• Three phase, neutral (with at least 50% rating of main buses) and continuous earth bus. Bus bar shall be provided with proper grade & colour of heat shrinkable sleeve.
• Rating of horizontal buses shall be same as that of incomer circuit breakers and
vertical run shall be same as that of outgoing breaker rating
- Temperature rise of bus bars shall not be more than 40 deg. C above an ambient of 50 deg. C.

1.02.03.05 Protection Requirements
- One auxiliary relay for each transformer incipient faults:
  a) Buchholz - alarm (63X)
  b) Oil temp. high alarm (490X)
  c) Winding temperature high alarm (49 X)
  d) Buchholz trip (63Y)
  e) Oil temp. high - trip (490Y)
  f) Winding temp. high trip (49Y)
- For the above faults, contacts to be made available for inter tripping primary side breaker also.
- All other protections as specified.

1.02.03.06 Construction Features (Mechanical Design)
- Sheet steel clad, floor mounted, free standing design, non-dust proof construction
  ⇒ Extension bus links properly spaced for terminating single cables of size 120 sq. mm and above as well as for terminating multiple cables of all sizes.
  ⇒ Where more than one cable have to be terminated per unit, the arrangement shall permit connection and disconnection of individual cables separately without disturbing other cables.
  ⇒ Double, compression type brass cable glands and crimping type, tinned, heavy duty copper lugs suitable for the type, size and number of cables to be terminated, to be supplied with the switchboard for all LT power and control cables.
  ⇒ The interior of the switchboard shall be finished with ‘OFF WHITE’ paint shade.
  ⇒ All the panels shall be of uniform depth.
  ⇒ All panels shall be supplied with base channels.
  ⇒ The enclosure class shall be IP52 or better.

1.02.03.07 Relays
- Flush mounted
- Mechanically operated flag indicators with all relays capable of being reset without opening casing
- Shall withstand impulse voltage in accordance with IS/IEC recommendation.
- Test facility by plug from panel front.
- CT secondary shall be shorted on relay withdrawal.
- Diagram plate at the back of case to identify connections.
- The relay shall be microprocessor based numerical and communicable type.

1.02.03.08 Circuit Breaker
01. Electrical Features
- Air break triple pole (4 pole in case of DG power incomer) drawout type conforming to IS 13947.
- Identical tripping/closing coil rating shall be provided as per the supplier's standard.
- Rated continuous current as specified.
- Symmetrical breaking capacity and 1 second rating of the breaker not less than the system short circuit level specified.
- Making capacity 2.55 times breaking capacity.
- Performance category :  P2
• Auxiliary contacts : 6 NO + 6 NC minimum, convertible from NO to NC and vice versa at site.

Ratings:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous</td>
<td>10 amps</td>
</tr>
<tr>
<td>AC 11</td>
<td>4 amps at 240 V</td>
</tr>
<tr>
<td>DC 11</td>
<td>0.5 amps at 110 V</td>
</tr>
</tbody>
</table>

02. Operating Mechanism

• Manual or power operated mechanism as applicable
• Spring charged stored energy mechanism to ensure high speed closing and tripping independent of the operating forces.
• Anti-pumping and trip free feature
• Emergency tripping by mechanically operated trip push button (shrouded to prevent accidental closing) acting directly on the trip bar.
• Closing operation of the breaker to charge the tripping spring, ready for tripping.
• Mechanical indication to show:
  - Closing spring charged
  - Breaker ON/OFF/TRIP
• Breaker to close only when spring fully charged
• Non-reset type operation counter
• For manually operated breakers:
  - Independent manual charging of closing spring and closing by handle.
  - Alternatively, closing by mechanical push button with spring previously charged by handle.
• For electrically operated breakers:
  - Charging of closing spring by motor
  - Closing by closing coil
  - Spring charging motor and closing coil suitable for rated control voltage (240 AC unless otherwise specified).
  - One opening and one closing operation without control supply.
  - Provision also for manual closing with spring charging motor automatically decoupled as soon as charging handle is inserted.

03. Drawout Features

• 3 distinct positions viz. service, test, and isolated with the door closed.
• Mechanical position indication and locking/latching facility for all 3 positions.
• Power connections - self-aligning, plug-in type.
• Control connections - sliding or plug socket type, mechanically coded, to prevent wrong insertion, continuous rating 16 amps minimum.
• Automatic safety shutters to prevent accidental contact with live parts when the breaker is withdrawn.

04. Safety Interlocks

• It shall not be possible to close the breaker in any intermediate position other than the 3 fixed positions.
• With the breaker closed, it shall not be possible to rack it in from any of the 3 position to another.
• Mechanical stopper to prevent accidental falling while withdrawing.
• It shall not be possible to rack in the breaker from isolated to 'test' position with the door open together with provision for defeat of this interlocking, however, it shall be possible to close the door only when the breaker is brought back to 'isolated' position.
• It shall be possible to open the door only when
  ⇒ breaker is OFF and
  ⇒ is in 'Isolated' position.
• Remote closing of breaker is not permitted with door open.
• Insertion of breaker into 'Service' position shall not be possible if the shutters are not free.

05. Internal Control Wiring
• Control wiring by 1100V grade PVC insulated, single core copper conductor of minimum cross section 2.5 sq. mm
• Flexible wires, protected against mechanical damage for wiring to door-mounted devices.
• Wires identified at each end in accordance with schematic diagrams by interlocked type ferrules.
• Colour code for control wiring:
  | AC – black | Earth wire - Green |
  | DC – light grey | Trip circuit - Red |
• All connections external to a feeder, all the auxiliary contacts of the LT breaker, and all spare contacts of the relays shall be wired on to the terminal blocks.
• Interconnection between panels of adjacent shipping sections to be brought out to a separate terminal block, wires for interconnection properly labeled, looped and bunched inside the panel for connection at site.
• Not more than two connections shall be carried out on one terminal.

06 External Terminations
06.1 Control Terminations
• 650V grade multiway terminal blocks of non-tracking moulded plastic complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips.
• Power and control terminals segregated.
• Control terminals of minimum rating 10 amps suitable to receive 2.5 sq. mm copper conductor.
• 20% spare terminals in each control terminal block.

06.2 Power Terminations
• Suitable for accepting cables/bus trunking as specified in the technical particulars.
• All spare contacts wired up to terminal block of the panels
  a) Protective relays - withdrawable type
  b) auxiliary, timer relays - fixed type

07.0 Microprocessor based releases
07.01 General
• The control unit shall be interchangeable on site for adaptation to changes in the installation.
• Sensors shall be non-magnetic or of the Rogosky type for accurate current measurements.
• The control unit shall measure the true RMS value of the current.
• The control unit shall comprise a thermal memory to store temperature-rise data in the event of repeated overloads or earth faults. It shall be possible to disable this function if necessary.
07.02 Protection
- The control unit shall offer the following protection functions as standard:
  1. Long-time (LT) protection with an adjustable current setting and time delay;
  2. Short-time (ST) protection with an adjustable pick-up and time delay;
  3. Instantaneous (INST) protection with an adjustable pick-up and an OFF position.
  4. Earth-fault protection with an adjustable pick-up and time delay.
- Current and time-delay settings shall be indicated in amperes and seconds respectively on a digital display. Acknowledgement that the setting change should translate to the trip threshold.

07.03 Measurements
- An ammeter with a digital display shall indicate the true RMS values of the currents for each phase.
- An LCD Screen should continuously display the most heavily loaded phase apart from the load level on the three phases.
- A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.
- The control unit shall measure voltages and calculate power and energy values.
- These values shall be displayable on the screen and updated every second. The minimum and maximum values shall be stored in memory.

07.04 Communication
- The circuit breaker shall be capable of communicating the following data through a bus:
  - Circuit-breaker status (open/closed, connected/disconnected/test, tripped on a fault, ready to close);
  - Control-unit settings, including protection setting parameters.
  - Tripping causes;
  - The measurements processed by the control unit: current, voltage, frequency & power(active & reactive).
- It shall be possible to remotely modify circuit-breaker settings:
  - Settings within the range defined by the switches on the front panel of the control unit;
  - Settings of the protection functions and the alarms.
- It shall be possible to remotely control the circuit breaker of identified feeders only. (Viz. all incomers & buscouplers)

  Communications functions shall be independent of the control unit.

08. Indicating Instruments (Analog Meters)
- Taut band type
- Size
  - Incomer and sectionalizer: 144 sq. mm
  - Outgoing: 96 sq. mm
- Flush mounting: in front of the cubicle
- Accuracy class - 1.0
- Ammeters shall be compatible with CTs of 5A secondary and read actual currents.
- For motor feeders ammeters shall have suppressed scale up to 6 times of full load current after 1.2 times of full load current and shall have red mark on full load
value.

09. **Protective Devices**
    All control circuits shall be individually fed by MCBs with built in thermal and magnetic releases. HRC fuses shall be provided for protection of spring charged motors of electrically operated breakers.

10. **Contactors**
    Contactors shall break without damage 8 times rated current upto 100 amp rating and 6 times rated current for above 100 amp rating. Continuous current shall not exceed 2 amp and initial pick up shall be limited to 9 amp. Class of insulation shall be E or better. Drop out voltage shall be 45-65% of rated voltage and pick up shall be 85-110% contactor duty shall be AC3 unless otherwise specified in design parameters.

11. **Annunciation Scheme**
    - Shall be static type.
    - Hooter and bell shall be provided for trip & alarm indication respectively.
    - Number of points shall be as per list.
    - Shall have facilities for test, reset and accept.
    - Shall consists of annunciation windows, relay blocks warning bell, emergency hooter, push buttons etc.
    - All windows shall have two bunch LED in parallel.
    - All accessories including actuator (if respective scheme is in Contractor's scope) shall be provided.
    - Sequence of operation shall be as follows:

```
<table>
<thead>
<tr>
<th>Description</th>
<th>Audio</th>
<th>Visual</th>
</tr>
</thead>
<tbody>
<tr>
<td>On occurrence of fault</td>
<td>ON</td>
<td>Flashing</td>
</tr>
<tr>
<td>On accepting</td>
<td>OFF</td>
<td>Steady ON</td>
</tr>
<tr>
<td>On resetting (fault cleared)</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>On resetting (fault persists)</td>
<td>OFF</td>
<td>Steady ON</td>
</tr>
</tbody>
</table>
```

12. **Control Supply**
    - Suitable arrangement for 240V AC reliable control supply of adequate rating shall be provided in each 415V switchboard.
    - Two 240V AC feeders shall be provided in each board for control and annunciation purpose.
    - Shunt trip shall be suitable for operation on 240V AC.
    - Shall have supervision facility, alarm shall be provided for non availability of any one of the control supply.
    - MCBs shall be provided on incoming sides of supplies.
    - Control buses of two sections shall be connected through sectionalising switch.
    - Indication lamps shall be connected to 240V AC supply.
    - Isolation arrangement shall be provided on each panel to facilitate fault location and testing. Separate fuses shall be provided for spring charging motors, for indication lamps and for closing/tripping circuits of each cubicle.

13. **Inter Tripping**
    - Provision shall be made for tripping of incomer LT breaker on tripping of upstream HT breaker.
    - Provision for tripping of upstream HT breaker on fault tripping of LT incomer breaker shall also be provided.
14. Indicating Lamps
   i) LED cluster type.
   ii) LEDs used shall be of the colour of the lamp.
   iii) Color shall be as follows:

<table>
<thead>
<tr>
<th>State</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>RED</td>
</tr>
<tr>
<td>OFF</td>
<td>GREEN</td>
</tr>
<tr>
<td>CIRCUIT HEALTHY</td>
<td>WHITE</td>
</tr>
<tr>
<td>FAULT/WARNING</td>
<td>AMBER</td>
</tr>
<tr>
<td>SPRING CHARGED</td>
<td>BLUE</td>
</tr>
</tbody>
</table>

15. Control and Selector Switches
   - Control switches for circuit breaker ON/OFF control 3 position spring return to neutral with lost motion device and pistol grip handle.
   - Other control and selector switches - stay put type with wing type knobs.

16. Push Buttons
   - Contact Rating:
     | State       | Rating                                  |
     |--------------|-----------------------------------------|
     | Continuous   | 10 amps                                 |
     | AC 11        | 1.5 amps at 240V                        |
     | DC 11        | 0.5 amps at 110 V DC, L/R - 40 ms        |
   - Colour:
     | State        | Colour  |
     |--------------|---------|
     | ON           | RED     |
     | OFF          | GREEN   |
     | ACCEPT       | BLUE    |
     | RESET        | BLACK   |
     | TEST         | YELLOW  |

17. Protective Earthing
   - Continuous earth bus of minimum size 50 x 6 mm copper or equivalent aluminium/galvanized steel section, designed to carry the peak short circuit and short time fault current as specified.
   - Provided at the bottom extending throughout the length of the board, bolted/brazed to the frame work of each panel with an earthing terminal at each end, for terminating external earth conductor.
   - Vertical earth bus for earthing individual functional units.
   - All non-current carrying metal work (including metallic cases of instruments and other panel mounted components) effectively bonded to the earth bus.
   - Hinged doors earthed through flexible earthing braid.
   - Looping of earth connection, resulting in loss of earth connection to other devices, when the loop is broken, not permitted.
   - Withdrawable units provided with self-aligning, spring loaded, silver plated copper scrapping earth contacts of make before/break after type ensuring earth continuity from service to the test position.

18. Breaker Handling Truck
   - One for each switchboard, for withdrawing the breakers from the switchboard.
   - Height of platform adjustable to suit the levels at which the breakers are mounted.
   - Adequate mechanical strength for handling the largest breaker.
   - Guide rails and stops.
   - Incomer shall have analog meter (96 x96 mm) to measure line voltage/ bus voltage & current (New point)
19. **Auto Changeover Scheme**
   - Usually both the incomers shall be ‘ON” with bus-coupler in the ‘OFF’ condition.
   - In case of failure of one of the supply feeders (say by upstream fault), it will be sensed by the under-voltage relay which in turn will trip the incoming breaker after a pre-set time delay.
   - Through the normally closed auxiliary contacts of the tripped incoming breakers, the bus-coupler breaker shall close provided the other section is “Healthy”.
   - The automatic transfer scheme shall be such that the automatic closing of the bus section can be done only once and in case the bus coupler breaker trips during auto changeover, no further auto closing shall be permitted. Auto changeover shall not take place if the incomer breaker trips on fault. The restoration of power shall be manual.
   - The automatic transfer circuit shall be controlled through an auto manual changeover switch.

20. **Technical Particulars**

<table>
<thead>
<tr>
<th>LT Switchboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal system voltage</td>
</tr>
<tr>
<td>System earthing</td>
</tr>
<tr>
<td>Short time rating</td>
</tr>
<tr>
<td>Making capacity</td>
</tr>
<tr>
<td>Control supply</td>
</tr>
<tr>
<td>Configuration</td>
</tr>
<tr>
<td>Colour code</td>
</tr>
<tr>
<td>Busbar rating</td>
</tr>
<tr>
<td>Enclosure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circuit Breakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symmetrical breaking current</td>
</tr>
<tr>
<td>Making capacity</td>
</tr>
<tr>
<td>Short time rating (for 1 second)</td>
</tr>
<tr>
<td>Rating for incomers and buscouplers</td>
</tr>
<tr>
<td>Rating for outgoing</td>
</tr>
<tr>
<td>Closing mechanism</td>
</tr>
<tr>
<td>Incomer &amp; bus sectionalizer</td>
</tr>
<tr>
<td>Outgoing</td>
</tr>
<tr>
<td>Tripping mechanism</td>
</tr>
<tr>
<td>Control supply</td>
</tr>
<tr>
<td>No. of auxiliary contacts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Termination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomer</td>
</tr>
<tr>
<td>Outgoing</td>
</tr>
<tr>
<td>Finish paint</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feeder Arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomer &amp; buscoupler</td>
</tr>
<tr>
<td>(Mounted in single tier arrangement)</td>
</tr>
</tbody>
</table>
### 21. Schedule of Components

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Schedule of components equipment specification</th>
<th>Type of Feeder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B/C Incomer Out going ACB Feeder</td>
</tr>
<tr>
<td>1.</td>
<td>415V,50kA air circuit breaker with:</td>
<td>1 1 -</td>
</tr>
<tr>
<td></td>
<td>* independent, motorized, spring charged mechanism with electrical/manual ON/OFF control mechanism * shunt trip * ON/OFF indicator</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>415V,50kA air circuit breaker with:</td>
<td>- - 1</td>
</tr>
<tr>
<td></td>
<td>* independent, manual, spring charged mechanism. * shunt trip * mechanical ON/OFF indicator</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Microprocessor based intelligent type direct acting O/C, S/C &amp; E/F release with measurement control &amp; data transfer facility.</td>
<td>1 1 -</td>
</tr>
<tr>
<td>4.</td>
<td>Microprocessor based direct acting O/C, S/C &amp; E/F release with measurement &amp; data transfer features without remote control facility.</td>
<td>- - 1</td>
</tr>
<tr>
<td>5.</td>
<td>Control switch ON/OFF with spring return to neutral</td>
<td>1 1 1</td>
</tr>
<tr>
<td>6.</td>
<td>Multifunction meter</td>
<td>1 1 1</td>
</tr>
<tr>
<td>7.</td>
<td>Current transformer, class 1.0 for metering</td>
<td>3 3 3</td>
</tr>
<tr>
<td>8.</td>
<td>Microprocessor based motor protection relay</td>
<td>- - 1</td>
</tr>
<tr>
<td></td>
<td><em>(for motor feeders only)</em></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>ON/OFF/Trip on Fault/Trip circuit healthy lamps</td>
<td>3 4 4</td>
</tr>
<tr>
<td>10.</td>
<td>Auxiliary relays flag indication for buchholz trip and alarm and oil temperature trip and alarm signals and winding temp. alarm and trip signals</td>
<td>- 6 -</td>
</tr>
<tr>
<td>11.</td>
<td>Auto changeover scheme with under voltage relay, check synchronization relay, PT etc.</td>
<td>Between incomers &amp; bus couplers</td>
</tr>
<tr>
<td>12.</td>
<td>Set of relays, contactors, timers, etc. for annunciation scheme</td>
<td>As per Requirement</td>
</tr>
<tr>
<td>13.</td>
<td>Set of relays, contactors, timers for auto changeover scheme</td>
<td>As per Requirement</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Schedule of components equipment specification</td>
<td>Type of Feeder</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B/C</td>
</tr>
<tr>
<td>14.</td>
<td>Impulse switch for tripping 6.6 kV or 11kV breaker</td>
<td>-</td>
</tr>
<tr>
<td>15.</td>
<td>Two position, two contacts stay put switch with pistol grip handle for closing permission of upstream 6.6 kV or 11kV breaker</td>
<td>-</td>
</tr>
<tr>
<td>16.</td>
<td>ON/OFF indication lamp for upstream breaker.</td>
<td>-</td>
</tr>
<tr>
<td>17.</td>
<td>Inter tripping push button to trip the upstream breaker</td>
<td>-</td>
</tr>
<tr>
<td>18.</td>
<td>Analog Voltmeter with selector switch</td>
<td>1</td>
</tr>
<tr>
<td>19.</td>
<td>Analog Ammeter</td>
<td>-</td>
</tr>
</tbody>
</table>

1.02.04 LT BUSDUCT

01. Electrical Design
   i) Electric power supply (Unless otherwise specified) 415V, 3 phase, 50 Hz system.
   ii) Insulation level
   • Rated Voltage : 415 V
   • Rated insulation voltage : 1100V
   • One minute power frequency voltage : 2.5 kV
   • Clearance in air (minimum)
     - Phase to phase (mm) : 25.4 mm
     - Phase to earth (mm) : 19.0 mm
   • Neutral grounding : Solidly grounded
   iii) Short circuit strength
   • Rated short time withstand current not less than the system short circuit level specified for 1 Sec duration.
   • Rated peak withstand current not less than 2.1 times the system short circuit level.
   iv) Rated current
   • Rated continuous current as specified while in enclosure and at specified ambient temperature with maximum temperature of bus bars limited to 90 deg. C
   • Neutral bus where specified with rating not less than half the rating of phase bus.

02. General Arrangement
   • Rectangular, non-segregated phase, totally enclosed type.
   • Comprising of following sections, as applicable, to make the installation complete and to match with the terminal equipment :
     ⇒ Switchgear lead-in section with flexible hood.
     ⇒ Straight section in standard length
     ⇒ Matching section (length as required)
     ⇒ Transformer lead-in section
     ⇒ Corner sections (horizontal and vertical)
     ⇒ Phase cross-over section, if required, to match phase sequence of boards.
   • 240V AC space heater to be provided at suitable intervals and wired to external
terminal box with heat resistant cables.
- Silica gel breathers at appropriate locations.
- Horizontal bends to be avoided by positioning the switchboard incomers at appropriate place.

03. Construction Details
- Degree of protection for enclosure IP 52 or better for indoor installation, and IP55 for outdoor part.
- Enclosure material: Aluminum sheet, as specified of minimum thickness 2.0 mm for sheet steel & 2.5 mm for Aluminum.
- Enclosure construction rectangular welded construction.
- Maximum temperature of enclosure under rated operating conditions limited to 75 deg. C
- Bolted covers with gaskets for easy inspection and access to insulators and bus bar joints.
- Gasketted (Neoprene) connections between adjacent sections of metallic enclosure.
- Rubber bellows at each end to take care of vibrations.
- Provision for mounting on brackets.
- Seal off bushings shall be provided for busduct with indoor & outdoor part.
- The outdoor part shall be provided with sloping top.
- Seal off bushings shall be provided for busduct with indoor & outdoor part.
- Supply of painted MS supporting structures with necessary hardware shall be included in the scope of supply.
- Surface treatment.
  Two coats of epoxy paint for outdoor and synthetic enamel paint for indoor application, preceded by de-rusting, cleaning chemically, degreasing, pickling in acid, cold rinsing, phosphating, passivating and spraying with two coats of zinc oxide primer.
- Shade of paint:
  ⇒ Interior : Black
  ⇒ Exterior : Light grey shade 631 of IS-5 (unless otherwise specified) for outdoor part
  Shade 632 of IS-5(unless otherwise specified) for outdoor part.

04. Busbars and connections
- Material EC grade aluminium alloy equivalent to E91E WP conforming to IS 5082, 1981; or high conductivity electrolytic grade copper as per IS-613, 1984.
- Final operating temperature of both bus bars and joints under continuous operation in enclosure limited to 90 deg. C by thermometer method.
- Bus bar shall be as per IS-5082,IS-13947 & IS-5578.
- Phase identification by colour at ends and at regular intervals.
- Busbar joints of bolted type, with zinc bichromated high tensile steel bolts, nuts and spring washers. Bus-bar joint shall be chamfered as per the manufacturer's practice.
- Busbar surfaces to be tinned at joints and coated with oxide inhibiting grease prior to jointing.
- Copper busbar surface should be tinned.
- Flexible connections for termination on equipment.
- Expansion joints on straight runs with joints staggered in adjacent phases.
- Bimetallic joints for jointing between dissimilar metals.
- Busbar support insulators of non-hygroscopic material, having high impact and
05. **Protective earthing**
- Aluminium earth bus of size 50 x 10 mm running throughout the length of the busduct, positively connected to the body of the busduct.
- Provision at each end of busduct for terminating external earth conductor.

06. **Technical particulars for Design**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Application</td>
<td>Indoor</td>
</tr>
<tr>
<td>2.</td>
<td>Rated system voltage</td>
<td>415 V</td>
</tr>
<tr>
<td>3.</td>
<td>System earthing</td>
<td>Solidly earthed</td>
</tr>
<tr>
<td>4.</td>
<td>Rated continuous current as specified ambient conditions (in enclosure)</td>
<td>4000 A</td>
</tr>
<tr>
<td>5.</td>
<td>Rated short time withstand current (kA.rms) and its duration</td>
<td>50 kA for 1 Sec.</td>
</tr>
<tr>
<td>6.</td>
<td>Rated peak withstand current (peak)</td>
<td>105 kA</td>
</tr>
<tr>
<td>7.</td>
<td>Temp rise over ambient of 50 deg. C</td>
<td></td>
</tr>
<tr>
<td>- Busbars</td>
<td></td>
<td>40 deg. C</td>
</tr>
<tr>
<td>- Enclosure</td>
<td></td>
<td>25 deg. C</td>
</tr>
<tr>
<td>8.</td>
<td>Busbar material</td>
<td>Aluminium/ Copper</td>
</tr>
<tr>
<td>9.</td>
<td>Neutral bus</td>
<td>To be provided</td>
</tr>
<tr>
<td>10.</td>
<td>Earth bus material</td>
<td>Aluminium</td>
</tr>
<tr>
<td>11.</td>
<td>Earth bus size</td>
<td>2 nos. 50 x 10</td>
</tr>
<tr>
<td>12.</td>
<td>Supporting insulators</td>
<td>SMC/ FRP</td>
</tr>
<tr>
<td>13.</td>
<td>Busduct enclosure material</td>
<td>Aluminium</td>
</tr>
<tr>
<td>14.</td>
<td>Busduct enclosure material thickness</td>
<td>2.5 mm</td>
</tr>
<tr>
<td>15.</td>
<td>Busduct support structure</td>
<td>To be provided</td>
</tr>
<tr>
<td>16.</td>
<td>Overall (approximate) length of busduct (to be finalized, during detailing) including bends flanges etc.</td>
<td>8 m per set</td>
</tr>
<tr>
<td>17.</td>
<td>Type</td>
<td>Phase non-segregated type</td>
</tr>
<tr>
<td>18.</td>
<td>Maximum voltage at which busduct can operate</td>
<td>1100V</td>
</tr>
<tr>
<td>19.</td>
<td>One minute power frequency withstand voltage(kV)</td>
<td>2.5</td>
</tr>
<tr>
<td>20.</td>
<td>End connections</td>
<td>Copper flexibles</td>
</tr>
<tr>
<td>21.</td>
<td>Clearance:</td>
<td></td>
</tr>
<tr>
<td>- Phase to phase</td>
<td></td>
<td>25.4 mm.</td>
</tr>
<tr>
<td>- Phase to earth</td>
<td></td>
<td>19 mm.</td>
</tr>
<tr>
<td>22.</td>
<td>Accessories:</td>
<td>To be provided</td>
</tr>
<tr>
<td>- Space heater with thermostat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Silica gel breather</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Busbar support structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Enclosure Protection class</td>
<td>IP-52</td>
</tr>
<tr>
<td>24.</td>
<td>Paint-Shade</td>
<td></td>
</tr>
<tr>
<td>- Interior</td>
<td></td>
<td>Black</td>
</tr>
<tr>
<td>- Exterior</td>
<td></td>
<td>Shade 631 of IS:5</td>
</tr>
</tbody>
</table>

1.02.05  **Power Distribution Board (PDB)**
- 415V, 3 phase, 4 wire, 50 kA (short time rating for 1 sec.) indoor type.
- Board shall be single front, metal clad, front matched dust and vermin proof, fully compartmentalized and extensible on both sides, IP51 type enclosure.
- Degree of protection for enclosure IP 52 or better for indoor installation, and IP55 for outdoor part.
- Shall have base channel of size ISMC 75.
- Shall have isolated busbar chamber for main busbar at the top, running through out the length of the board. Chamber shall have removable cover.
- Cable alley shall have sufficient space for aluminium power cables and bottom cable chamber shall be left free completely isolated from the vertical busbars.
- Busbars shall have same cross section through out the length. Rating of the neutral busbar shall be 50% of the main busbar. Earth bus bar shall run in bottom chamber throughout the length of the panel.
- Shall have moulded case circuit breaker triple pole, air break type with independent manual quick make and quick break type. MCCB shall be capable of breaking rated current at .3 pf at rated voltage. MCCB shall withstand the fault current envisaged for 415V system.
- All feeders shall have ON/OFF lamps and 96 sq.mm size ammeter.
- Incomers of board and outgoing shall be MCCBs with E/F protection.

1.02.06 MOTORS & FIELD DEVICES

01. Low voltage squirrel cage induction motors:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Standard</td>
<td>IPSS 1-03-001 / IS 325 / IEC 34 &amp; IEC 72</td>
</tr>
<tr>
<td>2.0</td>
<td>Constructional Features</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Frame size &amp; rating</td>
<td>As per IS 325</td>
</tr>
<tr>
<td>(ii)</td>
<td>Motor body</td>
<td>Grey iron casting as per IS:210-1978</td>
</tr>
<tr>
<td>(iii)</td>
<td>Motor Feet</td>
<td>Integrally cast with the stator</td>
</tr>
<tr>
<td>(iv)</td>
<td>Body Design</td>
<td>- Prevent breakage or other failures due to vibrations normally encountered in heavy industries .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Motors shall be of weather proof construction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Designed to operate in the humid air stream</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Drain plugs to be provided .</td>
</tr>
<tr>
<td>(v)</td>
<td>Protection for Motor &amp; Bearing</td>
<td>IP - 55 (with canopy for motor if installed outdoor)</td>
</tr>
<tr>
<td>(vi)</td>
<td>Shaft ends &amp; Extension</td>
<td>Cylindrical as per requirement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proper drilling and tapping shall be provided for mounting of tachos for speed feedback (if required )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crane motor in 225 and above frame sizes shall have tapered shaft (1:10) ( New point)</td>
</tr>
</tbody>
</table>
(vii) **Bearings**
- For motor of rating upto 5 kW, ball bearings shall be used for both DE & NDE end.
- For ratings above 5 kW the DE end shall be provided with roller bearing and NDE end shall be provided with ball bearing.
- Bearings for motors shall be of C3 clearance.
- Bearings shall be suitable for running of motor in either direction.

(viii) **Hazardous Area safety design**
- As per requirement

(ix) **Canopy**
- To be provided for all outdoor motors.

(x) **Greasing point**
- At DE & NDE sides.

(xi) **Paint shade**
- Light grey shade 631 as per IS:5 or RAL 7030 (grey).

(xii) **Direction of Rotation**
- For crane and mill duty motors : reversible
- For general purpose continuous duty motor : Bidirectional (New point)

### 3.0 Terminal box

<table>
<thead>
<tr>
<th>(i) Location</th>
<th>Location on top preferably</th>
</tr>
</thead>
</table>
| (ii) Suitability | - 4 Core Aluminium Cable  
- Extension shall be done to receive the aluminium cables to avoid cramping of the cables in the terminal box. |
| (iii) Rotation | 4 X 90 deg. |
| (iv) Earthing stud | Inside Terminal Block |

### 4.0 Cooling
- TEFC
- Effective irrespective of direction of rotation

### 5.0 Quality of operation

| (i) Vibration intensity | Shall be limited as per IS 12075-1986. |
| (ii) Noise level | As per IS: 12065-1987 |
| (iii) Balancing | Motors shall be dynamically balanced with full key on the shaft- end and fan |

### 6.0 Electrical design

| (i) Power Supply | 415 V +10 & - 15%  
50 Hz +/- 6%  
3-phase, 4-wire AC  
50 kA for 1 second, solidly earthed. |
| (ii) Starting | DOL |
| (iii) Min Voltage for Start & Run | 85 % of rated voltage at terminal |
| (iv) Starting Torque | >= 160 % Rated Torque |
| (v) Breakdown or pullout torque | Minimum 275 % of the rated torque |
| (vi) Starting current | <= 600% Rated current |
| (vii) Duty | S1/ ......or as specified in TS  
For crane duty S5 40% with 150 start/hour.  
For conveyor application S-3 and 6 starts / hr  
For continuous duty- efficiency class EFF-1. |
| (viii) Starts/Hour permissible | 3 equally spread or 2 in quick succession from cold or one hot start, under rated load condition. |
| (ix) Max speed permissible | 120% over speed for 2 minutes |
| (x) Overload capacity | Capable of withstanding 60% Overload for 15 sec. |
| (xi) Efficiency | All continuous duty motor (S1-100%) shall be of high |
efficiency confirming to eff2 class as per IEEMA-19-2000.

(xii) Derating Motor designed at 50 deg.C shall be derated suitably for mentioned ambient temperature.

(xiii) Motor connections Motor with frame size 90 shall be connected in star and of frame sizes more than 90 shall be connected in delta. For delta connected motors 6 leads shall be brought out.

(xiv) Insulation Class F

(xv) Minimum temperature rise Permissible temperature rise Limited to class ‘B’ (120 deg absolute)

(xvi) Torque Type Normal / High / High slip type / Stall Torque type (as required for the specific application)

(xvii) Space Heater Out door motors above 45 kW Indoor Motor above 110 kW

(xviii) No. of Poles 4 pole (unless specific drive requirement or economics call for other poles).

(xix) Testing As per approved QAP during engineering stage.

(xx) Mounting Normally horizontally foot mounting. Other type of mounting as per specific requirement.

02. Low voltage slip ring induction motors (Only for cranes and mill duty) :-

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Standard</td>
<td>IPSS:1-03-001-92, IPSS 1.03-004-93, IS 325, IEC 34 &amp; IEC 72</td>
</tr>
<tr>
<td>2.0</td>
<td>Application</td>
<td>Slip ring induction motors shall be used only for drives of charging cranes. Slip ring motors shall be employed for intermittent duty drives requiring frequent switching operations and speed control and for heavy drive applications requiring high starting torque and meeting frequent overload conditions.</td>
</tr>
</tbody>
</table>

3.0 Constructional Features

(i) Frame size & rating As per IS 325

(ii) Motor body Grey iron casting as per IS:210-1978

(iii) Motor Feet Integrally cast with the stator

(iv) Body Design - Prevent breakage or other failures due to vibrations normally encountered in heavy industries.

- Motors shall be of weather proof construction.

- Designed to operate in the humid air stream

- Drain plugs to be provided.

- All motors to have continuously rated slip rings.
<table>
<thead>
<tr>
<th></th>
<th>Protection for Motor &amp; Bearing</th>
<th>IP55 degree of protection as per IS : 4691.</th>
</tr>
</thead>
</table>
| (vi) | Shaft ends & Extension | - Shall be of high grade steel.  
- Cylindrical as per requirement  
- Proper drilling and tapping shall be provided for mounting of tachos for speed feedback (if required) in non drive end or shaft shall be extended with different diameter and length.  
Tapered shafts for all crane drive motors shall be provided. Motors in 225 and above frame size shall have tapered shaft (1:10).  
- Provision of double identical shaft extension (cylindrical & taper) to be made (in case of requirement for a particular application). |
| (vii) | Slip rings | - All motors to have continuously rated slip rings.  
- Phosphor bronze or steel slip rings shall be provided. Cast iron slip rings shall not be used.  
- Brush holders shall be in a complete assembly unit.  
- Slip ring unit shall have a cover with inspection window.  
- For higher range of motors, separate disc is provided between the slip ring and rotor windings to prevent carbon dust ingestion into windings. |
| (viii) | Bearings | - For motor of rating upto 5 kW, ball bearings shall be used for both DE & NDE end.  
- For ratings above 5 kW the DE end shall be provided with roller bearing and NDE end shall be provided with ball bearing.  
- Bearings for motors shall be of C3 clearance.  
- Bearings shall be suitable for running of motor in either direction. |
| (ix) | Hazardous Area safety design | As per requirement |
| (x) | Canopy | To be provided for all outdoor motors. |
| (xi) | Greasing point | At DE & NDE sides for online greasing facility without dismantling the motor. |
| (xii) | Paint shade | Light grey shade 631 as per IS:5 or RAL 7030 (grey). |

### 4.0 Terminal box

| (i) | Location | On top preferably |
| (ii) | Suitability | - 4 Core Aluminium Cable  
- Extension shall be done to receive the aluminium |
cables to avoid cramping of the cables in the terminal box.

(iii) Rotation 4 X 90 deg.

(iv) Earthing stud One earthing stud shall be provided in the terminal box and two terminals on mounting feet.

(v) Stator and rotor connections Separate and distinctly marked terminal box to be provided for stator and rotor connections.

(vi) Protection class IP 55 in all the cases.

(vii) Cable glands Suitable for double compression type cable glands.

5.0 Cooling

- TEFC design only
- Effective irrespective of direction of rotation
- The cooling code of motor is IC 411 as per IS 6362.

6.0 Quality of operation

(i) Vibration intensity Shall be limited as per IS 12075-1986.

(ii) Noise level As per IS: 12065-1987

(iii) Balancing Motors shall be dynamically balanced with full key on the shaft-end and fan.

7.0 Electrical design

(i) Power Supply
- 415 V +10 & - 15%
- 50 Hz +/- 6%
- 3-phase, 4-wire AC,
- 50 kA for 1 second, solidly earthed.

(ii) Starting DOL or thyristor converter (ASTAT or SIMOTRAS or equiv.) Soft starter feature through static voltage control/VVVF as per application

(iii) Min Voltage for Start & Run 80 % of rated voltage at terminal

(iv) Breakdown or pullout torque Pull out torque of the intermittent duty motors to be not less than 300% of the rated torque at 40% duty factor.

(vi) Starting current <= 600% Rated current

(vii) Duty Duty cycle shall not be less than S4-40%, with a minimum of 150 starts per hour (600 starts / hour for charging cranes and other process cranes).
For conveyor application S-6 duty.

(viii) Starts/Hour permissibe Mechanically and electrically shall be suitable for required number of switching / reversals or starts per hour.

(ix) Max speed variation 250 % of rated synchronous speed at high accelerating rates and rapid reversals.

(x) Max speed 250 % of rated speed or 2000 rpm whichever is less.

(xi) Rated synchronous speed Motors shall be of low synchronous speed for ease of dynamic balancing of hoist rotating unit.
The motor speed preferably shall be as follows:
- Upto 37 KW -> 1000 rpm
- Above 37 KW upto 90 KW -> 750 rpm
- Above 90 KW -> 600 rpm

(xii) Overload capacity 1.5 times the rated current for 2 minutes

(xiv) Void

(xvi) Derating Motor designed at 50 deg.C shall be derated suitably for mentioned ambient temperature.

(xvii) Insulation Class H
(xviii) Torque Type
Normal / High / High slip type / Stall Torque type
(as required for the specific application)

(xix) Space Heater
Out door motors above 45 kW
Indoor Motor above 110 kW

(xx) Over temperature detection and
protection.
Slip ring motors for essential drives to be provided with
Pt 100 resistance thermometers / thermocouples or
thermistors .

(xxi) No. of Poles
Not applicable

(xxii) Testing
As per approved QAP during engineering stage .

(xxiii) Mounting
Normally horizontally foot mounting .
Other type of mounting as per specific requirement .

(xxiv) Derating
Motors shall be derated considering all the factors
- variation in voltage and frequency .
- Ambient temperature
- Thermal ability due to constant and variable
  losses of the motor
- Type of load driven

03. Roller Table Motors (Torque motors)

| 1.0 | Standard | IPSS 1-003-007-85 |
| 1.0 | Duty & type | All travel mechanism shall have roller table duty motors . |
| 2.0 | Insulation class | Class H insulation . temperature rise limited to class F . |
| 3.0 | Maximum speed | All roller table duty motors shall have a maximum speed of 1000 RPM . |
| 4.0 | Cooling | Shall be TENV type only . IC 410 . |
| 5.0 | Temperature sensor | Roller table motor (Torque motor) shall have built in PTC thermistors . |
| 6.0 | Locked rotor withstand time | Ability to withstand locked rotor conditions for minimum 1 min. under hot conditions . The motors shall meet the process requirement also . |
| 7.0 | Control system | All the roller table motors shall be inverter duty in case of VFD control otherwise RDOL . |

04. High voltage squirrel cage induction motors

<p>| Sl.No. | Parameters | Description |
| 1.0 | Standard | IPSS 1-03-018/IS 325 |
| 2.0 | Constructional Features |
| i). | Frame size &amp; rating | As per IS 325 |
| ii) | Stator Frame | Fabricated Steel / High grade cast Iron |
| iii) | Stator Core | Laminated sheets of high grade low loss silicon steel |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>iv)</td>
<td>Motor body</td>
<td>Grey iron casting as per IS:210-1978</td>
</tr>
<tr>
<td>v)</td>
<td>Casing Feet</td>
<td>Integral with the motor frame</td>
</tr>
<tr>
<td>vi)</td>
<td>Body Design</td>
<td>Prevent breakage or other failures due to vibrations normally encountered in heavy industries</td>
</tr>
<tr>
<td>viii)</td>
<td>Shaft</td>
<td>Forged Steel shaft</td>
</tr>
<tr>
<td>ix)</td>
<td>Bearings (below 1000kW )</td>
<td>Anti-friction Bearing with Regreasing facility &amp; with grease quantity controllers</td>
</tr>
<tr>
<td>x)</td>
<td>Vibration monitor</td>
<td>Shall be provided at the DE end of motor bearing</td>
</tr>
<tr>
<td>xi)</td>
<td>Pedestals insulation</td>
<td>Against circulating shaft currents</td>
</tr>
<tr>
<td>xii)</td>
<td>Hazardous Area safety design</td>
<td>NA / as specified</td>
</tr>
<tr>
<td>xiii)</td>
<td>Indication of direction of rotation</td>
<td>By Arrow blocks on non-driving end</td>
</tr>
<tr>
<td>xiv)</td>
<td>RTD &amp; BTD ( PT100 type)</td>
<td>All motors shall be provided with Bearing (DE &amp; NDE) temperature detectors and 6 nos. stator winding temperature detectors, RTDs for monitoring alarm and trip conditions. RTD's shall be of PT100 type (duplex).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analog input cards shall be provided in PLC for online monitoring of bearing (DE &amp; NDE) and winding temperature of HT motors above 1000 KW .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For HT motors, temperature of each RTD (for winding / bearing) shall be wired to PLC system and limit value contacts for alarm and tripping shall be generated in the PLC along with the display of all parameters of the motor including the winding and bearing temperature.</td>
</tr>
<tr>
<td>xv)</td>
<td>Vibration monitoring</td>
<td>Vibration monitoring (online) shall be provided at the DE end of motor bearing for motors of ratings 1000 kW and above and it should be connected to PLC for online monitoring .</td>
</tr>
<tr>
<td>xvi)</td>
<td>Paint shade</td>
<td>Light grey, shade no. 631 as per IS 5</td>
</tr>
</tbody>
</table>

### 3.0 Terminal box

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Protection</td>
<td>IP - 55</td>
</tr>
<tr>
<td>ii)</td>
<td>Type</td>
<td>Phase segregated</td>
</tr>
<tr>
<td>iii)</td>
<td>Location</td>
<td>As per requirement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 no. each on opposite sides of motor.</td>
</tr>
<tr>
<td>iv)</td>
<td>Winding star point</td>
<td>Winding star point shall be kept outside in the motor for more than 200 KW HT motor and other</td>
</tr>
</tbody>
</table>
important HT motor.

- In case no differential protection is required, star point of the winding may be formed inside the neutral terminal box to be provided on one side of the motor. The phase segregated terminal box shall be placed on other side of the motor.

<table>
<thead>
<tr>
<th>v)</th>
<th>Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>– Termination of XLPE cables with heat shrinkable cable end seals.</td>
</tr>
<tr>
<td></td>
<td>– Each terminal box to have two inlets to accommodate any parallel cables as required.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>vi)</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To suit cable entry from Top / Bottom</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>vii)</th>
<th>Earthing stud</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inside TB for protective earth conductor termination</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>viii)</th>
<th>No. of terminal boxes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Separate for Space heaters, RTDs / BTDs, Vibration monitor etc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ix)</th>
<th>Fault withstand (Min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rated Short circuit level of the system voltage for 0.25 sec</td>
</tr>
</tbody>
</table>

4.0 Cooling

- TEFC / CACA / CACW
- CACW system shall be complete with temperature and pressure monitoring devices.

5.0 Quality of operation

<table>
<thead>
<tr>
<th>i)</th>
<th>Vibration intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Limited to 37.5 micron peak to peak.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ii)</th>
<th>Noise level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous noise level should not exceed 85 db A at a distance of 1.0 m from the motor body as per IS: 12065-1987.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>iii)</th>
<th>Balancing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dynamically balanced with full key on shaft end and fan</td>
</tr>
</tbody>
</table>

6.0 Electrical design

<table>
<thead>
<tr>
<th>i)</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High efficiency design of 96% at Full load</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ii)</th>
<th>Starting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DOL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>iii)</th>
<th>Min Voltage for Start &amp; Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80% of rated voltage at terminal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>iv)</th>
<th>Starting Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As specified in application</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>v)</th>
<th>Starting current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;= 600% Rated current</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>vi)</th>
<th>Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>vii)</th>
<th>Starts permissible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 successive start from cold condition OR 2 successive start from hot condition.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>viii)</th>
<th>Starts / hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 equally spread in normal Voltage, Frequency &amp; Load</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ix)</th>
<th>Max speed permissible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150 % rated for 2 minutes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>x)</th>
<th>Differential protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Required for 1000 kW &amp; above</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xi)</th>
<th>Insulation Material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class F &amp; confirming to IEC 34 - 15/1990</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xii)</th>
<th>Insulation Material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cast resin rich / VPI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xiii)</th>
<th>Minimum temperature rise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Permissible temperature rise</td>
</tr>
<tr>
<td></td>
<td>Limited to class 'B' (120 deg absolute)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xiv)</th>
<th>Space Heater</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Required &amp; automatically off during RUN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xv)</th>
<th>No. of Poles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 (or as mentioned specifically)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xvi)</th>
<th>Locked rotor current withstand time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 sec longer than starting time under rated load condition.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xvii)</th>
<th>Surge protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As specified</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xviii)</th>
<th>Operational design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Suitable to VCB Breaker</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xix)</th>
<th>Motor winding and inter turn insulation, connections and</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shall be fully insulated using mica insulation. For such motors surge absorbers (with non-linear resistance)</td>
</tr>
</tbody>
</table>
 leads: shall be provided within 10 to 15 meters from the motor terminals to limit the over voltages. OR
In case mica is not provided in motor insulation, both surge capacitors and surge absorbers (with non-linear resistance) shall be provided within 10 to 15 mtrs from the motor terminals to limit the over voltages and rate of rise of voltage.

05. Synchronous Motors

<table>
<thead>
<tr>
<th>2.0</th>
<th>Constructional Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Frame size &amp; rating</td>
</tr>
<tr>
<td>ii)</td>
<td>Stator Frame</td>
</tr>
<tr>
<td>iii)</td>
<td>Stator Core</td>
</tr>
<tr>
<td>iv)</td>
<td>Motor body</td>
</tr>
<tr>
<td>v)</td>
<td>Casing Feet</td>
</tr>
<tr>
<td>vi)</td>
<td>Body Design</td>
</tr>
<tr>
<td>viii)</td>
<td>Shaft</td>
</tr>
<tr>
<td>ix)</td>
<td>Bearings (below 1000kW )</td>
</tr>
<tr>
<td>x)</td>
<td>Vibration monitor</td>
</tr>
<tr>
<td>xi)</td>
<td>Pedestals insulation</td>
</tr>
<tr>
<td>xii)</td>
<td>Hazardous Area safety design</td>
</tr>
<tr>
<td>xiii)</td>
<td>Indication of direction of rotation</td>
</tr>
<tr>
<td>xiv)</td>
<td>RTD &amp; BTD ( PT100 type)</td>
</tr>
</tbody>
</table>
Vibration monitoring - Vibration monitoring (online) shall be provided at the DE end of motor bearing for motors of ratings 1000 kW and above and it should be connected to PLC for online monitoring.

Paint shade - Light grey, shade no. 631 as per IS 5

3.0 Terminal box
i) Protection - IP - 55
ii) Type - Phase segregated
iii) Location - RHS viewed from DE / On top
   - 01 nos. each on opposite sides of motor in case of Differential Protection (or not) / Neutral TB opposite to main TB
v) Suitability - Termination of XLPE cables with heat shrinkable cable end seals.
   - Each terminal box to have two inlets to accommodate any parallel cables as required.
vi) Reversible - To suit cable entry from Top / Bottom
vii) Earthing stud - Inside TB for protective earth conductor termination
viii) No. of terminal boxes - Separate for Space heaters, RTDs / BTDs, Vibration monitor etc
ix) Fault withstand (Min.) - Rated Short circuit level of the system voltage for 0.25 sec

4.0 Cooling - TEFC / CACA / CACW
   - CACW system shall be complete with temperature and pressure monitoring devices.

5.0 Quality of operation
i) Vibration intensity - Limited to 37.5 micron peak to peak.
ii) Noise level - Continuous noise level should not exceed 85 db A at a distance of 1.0 m from the motor body as per IS: 12065-1987.
iii) Balancing - Dynamically balanced with full key on shaft end and fan

2.0 Design - Motors shall be of cylindrical design with brush less excitation system and automatic voltage and power factor regulation.

3.0 Power factor - 0.9 or better.

4.0 Motor winding - Motor stator winding braced for full voltage starting.
   - Squirrel cage type winding with short circuited rotor bars for producing starting torque and accelerating torque to bring the synchronous motor upto the speed
   - All the three windings stator, rotor and exciter shall be VPI (Vacuum pressure impregnation).

5.0 Bearings - Small frame size motors shall have endshield bearings and large motors shall have pedestal bearings.
6.0 Cooling

All the three modes of cooling arrangement as per requirement
- Open air (for the areas where air is relatively clean e.g. water supply pump houses)
- Air to water (in closed cooling circuit)
- Air to air cooling (ID fan etc.) A shaft mounted fan or a separate fan to be provided for air circulation.

7.0 Excitation method

Brushless excitation system (Integral exciter and rotating rectifier assembly to eliminate the need for brushes and slip rings both on exciter and motor respectively).

8.0 Automatic system power factor correction.

Motor field to have micro processor based thyristor controlled static excitation system (for automatic system power factor correction).

9.0 Motor synchronism protection

Field monitor relay to be provided for monitoring the power factor of the system which in turn trips the motor and the exciter field off if synchronism is not achieved within a specific length of time or if the motor pulls out of step.

10.0 Insulation class

Class F insulation for field windings as well as for stator with temperature rise limited to 70 deg. C (as measured by resistance method) over an ambient of 50 deg. C.

11.0 Locked rotor withstand time

Motors shall be capable of withstanding locked rotor current for atleast 5 second longer than starting time under rated load condition.

12.0 Starting method

DOL / Auto transformer starting method / Load commutated inverter (LCI)

13.0 Space Heater

Space heater to be provided.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1.0   | Type       | - AC Squirrel cage induction motor.  
|       |            | - Inverter Duty |
| 2.0   | Standard   | - IPSS 1-03-001/IS 325  
|       |            | - NEMA Standard MG1-1993 Part 31, or the latest revision in so far as it is applicable. |
| 3.0   | Constructional Features | |
| A     | Frame size & rating | - As per IS 325 |
- 10:1 constant torque speed range motors may exceed frame standard by one frame rating.

| B  | Motor body | Grey iron casting as per IS:210-1978 |
| C  | Motor Feet | Integrally cast with the stator |
| D  | Body Design | - Prevent breakage or other failures due to vibrations normally encountered in heavy industries.
- Motors shall be of weather proof construction.
- Designed to operate in the humid air stream. |
| E  | Protection for Motor & Bearing | IP - 55 |
| F  | Motor Shaft | Shall be provided with an external recessed slinger at the drive end of the motor to provide additional (minimum IP-54) protection from moisture and foreign material. |
| G  | Shaft ends & Extension | - Cylindrical as per requirement
- Shaft shall be extended for encoder / tacho. mounting, accordingly suitable hole shall be drilled and tapped. |
| H  | Internal Encoder | Motors with speed variation of 1000:1 at constant torque shall have internal builtin encoder for speed feedback |
| I  | Bearing | - Roller type bearing upto 5 kW.
- Ball Bearing at NDE end for above 5 kW.
- All motors shall have fully re-greaseable, anti-friction bearings.
- All motors shall have cast iron inner bearing caps.
- Bearings shall be oversized.
- All motors shall have a charged lubrication system to inhibit moisture condensation.
- Standard motors shall have extended grease fittings on the opposite drive-end to facilitate re-lubrication. Grease ports shall be located on the periphery of the motor endshield.
- Motor shall be fitted with a shaft slinger or V ring seal on the drive end for a minimum of IP-54 protection (to help protection of bearing from ingress of dust, dirt or fluids). |
| J  | Hazardous Area safety design | NA |

4.0 Terminal box

| A  | Location | RHS viewed from DE / On top |
| B  | Suitability | - 4 Core Aluminium Cable |
- The terminal box shall be oversize as compared to NEMA requirements.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Rotation</td>
<td>4 X 90 deg.</td>
</tr>
<tr>
<td>D</td>
<td>Earthing stud</td>
<td>Inside Terminal Block</td>
</tr>
</tbody>
</table>
| E | Miscellaneous | - Shall be gasketed between the terminal box halves.  
- The conduit box shall be field convertible to cast iron.  
- External screws and bolts shall be grade five, hex heads and be plated to resist corrosion. |

### 5.0 Cooling
- TEFC, Effective bi-directional
- TENV (for roller table duty)
- Motor with 1000:1 speed range and constant torque shall have external fan.
- External fan motor shall be 3 phase, 415 V AC
- Thermistors shall be provided in the windings.

### 6.0 Quality of operation

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
| A | Vibration intensity | - Shall be limited as per IS 12075-1986.  
- Shall not exceed .08 inches / second velocity. |
| B | Noise level | As per IS: 12065-1987 |

### 7.0 Electrical design

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Power Supply</td>
<td>415 V +10 &amp; - 15% , 50 Hz +/- 6% , 4-wire AC, 50 kA for 1 second, solidly earthed.</td>
</tr>
<tr>
<td>B</td>
<td>Starting</td>
<td>Variable Frequency Drive</td>
</tr>
</tbody>
</table>
| C | Service factor | - 1.0 for VFD power.  
- 1.15 for sine wave power. |
| D | Peak transient voltage | 1600 V |
| E | Minimum rise time | 0.1 microsecond |
| F | Starting Torque | 200 % rated torque for 1 minute below base speed |
| G | Constant horsepower operation | 1.5 times base speed. |
| H | Duty | Application dependent |
| I | Max speed permissible | 150 % rated for 2 minutes |
| J | Derating for VFD | As per above mentioned standard |
| K | Insulation | Class H limited to class F. |
| L | Load Type | Constant Torque / Variable Torque (As per application) |
| M | Space Heater | - Out door motors above 45 kW  
- Indoor Motor above 110 kW |
| N | No. of Poles | 4 / 6 / 8 |

### 8.0 Operating Characteristics

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Operation with variation in the motors</td>
<td>Motors shall operate successfully under running</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
|   | voltage or the frequency conditions at rated load with variation in the voltage or the frequency not exceeding the following conditions:  
- +/-10% rated voltage at rated constant V/f ratio except for specific torque boost situations.  
Motors shall operate successfully under running conditions at rated load and V/f ratio when the voltage unbalance at the motor terminals does not exceed one percent. |   |
| B | Torques | Motors shall meet or exceed the minimum locked rotor (starting) and breakdown torques specified in NEMA Standard MG1 Part 12 for Design B for the rating specified when on sine wave power. |
| C | Operating speed range | - Zero to base speed in case of VT.  
- 1000: 1 for CT (with blower cooling)  
- 10:1, 6:1, 4:1 for CT. |
| D | Locked rotor (starting) currents | Shall not exceed NEMA Design B values for the specified rating on 5:1 constant torque or less and variable torque motors. NEMA Design A values are allowed for 6:1 constant torque or higher value constant torque rated motors.  
Motors shall be capable of a 20 second stall at six times full load current without injurious heating to motor components. |
| E | Efficiency | - Shall have a nameplate minimum and nominal full load efficiency for motors when tested in accordance with NEMA standard MG1 Part 12, IEEE Test Procedure 112 Method B, using accuracy improvement by segregated loss determination including stray load loss measurements. |
| 9.0 | Motor location | Outdoor / indoor installation. |
| 1.0 | Painting | For indoor motors:  
Total thickness of painting shall be 140 microns.  
For outdoor motors:  
Total thickness of painting shall be 240 microns. |
| 11.0 | Nameplate | - Shall be of corrosion resistance stainless steel.  
- In addition to standard nameplate information following informations shall be included:  
  o Nominal efficiency.  
  o Bearing identification numbers. |
### 07. DC Electromagnetic brake

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage</td>
<td>220V DC</td>
</tr>
<tr>
<td>2.0</td>
<td>Application</td>
<td>Suitable for steel mill duty having long mechanical life.</td>
</tr>
</tbody>
</table>
| 3.0 | Duty | Shunt brake for  
- Continuous duty  
- Intermittent duty  
Series brake for  
- One hour duty (mill duty)  
- Half hour duty (crane duty) |
| 5.0 | Mounting | Floor mounting, two shoes, self-aligning, quick acting with self-lubricating robust bearings. |
| 6.0 | Brake shoe lining | Lining of tough heat resistant material with countersunk fixing rivets to prevent rubbing against the brake wheel. |
| 7.0 | Shoe adjustment and indications |  
- Facility for brake torque adjustment  
- Lining wear indication |
| 8.0 | Coil | Insulation : Class F |
| 9.0 | Braking Torque rating | Minimum 150% of the motor FLT |
| 10.0 | Temperature limit for brake magnet and brake drum | Brake magnet :  
- The magnet shall not become heated , during operation , to a temperature exceeding 150 deg. C  
Brake drum :  
- The temperature of the drum during working of the brake shall not exceed 200 deg. C |
<p>| 11.0 | Limit switch | Limit switches to be provided for contact feedback used for interlocking , indications etc. |
| 12.0 | Safety for fail safe operation | Electrically released and spring applied for fail safe operation (gravity operated counterweight type are not acceptable) |</p>
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.0</td>
<td>Maintainability of brake coil</td>
<td>Brake coil connection brought to appropriate terminal box for ease in maintenance and terminals covered for protection against accidental touch.</td>
</tr>
<tr>
<td>14.0</td>
<td>Residual magnetic gap adjustment</td>
<td>To increase the residual magnetic gap for reducing brake application time anti magnetic shim shall be provided.</td>
</tr>
<tr>
<td>15.0</td>
<td>Brake panel</td>
<td>Necessary rectifier and brake forcing equipment shall be included for DC electro-magnet brakes used with AC system.</td>
</tr>
<tr>
<td>16.0</td>
<td>Installation of brake panel</td>
<td>DC electromagnetic brake panel shall be installed in MCC room.</td>
</tr>
</tbody>
</table>

### 08. Field Switches

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Enclosure protection</td>
<td>All field switches to have enclosure class IP-65 in covered area &amp; IP-67 in open area.</td>
</tr>
<tr>
<td>2.0</td>
<td>Contacts</td>
<td>Minimum separate contacts 2NO &amp; 2NC for interlocks and as required for process.(with external JB)</td>
</tr>
</tbody>
</table>

### 09. Power Resistance

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Resistor design</td>
<td>To meet arduous heavy duty industrial and steel works application, unbreakable, rigid, resilient &amp; rust less.</td>
</tr>
<tr>
<td>2.0</td>
<td>Material</td>
<td>Fechral edge wound</td>
</tr>
<tr>
<td>3.0</td>
<td>Duty rating</td>
<td>10 minutes rating of BS: 587 and conforming to IPSS No. 1-10-002-82 and addendum No 1 to IPSS (March 1985).</td>
</tr>
<tr>
<td>4.0</td>
<td>Construction</td>
<td>Every turn of every grid is fully supported so that adjacent turns and adjacent grids can neither vibrate nor distort so as to make mutual contact. The complete grid is spot welded to its neighbors thus eliminating slacken support due to heating and cooling and is mounted on mica insulated high tensile steel tie-rod and mica creepage washers. A tripping point is formed on each grid by a hole in the welded portion which is double thickness and absolutely flat. All grids shall have either zinc alloyed or cadmium plated surface for permanent weather proofing. Highest quality mica and porcelain insulated terminals are to be used.</td>
</tr>
</tbody>
</table>
The thermal loading of the resistance box should be uniform. The terminals shall be easily accessible at the lower most stack.

Testing shall be carried in accordance to BS: 587.

Shall be of Fechral edge wound resistance boxes. The element design shall be either circular (Russian design) or elliptical (BHEL design). Punched grid resistance boxes shall not be used for crane control.

1.02.07 Individual Drive Control Level

01. Variable Frequency Drive (VFD)

| 1.0 | Basic design particulars | - Digital control technology with vector control (with / without PG as per requirement).  
- IGBT based with sine coded PWM control.  
- VFD shall communicate to basic automation system on system communication bus.  
- Suitable for variable torque or constant torque applications requiring harmonic control as defined by IEEE 519-1992.  
- The drive shall have an internal EMC filter capable of meeting the Second Environment levels for the EMC directive without the need for additional components.  
- Shall confirm to IEC 146 - International Electrical Code.  
- For 4 quadrant operational drives, active front end type VFD shall be provided.  
- Where speed control is desired for production and quality control VFD is to be provided.  
- Where speed control is not required soft starter or motor intelligent controllers are to be provide.  
| 2.0 | Drive controller | - Software configurable to either V/Hz (single or multi |
| 3.0 Type of connection | - Three full wave diode rectifiers supplied by phase shifted, three phase AC to provide a fixed DC voltage.  
- DC bus inductor on all ratings  
- DC link capacitors  
- Insulated Gate Bipolar Transistor (IGBT) power section, shall be rated for variable / constant torque applications. The power section shall use vector dispersal pulsewidth modulated (PWM) IGBT gate control algorithm and soft switching IGBT’s to reduce motor terminal dv/dt and allow longer cable length from drive to motor without output filters.  
- The Main Control Board shall be the same for all ratings to optimize spare parts stocking and exchange  
- Common control connection for all ratings. |
| 4.0 Overload capacity | - 110% of the rated current for 1 minute, 30 seconds at 150% (with inverse characteristics proportional to time) for variable torque applications. Repetition interval shall not be less than 9 minutes  
- 150% of the rated current for 1 minute overload, 30 seconds at 200% (with inverse characteristics proportional to time) and 200% of rated current for 0.5 sec. for constant torque applications. Repetition interval shall not be less than 60 minutes. |
| 5.0 Efficiency | More than 97% or better at full speed and full load. |
| 6.0 Input power supply | - 415 V AC +10% & -15%  
- 3 phase  
- 50 Hz +/ - 6%  
- 4 wire neutral earthed system. |
| 7.0 Voltage variation | - Voltage variation of (+/-) 0.1 % with an input variation of +10% - 15%. |
- Steady state regulation of (+/-) 0.25% guaranteed against 100 to 200 % load disturbance and +6% & -6% input supply frequency variation.
- The drive should be designed to operate on an AC supply, which may contain line notching, and up to 10% harmonic distortion.

8.0 Environmental conditions

8.1 Storage ambient temperature range
Upto to 70º C (-40º to 158ºF).

8.2 Operating ambient temperature range without derating.
IP42 & above : 0º C to 50º C (0º to 122º F)

8.3 Relative humidity
Upto 100% non-condensing.

8.4 Operating elevation
Up to 1000 Meters (3,300ft) without derating.

8.5 Shock
15G peak for 11ms duration

8.6 Vibrations
Suitable to withstand vibrations more than 0.5g.

9.0 Reference

9.1 Input reference voltage
O +/- 10 V DC / 0 – 10 V DC / 4 – 20 mA .

9.2 Reference signals
The drive should be capable of the following speed reference signals
- Digital MOP
- Jog
- HIM (Program/Control panel)
- Analog Input signals
- Preset Speeds
- Communication module commands
All reference signals may have a trim signal applied to them for finer resolution and accuracy. Trim source and amount should be programmable.

9.3 Loss of reference
The drive should be capable of sensing the reference loss conditions . In the event of loss of an analog input reference signal, the drive should be user programmable to the following
- Fault the drive
- Alarm and maintain last reference
- Alarm and go to preset speed
- Alarm and go to minimum speed
- Alarm and go to maximum speed
- Alarm and maintain last output frequency
Signal loss detection should be available regardless of the function of the analog input.

10.0 Output

10.1 Output voltage
From 0 to rated motor voltage .

10.2 Output frequency
0.5 - 400 Hz.

10.3 Output Waveform
Sinusoidal
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.4</td>
<td>Output frequency resolution</td>
<td>0.01 Hz.</td>
</tr>
<tr>
<td>11.0</td>
<td>Reflected wave</td>
<td>Maximum of 3.15 times the bus voltage or 1600V, whichever is less, up to cable lengths of 200 metres.</td>
</tr>
</tbody>
</table>
| 12.0    | Starting torque | 150 % / 0.3 Hz. (without PG)  
150 % / 0 RPM (with PG) |
| 13.0    | Torque accuracy | + / - 5 %. |
| 14.0    | Speed control accuracy | + / - 0.02 %.  
IR compensation to be provided for drive without PG. |
| 15.0    | Ramp rate | - Linear acceleration and deceleration adjustable independently from 0 to 3600 seconds.  
- Provision of remotely selectable Accel / Decel settings should be accessible through digital inputs also. |
| 16.0    | Main power components in incoming AC side | - ACB / MCCB with 50 KA rating  
- Matching input isolation transformer / line reactor for harmonic and noise suppression. For input isolation transformer, the K factor shall be 4.0 or less.  
- AC line surge suppression network.  
- Input contactor. |
| 17.0    | Converter – Inverter Equipment | - Diode / Thyristor bridge for AC/DC.  
- DC link circuit with reactor/capacitor  
- IGBT bridge for Inverter for DC/AC.  
- Harmonic transformer.  
- Main PLC to take care of interlocking and sequencing etc.  
- Mimic panel (where drive is HT) |
| 18.0    | Load side components | - Filter network  
- Electronic over-load relay for each motor (with display).  
- Line contactors in output side (if required).  
- Output reactor / terminator (if required) |
| 19.0    | Terminal blocks | - Separate for control and power wiring.  
- Power terminal blocks to withstand a minimum of 90 °C and marked for both inputs and outputs.  
- Uniform color-coding to be followed for cabling, TB, etc. |
| 20.0    | By-pass Arrangement | By-pass arrangement shall be provided to operate the motor in case of failure of VFD. |
| 21.0    | Diode Bridge | Minimum ratings of Diode cells.  
- PIV rating : 2.5 times the peak value of line voltage  
- dv/dt rating : 200V/microsecond for voltage control and 1000V / microsec. for inverter control.  
- di/dt rating : 100A / microsecond. |
| 22.0    | Input / Outputs | - Hard-Wired I/O |
Hardwired I/O should be provided via separate I/O cards

- **Standard I/O Card**
- The “Standard I/O board should consist of both digital and analog I/O. It should be available in two versions; one for 115/240 VAC digital I/O and one for 24V AC/DC digital I/O.
- **Analog I/O**
  - Differentially isolated ±10V (bi-polar) / 20mA analog inputs.
- **Digital Outputs**
  - Relay outputs – Minimum 04 nos.
  - Contact output ratings should be 240V AC / 24V DC, Maximum 2.0 Amp

### Protective features

<table>
<thead>
<tr>
<th>23.0</th>
<th>AC line surge suppression network and overvoltage protection.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Under voltage in supply network</td>
</tr>
<tr>
<td></td>
<td>- Phase sequence protection and monitoring</td>
</tr>
<tr>
<td></td>
<td>- Single phase failure</td>
</tr>
<tr>
<td></td>
<td>- Motor loss</td>
</tr>
<tr>
<td></td>
<td>- Under voltage in DC bus</td>
</tr>
<tr>
<td></td>
<td>- Over voltage in DC bus</td>
</tr>
<tr>
<td></td>
<td>- Over speed protection in the event that the output frequency exceeds the maximum reference by a specified amount.</td>
</tr>
<tr>
<td></td>
<td>- Over load</td>
</tr>
<tr>
<td></td>
<td>- Earth fault</td>
</tr>
<tr>
<td></td>
<td>- Instantaneous over current</td>
</tr>
<tr>
<td></td>
<td>- Transformer fault, If applicable</td>
</tr>
<tr>
<td></td>
<td>- Cooling fan failure</td>
</tr>
<tr>
<td></td>
<td>- Stall monitor for motor alarms</td>
</tr>
<tr>
<td></td>
<td>- Controlled shut down, when properly fused, with no component failure in the event of an output phase to phase or phase to ground short circuit and annunciation of the fault condition.</td>
</tr>
</tbody>
</table>

### Annunciations

<table>
<thead>
<tr>
<th>24.0</th>
<th>Following faults shall be annunciated in keypad of the drive / HMI.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- AC line surge suppression network and overvoltage protection.</td>
</tr>
<tr>
<td></td>
<td>- Under voltage in supply network</td>
</tr>
<tr>
<td></td>
<td>- Phase sequence protection and monitoring</td>
</tr>
<tr>
<td></td>
<td>- Under voltage in DC bus</td>
</tr>
<tr>
<td></td>
<td>- Over voltage in DC bus</td>
</tr>
<tr>
<td></td>
<td>- Over speed monitor</td>
</tr>
<tr>
<td></td>
<td>- Over load</td>
</tr>
<tr>
<td></td>
<td>- Earth fault</td>
</tr>
</tbody>
</table>
### 25.0 Meters

- Output voltmeter and ammeter with selector switches.
- Input volt meter and ammeter with selector switches.
- Output frequency meter (digital type).
- KW meter for drive ratings above 200 KW.
  All digital display shall be programmable.

### 26.0 Other features

<table>
<thead>
<tr>
<th>26.1 Bus Regulation</th>
<th>DC Bus regulation should be available to reduce the possibility of drive overvoltage trips due to regenerative conditions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.2 Load dependent current limit</td>
<td>Programmable current limit from .1 amps to 150% of drive rated amps. Current limit to be active for all drive states; accelerating, constant speed and decelerating.</td>
</tr>
<tr>
<td>26.3 Dynamic Braking</td>
<td>The drive shall have an internal, built in 7th IGBT for use as a dynamic braking chopper. This IGBT shall have enough capacity to handle greater than or equal to 100% regeneration power from the output, continuously. The drive shall also have a “drive mounted” dynamic braking resistor for low level braking applications and interactive software to protect the “internally” mounted resistor from abuse.</td>
</tr>
<tr>
<td>26.4 Fault Memory</td>
<td>16 nos. of faults to be stored on FIFO basis for fault analysis.</td>
</tr>
<tr>
<td>26.5 Ride Through</td>
<td>The control logic should be capable of &quot;riding through&quot; a power outage of at least 0.5 seconds in duration. The inverter section should be shut off after an 18% drop in bus voltage to conserve power for the drive logic.</td>
</tr>
</tbody>
</table>
| 27.0 Selector switches | - Local / Remote.  
- Auto / Manual.  
- Main / Bypass.  
  All the selector switches shall be of 10 A rating. |
| 28.0 Pushbuttons | - Trip reset.  
- Start. |
## 29.0 Lamps
- Emergency stop.
- Drive ready.
- Drive trip.
- R, Y, B phase power ON.
- Control supply ON.

All the lamps shall be of cluster LED type having low voltage glow protection.

## 30.0 Regulation & control facilities
- Reference speed setter
- Ramp generator
- Speed feed back
- Current feed back
- Flying start
- Trigger module
- Pulse transformers
- Logic control module
- Sequence module
- PID control
- Zero speed / over speed monitor as applicable
- Momentary power loss restart.
- Auto tuning.
- Current limiter
- Skip Frequency
- Counter current / regenerative braking unit as applicable
- Active electronic components used shall be of industrial grade hermetically sealed.
- Output signals for fault alarm, frequency arrival, running signal.

## 32.0 Remote control facilities
- Shall have transducer to monitor the outputs like motor speed at remote place / HMI.
- Facility to accept speed reference from HMI / engineering station.

## 33.0 Auto / Manual Mode
- The HIM should utilize the ALT function key to transfer the drive from Automatic mode to Manual mode and back.
- When in Auto mode, the drive to receive its frequency command from the programmed source.
- When in Manual mode, control of the frequency command to be transferred to the HIM speed control keys (or potentiometer).
- The user should have the choice of preloading the HIM with the current “auto” frequency reference before transferring control to allow for smooth transitions without speed “jumps”.
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>34.0</strong></td>
<td><strong>Communication Bus</strong></td>
</tr>
<tr>
<td>RS485 (ModBus, ProfiBus-DP, DeviceNet) bus Internally mounted interfaces shall be provided to connect to different buses.</td>
<td></td>
</tr>
<tr>
<td><strong>35.0</strong></td>
<td><strong>Test points</strong></td>
</tr>
<tr>
<td>Two electronic test point parameters should be available to examine data within the drive memory that is not available through other parameters.</td>
<td></td>
</tr>
<tr>
<td><strong>36.0</strong></td>
<td><strong>Operator panel</strong></td>
</tr>
<tr>
<td>Shall be mounted on the front door of the unit. IP 66 protection class. - All adjustments to be made with the door closed. - Status and Power LEDs viewable through the cover - Status LEDs for communications status, including embedded DPI status, adapter health and communications network status, viewable through the cover.</td>
<td></td>
</tr>
<tr>
<td><strong>37.0</strong></td>
<td><strong>Membrane keypad</strong></td>
</tr>
<tr>
<td>- The keypad shall be logically designed for two operating areas with required number of keys. - Local operator control like - local start/stop, - jog forward/reverse. - Programming. Facility to run the drive without HIM shall be provided.</td>
<td></td>
</tr>
<tr>
<td><strong>38.0</strong></td>
<td><strong>LCD display</strong></td>
</tr>
<tr>
<td>- Display shall be black lighted, enabling viewing in extremes of lighting conditions - Display shall be in alphanumeric (in English only) - 21 characters, 7 lines. - All the faults stored in memory shall be displayed by scrolling.</td>
<td></td>
</tr>
<tr>
<td><strong>39.0</strong></td>
<td><strong>Construction features</strong></td>
</tr>
<tr>
<td>- Floor mounted, free standing - Dust and vermin proof - Sheet steel clad - Minimum 2.5 mm thick for panels. - Minimum 2.0 mm thick for doors and side covers. - Suitable to withstand vibrations to be encountered in steel plant application. - Cubicles with illumination lamps, door switches, space heaters and adequate sockets for soldering. - All control blocks plug-in-type with necessary test sockets. - Units shall be self contained and serviceable.</td>
<td></td>
</tr>
<tr>
<td><strong>40.0</strong></td>
<td><strong>Enclosure and ventilation</strong></td>
</tr>
<tr>
<td>- Enclosure conforming to IP-42 or better with weather proof enclosures - Units shall be provided with cooling fans and louvers at the</td>
<td></td>
</tr>
</tbody>
</table>
bottom sides with filters. All louvers shall have fine mesh filter behind them. 
- Ventilation through individual ventilation ducts from bottom not acceptable.
- For larger drives cooling fans of drives shall be powered from different power source.

<table>
<thead>
<tr>
<th>02. AC Line Reactor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 No. of phases</td>
<td>03</td>
</tr>
</tbody>
</table>
| 2.0 Input power supply | - 415 V AC + 10% & -15%
- 3 phase.
- 50 Hz +/− 6%.
- 4 wire neutral earthed system. |
| 3.0 Duty class | T2 as per IEEE-1973 |
| 4.0 Overload | - 125% for 2 hours
- 200% for 10 seconds |
| 5.0 Standard | IS: 5553 (Part-2) |
| 6.0 Insulation class | Class H |
| 7.0 Impedance | 3% / 5% (As per system calculation) |
| 8.0 Maximum temperature rise | 95 Deg. C |
| 9.0 Ambient temperature | 50 deg. C |
| 10.0 Location | Normally in the drive panel (In a separate enclosure in case of large size) |
| 11.0 Execution | IP 21 |
| 12.0 Termination | - Cables
- All termination should be brought out on 6 or 10 mm thick fibre glass strip.
- Terminal description should be engraved on termination strip |
| 13.0 Cooling | AN |
| 14.0 Winding Material | CRGO Si grade steel , Grade 51 or better |
| Construction | Coils should be hot dipped and whole assembly should br dipped in varnish. Clamping stud should be insulated from lamination. |
| 15.0 Rating | Inductance : As per calculation
RMS current rating : As per calculation
Inductance : AS per calculation |
| 16.0 Characteristic | Reactors will be linear upto 200% of rated current. |

03. Load Commutated Inverter (LCI)
| 1.0 | Standard | IEC 146-1-2 |
| 2.0 | Power System Input | 3 Phase AC, +/- 10% of rated voltage |
| 3.0 | Input voltage dip | 30% of rated voltage without tripping |
| 4.0 | Frequency | 50 Hz, +/- 6% |
| 5.0 | Operating environment | 50 deg. C, with 95% RH non condensing |
| 6.0 | Type of motor to be controlled | Synchronous motor |
| 7.0 | Efficiency | More than 99% |
| 8.0 | Isolation transformer | Indoor installation |
| | | - Oil or dry type as per IEC 76-2 |
| | | - Typical winding configuration:
<p>| | | - 6 pulse LCI: Delta-Wye |
| | | - Pulse LCI: Delta-Delta-Wye |
| | | - Taps: 2x2.5% above and below nominal voltage |
| | | - Winding conductor: Copper |
| | | - Insulation class: Class H (In case of dry type) |
| 9.0 | Bridge device | Thyristor |
| 10.0 | Configuration | |
| (i) | Source bridge | AC fed 6 or 12 pulse SCR, regenerative with N+1 devices |
| (ii) | Load bridge | 6 or 12 pulse output configuration with N+1 devices |
| 11.0 | Output speed control range | 10 – 160% of rated speed |
| 12.0 | Overload | 150% overload for 1 minute / every 10 minutes (for CT loads) |
| | | 110% overload for 1 minute / every 10 minutes (for VT loads) |
| 13.0 | Control | Forced commutation below 10% of rated speed |
| | | Load commutated above 10% of rated speed |
| | | Torque regulated |
| | | 4 quadrant speed control |
| | | Volt / Frequency control |
| | | Field excitation control |
| | | Programmable acceleration / deceleration ramps |
| 14.0 | Control accuracy | Without tacho |
| | | With tacho |
| (i) | Speed regulation | 0.1% |
| | | 0.005% |
| (ii) | Max. starting torque | 0.75 PU |
| | | 2.0 PU |
| (iii) | Max. forward speed | 1.0 PU |
| | | 1.0 PU |
| (iv) | Max. reverse speed | 0.5 PU |
| | | 1.0 PU |
| (v) | Constant HP speed range | Base to top |
| | | Base to top |
| (vi) | Constant torque speed range | 0.1 to base |
| | | 1.5 Hz to base |
| 15.0 | Torque reversal principal | DC link voltage reversal by firing of anti parallel thyristors in the bridge |
| | | No contactor is to be provided for the same |
| 16.0 | Protection | Overcurrent |
| | | Overvoltage |
| | | Earthfault |
| | | Over temperature |
| | | Motor bearing and winding temperature measuring and protection |
| 17.0 | Cooling | Water cooled with deionized water |
| | | Redundant cooling pump with automatic control |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>18.0</td>
<td>Auxiliary power supply</td>
</tr>
<tr>
<td>19.0</td>
<td>Reliability</td>
</tr>
<tr>
<td>21.0</td>
<td>Loudness</td>
</tr>
</tbody>
</table>
| 22.0 | I/O | • Standard I/O’s as per manufacturer.  
• In addition to standard I/O’s, a dedicated PLC in the drive panel for sequencing and interlocking of all the hardware interlocks of the LCI. |
| 23.0 | Metering | • Analog meters mounted on drive panels.  
• For remote monitoring required transducers/converters for transmission of signals in HMI. |
| 24.0 | Feedback devices | • Encoder for position feedback  
• Tacho for speed feedback |
| 25.0 | Communication bus | • Profibus / Controlnet / Modbus compatibility.  
In case of making compatible with PLC communication bus, required hardware and software to be provided. |
| 26.0 | Cable entry | • Top or bottom cable entry with no additional cubicle |

**1.02.08 INTELLIGENT TYPE MCC :-**

**A. General**

| 1.0 | Type | Metal clad.  
Non drawout type |
| 2.0 | Construction | Modular construction.  
Fully compartmentalized with metal/insulating material partition. |
| 3.0 | Enclosure class | IP52  
IP 54 for non intelligent MCC’s installed in non airconditioned environment. |
| 4.0 | Type of execution | Single front. |
| 5.0 | Mounting | Floor mounting.  
Free standing with ISMC 75. |
| 6.0 | Installation | Indoor. |

**B. Constructional Features :-**

| 1.0 | Sheet steel |  
Thickness | 2.0 mm for load bearing members.  
1.6 mm for non load bearing members. |
| 2.0 | Cable entry | Incomer :- Bottom cable entry.  
Outgoing :- Bottom cable entry. |
| 3.0 | Design | • Separate cable alley.  
• Extendable at both ends.  
• Rear access through removable rear hinged cover door |
on one side and screwed at other side.
- All the components shall be accessible from front.
- Motor controller shall be flush mounted on the respective door.
- Interchangeable facility of same type of feeder modules
- Each module to have covering at the bottom.
- ACB cubicle door shall close when the ACB is in isolated position.

4.0 Interlocking & protection
- Module door interlocked with main power isolating devices.
- Power circuit isolation device to have pad locking in the OFF position with door closed.

5.0 Operating height
- Minimum: ± 300 mm
- Maximum: ± 2000 mm.

6.0 Gland plate
- Undrilled removable bottom gland plates (3 mm thick)

7.0 Miscellaneous
- Neoprene rubber gasket shall be provided for all the doors, removable covers & between adjacent covers
- Lifting hooks for all the shipping sections
- Doors shall have concealed hinges.

8.0 Labelling
- Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of:
  - 25-50 mm for MCC panel in front and back side of the panel.
  - 5 mm for components and module name plates.
- Danger board on front and rear sides in English, Hindi.

9.0 Earthing
- Two separate earthing terminals will be provided.
- Bolted joints with tooth spring washers for good earth continuity.
- Earth bus to run in all cable alley of the panel.

10. Shipping length
- To be limited to 2.4 M.

11. Limiting dimensions
- Width of MCC: ± 800 mm
- Width of Module: ± 500 mm
- Width of Cable alley: ± 300 mm
- Height of module: ± 400 mm (min)
- Depth of MCC: ± 600 mm, maximum
- However depth of incoming ACB panel will be 1200 mm (minimum).

12. Paint shade
- Shade No. 631 as per IS-5:1992. or RAL 7035

13. Panel space heater
- In each panel with thermostat, MCB.

C. Busbars

(i) Main horizontal & vertical busbars
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0</strong></td>
<td><strong>Arrangement</strong></td>
<td>Three phase &amp; neutral.</td>
</tr>
<tr>
<td><strong>2.0</strong></td>
<td><strong>Material</strong></td>
<td>High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 -1981.</td>
</tr>
</tbody>
</table>
| **3.0** | **Phase Busbar Rating** | Shall be able to carry continuously the connected load (considering diversity factor) plus a 25% margin. Max. current density shall be:
1.0 A/sq.mm for Aluminium
1.5 A/sq.mm for Copper. |
| **4.0** | **Neutral Busbar Rating** | 50% of phase busbar rating |
| **5.0** | **Short circuit rating** | 50 kA for 1 sec. |
| **6.0** | **Busbar configuration** | Red-yellow-blue from front to back or top to bottom or left to right as viewed from front. |
| **7.0** | **Busbar insulation** | Heat shrinkable PVC
R,Y,B coloured sleeves for phases
Black for neutral. |
| **8.0** | **Busbar supporting insulators** | Non-hygroscopic
Flame retarded
Track resistant
High strength
Sheet moulded compound or equivalent polyester fibre glass moulded type. |
| **9.0** | **Max. temp. rise of bus** | Not to exceed 40 deg. C. above ambient of 50 deg.C. |
| **10.** | **Air clearance for bare busbar** | Phase to phase :- 25.4 mm (minimum)
Phase to earth  :- 19.0 mm (minimum) |
| **11.0** | **Joints and tap off points** | Busbar joints and tap off points shall be shrouded and bolted (with cadmium coated bolts with plain and spring washers and locknuts).
Bimetallic connectors for connection between dissimilar metals.
Antioxide grease for all bus connections. |
<p>| <strong>12.0</strong> | <strong>Neutral bus isolation</strong> | Through disconnecting link. |
| <strong>13.0</strong> | <strong>Vertical busbar</strong> | Rear side |
| <em>(ii)</em> | <strong>Earth bus</strong> |   |
| <strong>1.0</strong> | <strong>Material</strong> | GI. |
| <strong>2.0</strong> | <strong>Size</strong> | Minimum 50 x 6 mm with extension at both ends. |
| <em>(iii)</em> | <strong>Control bus</strong> |   |
| <strong>1.0</strong> | <strong>Material</strong> | Copper. |</p>
<table>
<thead>
<tr>
<th>Section</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Size</td>
<td>Minimum 25 x 3 mm</td>
</tr>
<tr>
<td>(iv)</td>
<td>Power supply bus for motor controller (from UPS)</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Voltage</td>
<td>240 V AC, 50 Hz</td>
</tr>
<tr>
<td>1.0</td>
<td>Material</td>
<td>Copper</td>
</tr>
<tr>
<td>2.0</td>
<td>Size</td>
<td>Minimum 25 x 3 mm</td>
</tr>
<tr>
<td>D.</td>
<td>Insulation level</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Rated insulation voltage</td>
<td>1100 V</td>
</tr>
<tr>
<td>2.0</td>
<td>Impulse withstand voltage</td>
<td>4 kV as per IS-13947 (Part I) 1993</td>
</tr>
<tr>
<td>3.0</td>
<td>One minute power frequency withstand voltage</td>
<td>2.5 kV for power circuit &amp; 500 V for control circuit</td>
</tr>
<tr>
<td>E.</td>
<td>Pollution Degree</td>
<td>Pollution Degree 3 As per IS-13947 (Part-1) : 1993 ; unless otherwise stated</td>
</tr>
<tr>
<td>E.</td>
<td>Intelligent Controllers</td>
<td>Modular type</td>
</tr>
<tr>
<td>1.</td>
<td>Type</td>
<td>Contacts from components (breakers, contactors,) shall be hardwired to I/O terminal block of the controller. All the potential transformer PT's, protection CT's (phase CT and neutral CT) shall be hard wired directly to the controller or the controller module shall have built-in CT and PT for protection &amp; metering purpose.</td>
</tr>
<tr>
<td>2.</td>
<td>Wiring</td>
<td>Separate power supply source (240 V AC) from UPS through MCB (for controller only). Separate power supply for (interrogation voltage) from MCC itself.</td>
</tr>
<tr>
<td>3.</td>
<td>Power supply</td>
<td>The controller shall have :- Minimum 12 digital and 4 analog inputs (For increasing the number of I/O's extended module can be added). Minimum 4 relay outputs (240 V AC, 10 A).</td>
</tr>
<tr>
<td>5.</td>
<td>Functions in controller</td>
<td>Protection Control Metering Annunciations</td>
</tr>
<tr>
<td>9.</td>
<td>Fault memory</td>
<td>Faults to be stored in memory on FIFO sequence.</td>
</tr>
<tr>
<td>10.</td>
<td>LED indications</td>
<td>Controller healthy Controller fault</td>
</tr>
</tbody>
</table>
11. Communication
- Each motor controller (motor / feeder) unit shall communicate on the communication bus (Devicenet / Modbus / Profibus) with PLC directly or through Data concentrator / CN2DN converter or any equivalent module / converter.
- The communication protocol (bus) for intelligent MCC and package PLC shall be same for ease of communication.

12. Communication Port
- 2 nos. RS 485 serial port

13. Communication
configuration
- Trunk line configuration (with dual redundancy) in horizontal wireways.
- Dropline configuration (with dual redundancy) in vertical wireways.
- Each Data concentrator / CN2DN converter or equivalent module shall communicate with PLC on higher level communication bus e.g Controlnet / Profibus / Modbus etc.

14. Communication speed
- 9.6 Kbps minimum (100 m distance)

15. No. of nodes (without repeaters)
- Minimum 32 nos.

16. Control
- From 16 character keypad and backlit LCD alphanumeric display provided on the controller.
- From HMI (located in control room).
- The keypad shall have the facility to start and stop the motor through a separate key (touch screen type) or separate PB’s are to be provided for the same on the front door of the module.

17. Software
- All the configuration and monitoring shall be done through inbuilt software.
- All the required software required for operation and communication shall be provided with latest version available.

F. Feeder arrangement

Incomers and Buscoupler

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Isolating Equipment</td>
</tr>
<tr>
<td></td>
<td>3 pole manual ACB</td>
</tr>
<tr>
<td></td>
<td>4 pole manual ACB (for DG source as second Incomer)</td>
</tr>
<tr>
<td></td>
<td>Both the Incomers and Buscoupler shall be drawout type</td>
</tr>
<tr>
<td>2.0</td>
<td>Quantity</td>
</tr>
<tr>
<td></td>
<td>Two incomer</td>
</tr>
<tr>
<td>3.0</td>
<td>Bus coupler</td>
</tr>
<tr>
<td></td>
<td>Required</td>
</tr>
<tr>
<td>4.0</td>
<td>Interlocking</td>
</tr>
<tr>
<td></td>
<td>Required</td>
</tr>
<tr>
<td></td>
<td>Normally only one Incomer shall be ON. After incoming power failure of any Incomer or ACB trips, second Incomer shall be made ON manually.</td>
</tr>
<tr>
<td>5.0</td>
<td>Interlocking type</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>6.0</td>
<td>Indication Lamps</td>
</tr>
<tr>
<td>--------------------------------</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>7.0</td>
<td>Meters and selector switches</td>
</tr>
<tr>
<td>8.0</td>
<td>Current transformer</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------</td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>9.0</td>
<td>Potential transformer</td>
</tr>
<tr>
<td>10.0</td>
<td>Relays (mounted in each ACB)</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**F. Outgoing feeder arrangements**

(i) **Motor Starter feeders**

<p>| 1.0 | Circuit breaker | Three pole MCCB  . |
|--------------------------------|-------------------|
| 2.0 | Power contactor | AC3/AC4 as per requirement . |
|--------------------------------|-------------------|
|                               | 3 pole .          |
|                               | Minimum 32 A at AC-3 duty . |
|                               | Contactor coil rating for 240 V AC . |
|                               | 2NO + 2NC auxiliary contacts . |
|                               | Mechanically interlocked for reversible drives . |
| 3.0 | Auxiliary contactors | Required nos. as per scheme . |
| 4.0 | Control supply isolation device | MCB |
| 5.0 | Test PB | Inside module for testing of power contactor when the module incoming power breaker is OFF |
| 6.0 | Space heater power provision | For motor feeders of 45 KW and above :- |
|--------------------------------|-------------------|
|                               | Through separate MCB and interlock with main power contactor . |
| 7.0 | Ammeter in LCS | Interposing CT shall be provided in the feeder module for |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>motor rating 37 KW and above.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>8.0</strong></td>
<td><strong>9.0</strong></td>
</tr>
<tr>
<td><strong>Thermal overload relay</strong> (for non intelligent MCC’s)</td>
<td><strong>Motor controller</strong></td>
</tr>
<tr>
<td>Electronic type (with indication for motors of rating 37 KW and above)</td>
<td></td>
</tr>
<tr>
<td><strong>A. Protections</strong></td>
<td></td>
</tr>
<tr>
<td>Thermal overload</td>
<td></td>
</tr>
<tr>
<td>Adjustable overload prealarm</td>
<td></td>
</tr>
<tr>
<td>Earth fault</td>
<td></td>
</tr>
<tr>
<td>Stalling</td>
<td></td>
</tr>
<tr>
<td>Unbalance</td>
<td></td>
</tr>
<tr>
<td>Short circuit</td>
<td></td>
</tr>
<tr>
<td>Single phase prevention</td>
<td></td>
</tr>
<tr>
<td>Under current</td>
<td></td>
</tr>
<tr>
<td>Too many starts</td>
<td></td>
</tr>
<tr>
<td>Under voltage</td>
<td></td>
</tr>
<tr>
<td>Under voltage lockout</td>
<td></td>
</tr>
<tr>
<td>Breaker or contactor failure alarm</td>
<td></td>
</tr>
<tr>
<td>Trip failure alarm</td>
<td></td>
</tr>
<tr>
<td>Over temperature</td>
<td></td>
</tr>
<tr>
<td>Winding and bearing temperature (for motor of rating 160 KW and above).</td>
<td></td>
</tr>
<tr>
<td><strong>B. Display data</strong></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td>Power factors</td>
<td></td>
</tr>
<tr>
<td>Power consumption , KW</td>
<td></td>
</tr>
<tr>
<td>Thermal capacity</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td>Phase and average Amp.</td>
<td></td>
</tr>
<tr>
<td>Earth fault current</td>
<td></td>
</tr>
<tr>
<td>% motor load</td>
<td></td>
</tr>
<tr>
<td>% unbalance</td>
<td></td>
</tr>
<tr>
<td>Peak current during starting</td>
<td></td>
</tr>
<tr>
<td>Starting time</td>
<td></td>
</tr>
<tr>
<td>Pre trip values</td>
<td></td>
</tr>
<tr>
<td><strong>C. Fault / alarm history description</strong></td>
<td></td>
</tr>
<tr>
<td>No. of trips</td>
<td></td>
</tr>
<tr>
<td>No. of operations ( Forward / reverse)</td>
<td></td>
</tr>
<tr>
<td>Hours run</td>
<td></td>
</tr>
<tr>
<td>Hours run last start</td>
<td></td>
</tr>
<tr>
<td>Kilowatt hours</td>
<td></td>
</tr>
<tr>
<td>Kilowatt peak demand</td>
<td></td>
</tr>
<tr>
<td>Alarm / trip history (with date and time)</td>
<td></td>
</tr>
</tbody>
</table>
### Alarm / trip description
- Reference start curve (in graphics)
- Start curve (in graphics)
- Time to trip / reset

### Power supply feeders

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Circuit breaker</td>
<td>Three pole MCCB. Three pole ACB (for rating above 630 A)</td>
</tr>
<tr>
<td>2.0 Indications</td>
<td>ON/OFF/TRIP indication lamp.</td>
</tr>
<tr>
<td>3.0 Earth fault protection</td>
<td>Required</td>
</tr>
</tbody>
</table>

### Panel wiring

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Power / current transformer circuit</td>
<td>1.1kV grade single core, black colour PVC insulated, stranded copper conductor of minimum size 2.5 sq.mm. For feeder rating 100A and above all the power circuit shall be through rigid busbar.</td>
</tr>
<tr>
<td>2.0 Control and potential circuit</td>
<td>1.1kV grade single core Black colour PVC insulated Stranded copper conductor of minimum size 1.5 sq.mm.</td>
</tr>
<tr>
<td>3.0 Ferrules</td>
<td>Numbered plastic/ceramic ferrules. Self locking type.</td>
</tr>
<tr>
<td>4.0 Marking</td>
<td>Wiring will be properly marked as per relevant IS.</td>
</tr>
<tr>
<td>5.0 Spare contacts</td>
<td>All spare contacts of relays selector switches &amp; contactors will be wired upto the terminal block. Each component shall have at least one potential free spare contact.</td>
</tr>
<tr>
<td>6.0 Terminals</td>
<td>- Power &amp; control terminals shall be segregated by insulating material like hylam/bakelite sheet. - Power terminals will be stud type. - Control terminals will be ELMEX type suitable for connecting two cores of 2.5 sq.mm wires. - Minimum 20 % spare terminals will be provided. - The minimum rating of control terminal shall be 10 Amps. - Color coded wires, TB’s of different voltage rating to be provided. - Uniform color-coding to be followed for cabling, TB, etc.</td>
</tr>
<tr>
<td>7.0 Cable glands</td>
<td>Double compression cable glands for receiving external power and control cables</td>
</tr>
</tbody>
</table>

### Control Supply

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Control transformer</td>
<td>1 nos. of 415V/240V control transformer of minimum 2.5 KVA in each section. Secondary unearthed.</td>
</tr>
</tbody>
</table>
### 2.0 Input and output side isolation device

<table>
<thead>
<tr>
<th>Input side</th>
<th>MCCB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output side</td>
<td>MCB</td>
</tr>
</tbody>
</table>

### 3.0 Control supply changeover system

Control supply auto and manual changeover through contactor logic and through selector switch respectively (Sel.sw. shall have a contact rating of 25 A at 240 V AC)

---

#### 1.02.09 STAND ALONE STARTER

**A. General** :-

| 1.0 Type | - Metal clad .  
| - Non drawout type. |
| 2.0 Construction | - Modular construction .  
| - Fully compartmentalized with metal / insulating material partition. |
| 3.0 Enclosure class | IP52. |
| 4.0 Type of execution | Single front. |

### B. Constructional Features :-

| 1.0 Material | CRCA |
| 2.0 Cable entry | - Incomer :- Bottom cable entry.  
| - Outgoing :- Bottom cable entry. |
| 3.0 Design | - Rear access through removable rear hinged cover door.  
| - All the components shall be accessible from front . |
| 4.0 Interlocking & protection | - Module door interlocked with main power isolating devices.  
| - Power circuit isolation device to have pad locking in the OFF position with door closed. |
| 5.0 Operating height | - Minimum :- 300mm  
| - Maximum :- 2000 mm. |
| 6.0 Gland plate | Undrilled removable bottom gland plates (3 mm thick) |
| 7.0 Miscellaneous | - Neoprene rubber gasket shall be provided for all the doors , removable covers & between adjacent covers .  
| - Lifting hooks for the panel .  
| - Doors shall have concealed hinges . |
| 8.0 Labelling | Clear legible identification labels (anodized aluminium with white letters engraved on black background ) with letter sizes of :-  
| - 25-50 mm for panel .  
| - 5 mm for components and module name plates .  
| - Danger board on front and rear sides in English , Hindi and local language . |
| 9.0 Earthing | Two separate earthing terminals will be provided.  
<p>| - Bolted joints with tooth spring washers for good earth continuity . |
| 10.0 Paint shade | Shade No. 631 as per IS-5:1992 equiv to RAL 7035 . |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11.0</td>
<td>Panel space heater</td>
<td>In each panel with thermostat, MCB.</td>
</tr>
<tr>
<td><strong>C. Busbars</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Arrangement</td>
<td>Three phase &amp; neutral.</td>
</tr>
<tr>
<td>2.0</td>
<td>Material</td>
<td>High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 –1981.</td>
</tr>
</tbody>
</table>
| 3.0 | Phase Busbar Rating | - Shall be able to carry continuously the connected load (considering all derating factors) plus a 25% margin.  
- Max. current density shall be  
  - 1.0 A/sq.mm for Aluminium  
  - 1.5 A/sq.mm for Copper. |
| 4.0 | Neutral Busbar Rating | 50% of phase busbar rating |
| 5.0 | Short circuit rating | 50 KA for 1 sec. |
| 6.0 | Busbar configuration | Red-yellow-blue from front to back or top to bottom or left to right as viewed from front. |
| 7.0 | Busbar insulation | Heat shrinkable PVC  
- R,Y,B coloured sleeves for phases  
- Black for neutral. |
| 8.0 | Busbar supporting insulators | Non-hygroscopic  
- Flame retarded  
- Track resistant  
- High strength  
- Sheet moulded compound or equivalent polyster fibre glass moulded type. |
| 9.0 | Max. temp. rise of bus | Not to exceed 35 deg. C. above ambient of 50 deg.C. |
| 10.0 | Air clearance for bare busbar | Phase to phase :- 25.4 mm (minimum)  
Phase to earth :- 19.0 mm (minimum) |
| 11.0 | Joints and tap off points | Busbar joints and tap off points shall be shrouded and bolted (with cadmium coated bolts with plain and spring washers and locknuts).  
- Bimetallic connectors for connection between dissimilar metals.  
- Antioxide grease for all bus connections. |
<p>| 12.0 | Neutral bus isolation | Through disconnecting link. |
| 13.0 | Busbar access | Rear side |
| (ii) | Earth bus |   |
| 1.0 | Material | GI. |
| 2.0 | Size | Minimum 50 x 6 mm with extension at both ends. |
| (iii) | Control bus |   |
| 1.0 | Material | Copper. |
| 2.0 | Size | Minimum 25 x 3 mm. |
| <strong>D. Insulation level</strong> |   |   |
| 1.0 | Rated insulation voltage | 1100 V |
| 2.0 | Impulse withstand voltage | 4 KV as per IS-13947 (Part I) 1993 |
| 3.0 | One minute power frequency withstand voltage | 2.5 KV for power circuit &amp; 500 V for control circuit |
| <strong>E. Pollution Degree</strong> |   |   |</p>
<table>
<thead>
<tr>
<th></th>
<th>Pollutant Degree</th>
<th>Pollution Degree 3 as per IS-13947 (Part-1) : 1993 ; unless otherwise stated</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. Components</td>
<td>Isolating Equipment</td>
<td>3 pole MCCB (upto 630A)</td>
</tr>
<tr>
<td>1.0</td>
<td>Indication Lamps</td>
<td>LED type indicating lamps for :-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- MCCB ON/OFF/TRIP.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Power ON R / Y / B .</td>
</tr>
<tr>
<td>3.0</td>
<td>Meters and selector switches</td>
<td>- 96 sq.mm size voltmeter with 7 position selector switches</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 96 sq.mm size ammeter with 4 position selector switches</td>
</tr>
<tr>
<td>4.0</td>
<td>Power contactor</td>
<td>AC3 duty of rated capacity .</td>
</tr>
<tr>
<td>5.0</td>
<td>Intelligent motor controller</td>
<td>As defined in clause no. 1.02.08 .</td>
</tr>
<tr>
<td>6.0</td>
<td>Motor protection relay (for non intelligent panel)</td>
<td>- Microprocessor based.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Suitable for 5A &amp; 1A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Protections</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Short circuit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Overload</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Earth fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Stalling protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Undervoltage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Overspeed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- No.of starts per hour (cold &amp; hot)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Communication facility with PLC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Memory for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Storing fault history &amp; trending</td>
</tr>
<tr>
<td>7.0</td>
<td>Auxiliary contactors</td>
<td>Shall be provided for logic operation and operating sequence .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shall have minimum 2NO+2NC auxiliary contacts.</td>
</tr>
<tr>
<td>G. Panel Wiring</td>
<td>Power / current transformer circuit</td>
<td>1.1Kv grade single core , black colour PVC insulated , stranded copper conductor of minimum size 2.5 sq.mm.</td>
</tr>
<tr>
<td>1.0</td>
<td>Power / current transformer circuit</td>
<td>1.1Kv grade single core , black colour PVC insulated , stranded copper conductor of minimum size 2.5 sq.mm.</td>
</tr>
<tr>
<td>2.0</td>
<td>Control and potential circuit</td>
<td>1.1Kv grade single core</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Black colour PVC insulated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Stranded copper conductor of minimum size 1.5 sq.mm.</td>
</tr>
<tr>
<td>3.0</td>
<td>Ferrules</td>
<td>Numbered plastic/ceramic ferrules .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self locking type .</td>
</tr>
<tr>
<td>4.0</td>
<td>Marking</td>
<td>Wiring will be properly marked as per relevant IS.</td>
</tr>
<tr>
<td>5.0</td>
<td>Spare contacts</td>
<td>All spare contacts of relays selector switches &amp; contactors will be wired upto the terminal block .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Each components shall have at least one potential free spare contacts.</td>
</tr>
<tr>
<td>6.0</td>
<td>Terminals</td>
<td>Power &amp; control terminals shall be segregated by insulating material like hylam / bakelite sheet .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power terminals shall be stud type .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control terminals shall be suitable for connecting two cores</td>
</tr>
</tbody>
</table>
of 2.5 sq.mm wires.
- Minimum 20 % spare terminals shall be provided.
- The minimum rating of control terminal shall be 10 Amps.
- Color coded wires, TB's of different voltage rating to be provided .
- Uniform color-coding to be followed for cabling, TB, etc.

7.0 Cable glands
- Double compression cable glands for receiving external power and control cables

I. Control Supply

| 1.0 | Control transformer | 1 nos. of 415V/240V control transformer of minimum 2.5 KVA Secondary unearthed. |
| 2.0 | Input and output side isolation device | Input side :- MCB, Output side :- MCB |

1.02.10 SOFT STARTER :-

A. Design Criteria:-

| 1.0 | Incoming supply voltage | 415 V + 10 % & -15% , 50 Hz. +/- 6 %, 3 phase |
| 2.0 | Control Supply | 240 V AC through control transformer. However there shall be provision of control supply of 110V/240 V AC through shorting links in control supply power terminal blocks |
| 3.0 | Output | Full wave in line control |
| 4.0 | Device | IGCT/IGBT/ /Fast acting switching semi conductor device. |
| 5.0 | Acceleration | Stepless |
| 6.0 | Pump control | Starting :- 2 – 30 seconds, Stopping :- 2 – 120 seconds |
| 7.0 | Adjustable current limit | 500 % of In |
| 8.0 | Adjustments | - Dwell time at current limit with ramp continuation after acceleration . - Acceleration time adjustable current limit - Minimum voltage adjustment - Voltage stability adjustment. - Initial torque ramp time adjustment . - Kick start |
| 9.0 | Overload tripping range | 100 – 130 % (as per manufacturer’s characteristic curve) |
| 10.0 | Overload capacity | Continuous :- 115 %, 60 seconds :- 250 %, 30 seconds :- 300 %, 05 seconds :- 450% |
| 11.0 | Other features | - Shall have facility to run in energy saving mode during light load operation of the drive |
- Shall have bypass mode. Motor can run in bypass mode in DOL.
- Soft starter mode or bypass mode can be selected through selector switch mounted on front side of the panel.
- In auto mode, soft starter shall start/stop after getting command from PLC.
- Shall have the facility of kickstart.
- Shall be able to communicate to PLC on dual redundant communication bus. Accordingly suitable cards/modules shall be mounted.

<table>
<thead>
<tr>
<th></th>
<th><strong>12.0 Protections</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short circuit</td>
</tr>
<tr>
<td></td>
<td>Overload</td>
</tr>
<tr>
<td></td>
<td>Under voltage protection</td>
</tr>
<tr>
<td></td>
<td>Current monitoring in each phases</td>
</tr>
<tr>
<td></td>
<td>Transient voltage suppressor (MOV)</td>
</tr>
<tr>
<td></td>
<td>Heat sink overtemperature protection</td>
</tr>
<tr>
<td></td>
<td>Over temperature switches on each pole.</td>
</tr>
<tr>
<td></td>
<td>RC Snubber ckt.</td>
</tr>
<tr>
<td></td>
<td>Semiconductor fuse to be provided before the soft starter controller.</td>
</tr>
<tr>
<td></td>
<td>Single phase protection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>13.0 LED Indications</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Power ON (green)</td>
</tr>
<tr>
<td></td>
<td>RUN (amber)</td>
</tr>
<tr>
<td></td>
<td>Fault (red)</td>
</tr>
<tr>
<td></td>
<td>O/C trip (red)</td>
</tr>
<tr>
<td></td>
<td>Phase loss trip (red)</td>
</tr>
<tr>
<td></td>
<td>Auxiliary trip (red)</td>
</tr>
</tbody>
</table>

**B. General :-**

<table>
<thead>
<tr>
<th></th>
<th><strong>1.0 Type</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Metal clad.</td>
</tr>
<tr>
<td></td>
<td>Non drawout type.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>2.0 Construction</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Modular construction.</td>
</tr>
<tr>
<td></td>
<td>Fully compartmentalized with metal / insulating material partition.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>3.0 Enclosure class</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IP52</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>4.0 Type of execution</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single front.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>5.0 Mounting</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Floor mounting.</td>
</tr>
<tr>
<td></td>
<td>Free standing with ISMC 75.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>6.0 Installation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indoor.</td>
</tr>
</tbody>
</table>

**C. Constructional Features :-**

|   | **1.0 Sheet steel** |
| Thickness          | - 2 mm for load bearing members.  
|                   | - 1.6 mm for non load bearing members.  
| Material          | CRCA  
| 2.0 Cable entry   | - Incomer :- Bottom cable entry.  
|                   | - Outgoing :- Bottom cable entry.  
| 3.0 Design        | - Rear access through removable rear hinged cover door.  
|                   | - All the components shall be accessible from front  
| 4.0 Interlocking & protection | - Module door interlocked with main power isolating devices.  
|                   | - Power circuit isolation device to have pad locking in the OFF position with door closed.  
| 5.0 Operating height | - Minimum :- 300mm  
|                   | - Maximum :- 2000 mm.  
| 6.0 Gland plate   | Undrilled removable bottom gland plates (3 mm thick)  
| 7.0 Miscellaneous | - Neoprene rubber gasket shall be provided for all the doors, removable covers & between adjacent covers.  
|                   | - Lifting hooks for the panel.  
|                   | - Doors shall have concealed hinges.  
| 8.0 Labelling     | - Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of :-  
|                   | 25-50 mm for panel.  
|                   | - 5 mm for components and module name plates.  
|                   | - Danger board on front and rear sides in English, Hindi and local language.  
| 9.0 Earthing      | - Two separate earthing terminals will be provided.  
|                   | - Bolted joints with tooth spring washers for good earth continuity.  
| 10.0 Paint shade  | Shade No. 631 as per IS-5:1992./ RAL 7035  
| 11.0 Panel space heater | In each panel with thermostat, fuse, switch.  

### D. Busbars

| 1.0 Arrangement | Three phase & neutral.  
| 2.0 Material    | High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 –1981.  
| 3.0 Phase Busbar Rating | Shall be able to carry continuously the connected load (considering all derating factors) plus a 25% margin.  
<p>|                   | Max. current density shall be |</p>
<table>
<thead>
<tr>
<th><strong>1.0</strong></th>
<th><strong>Busbar configuration</strong></th>
<th><strong>4.0</strong> Neutral Busbar Rating</th>
<th><strong>5.0</strong> Short circuit rating</th>
<th><strong>6.0</strong> Busbar configuration</th>
<th><strong>7.0</strong> Busbar insulation</th>
<th><strong>8.0</strong> Busbar supporting insulators</th>
<th><strong>9.0</strong> Max. temp. rise of bus</th>
<th><strong>10.0</strong> Air clearance for bare busbar</th>
<th><strong>11.0</strong> Joints and tap off points</th>
<th><strong>12.0</strong> Neutral bus isolation</th>
<th><strong>13.0</strong> Busbar access</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0 A/sq.mm for Aluminium</td>
<td>1.5 A/sq.mm for Copper .</td>
<td>50 % of phase busbar rating</td>
<td>Red-yellow-blue from front to back or top to bottom or left to right as viewed from front.</td>
<td>Heat shrinkable PVC R,Y,B coloured sleeves for phases Black for neutral.</td>
<td>Non-hygroscopic Flame retarded Track resistant High strength Sheet moulded compound or equivalent polyster fibre glass moulded type .</td>
<td>Not to exceed 35 deg. C. above ambient of 50 deg.C.</td>
<td>Phase to phase :- 25.4 mm (minimum) Phase to earth :- 19.0 mm (minimum)</td>
<td>Busbar joints and tap off points shall be shrouded and bolted ( with cadmium coated bolts with plain and spring washers and locknuts). Bimetallic connectors for connection between dissimilar metals . Antioxide grease for all bus connections .</td>
<td>Through disconnecting link .</td>
<td>Rear side</td>
</tr>
<tr>
<td><strong>(ii)</strong></td>
<td><strong>Earth bus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>1.0</strong> Material</td>
<td>GI.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>2.0</strong> Size</td>
<td>Minimum 50 x 6 mm with extension at both ends .</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>(iii)</strong></td>
<td><strong>Control bus</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>1.0</strong> Material</td>
<td>Copper.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td><strong>2.0</strong> Size</td>
<td>Minimum 25 x 3 mm</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td><strong>E.</strong></td>
<td><strong>Insulation level</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>1.0</strong> Rated insulation voltage</td>
<td>1100 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>2.0</strong> Impulse withstand voltage</td>
<td>4 Kv as per IS-13947 (Part I) 1993</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>3.0</strong> One minute power frequency withstand voltage</td>
<td>2.5 Kv for power circuit &amp; 500 V for control circuit</td>
<td></td>
<td></td>
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<tr>
<td><strong>F.</strong></td>
<td><strong>Pollution Degree</strong></td>
<td></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td><strong>1.0</strong> Pollution Degree</td>
<td>Pollution Degree 3</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tbody>
</table>
## G. Components

<table>
<thead>
<tr>
<th></th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Isolating Equipment</td>
</tr>
</tbody>
</table>
| 2.0 | Indication Lamps                                                                               | LED type indicating lamps for: ACB ON/OFF/TRIP.  
     |                                                                                               | Incoming power R / Y / B.  
     |                                                                                               | Auto / Remote / Local.  
     |                                                                                               | Soft starter mode / bypass mode.  
     |                                                                                               | Motor ON / OFF / TRIP. |
| 3.0 | Meters and selector switches                                                                   | 96 sq.mm size voltmeter with 7 position selector switches  
     |                                                                                               | 96 sq.mm size ammeter with 4 position selector switches |
| 4.0 | Power Contactor                                                                                 | AC3 duty of rated capacity. |
| 5.0 | Thermal overload relay                                                                          | Electronic type  
     |                                                                                               | CT operated  
     |                                                                                               | Shall be connected in bypass mode. |
| 6.0 | Auxiliary Contactors                                                                            | Shall be provided for logic operation and operating sequence.  
     |                                                                                               | Shall have minimum 2NO+2NC auxiliary contacts suitable for 5A DC. |
| 7.0 | Door mounted operating devices                                                                  | Start / stop operating PB.  
     |                                                                                               | Reset PB.  
     |                                                                                               | Selector switches: Auto / Remote / Local.  
     |                                                                                               | Soft starter mode / bypass mode. |

## H. Panel Wiring

<table>
<thead>
<tr>
<th></th>
<th>Panel Wiring</th>
</tr>
</thead>
</table>
| 1.0 | Power / current transformer circuit                                                             | 1.1Kv grade single core, black colour PVC insulated  
     |                                                                                               | stranded copper conductor of minimum size 2.5 sq.mm. |
| 2.0 | Control and potential circuit                                                                  | 1.1Kv grade single core  
     |                                                                                               | Black colour PVC insulated  
     |                                                                                               | Stranded copper conductor of minimum size 1.5 sq.mm. |
| 3.0 | Ferrules                                                                                        | Numbered plastic/ceramic ferrules.  
     |                                                                                               | Self locking type. |
| 4.0 | Marking                                                                                         | Wiring will be properly marked as per relevant IS. |
| 5.0 | Spare contacts                                                                                  | All spare contacts of relays selector switches & contactors will be wired upto the terminal block.  
     |                                                                                               | Each component shall have at least one potential |
| 6.0 | Terminals | Power & control terminals shall be segregated by insulating material like hylam / bakelite sheet. All control field wiring terminals shall be front access. Power terminals shall be stud type. Control terminals shall be suitable for connecting two cores of 2.5 sq.mm wires. Minimum 20 % spare terminals will be provided. The minimum rating of control terminal shall be 10 Amps. Color coded wires, TB’s of different voltage rating to be provided. Uniform color-coding to be followed for cabling, TB, etc. |
| 7.0 | Cable glands | Double compression cable glands for receiving external power and control cables |

### I. Control Supply

| 1.0 | Control transformer | 1 nos. of 415V/240 V control transformer of minimum 2.5 KVA. Secondary unearthed. |
| 2.0 | Input and output side isolation device | Input side :- MCB  
Output side :- MCB |

#### 1.02.11 Specifications of major components

**01. MOULDED CASE CIRCUIT BREAKER (MCCB)**

| 1.0 | Reference standard | IS : 13947 (Part-2) : 1993 |
| 2.0 | Rated Current | As specified in SLD |
| 3.0 | MCCB for motor feeders | MCCBs for motor feeders shall be motor protection type conforming to type-2 co-ordination. (MCCB without overload not available. EOCR is being used) |
| 4.0 | Short circuit rating | 50 kA (Minimum) (Ics =Icu). |
| 5.0 | Service Short circuit breaking capacity (Ics) | 100% of rated ultimate short circuit breaking capacity (Icu) |
| 6.0 | Operating handle | Yes |
| 7.0 | Safety Door interlock | Door interlock |
### STEEL AUTHORITY OF INDIA LIMITED

**BHILAI STEEL PLANT**

**GENERAL TECHNICAL SPECIFICATION**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>Withstand capability</td>
</tr>
<tr>
<td></td>
<td>Rated short time withstand current (Icw) will be 12 times maximum rated operational current for 1 sec.</td>
</tr>
<tr>
<td>9.0</td>
<td>Utilisation category</td>
</tr>
<tr>
<td></td>
<td>AC23B</td>
</tr>
<tr>
<td>10.0</td>
<td>Electrical features</td>
</tr>
<tr>
<td></td>
<td>- S/C, O/C, E/F protection for power supply feeders &amp; crane trolley line feeder MCCB’s.</td>
</tr>
<tr>
<td></td>
<td>- Features to minimise the let-through energy (I²t) in the event of short circuit on load side.</td>
</tr>
<tr>
<td></td>
<td>- Complete with continuous electronic / microprocessor based adjustable thermal and magnetic releases.</td>
</tr>
<tr>
<td></td>
<td>- MCCB’s for motor feeders shall be of motor duty class with magnetic trip only. Overload protection shall be through electronic overload relays.</td>
</tr>
<tr>
<td>11.0</td>
<td>Auxiliary contacts</td>
</tr>
<tr>
<td></td>
<td>1 NO + 1 NC</td>
</tr>
<tr>
<td></td>
<td>Alarm contacts.</td>
</tr>
<tr>
<td>12.0</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td></td>
<td>Can be used in load side or line side vice versa.</td>
</tr>
<tr>
<td></td>
<td>Shunt trip coil.</td>
</tr>
</tbody>
</table>

### 02. AC CONTACTORS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Service</td>
</tr>
<tr>
<td></td>
<td>Indoor within steel cubicle for maximum system voltage, starting of motors and miscellaneous loads</td>
</tr>
<tr>
<td>2.0</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>Shall conform to IS / IPSS</td>
</tr>
<tr>
<td>3.0</td>
<td>No. poles</td>
</tr>
<tr>
<td></td>
<td>3 pole air break.</td>
</tr>
<tr>
<td>4.0</td>
<td>Operating type</td>
</tr>
<tr>
<td></td>
<td>Magnetic coil operated at 240 V AC.</td>
</tr>
<tr>
<td></td>
<td>No economy resistors.</td>
</tr>
<tr>
<td></td>
<td>Insulation for coils shall be class ‘E’ or better</td>
</tr>
<tr>
<td>5.0</td>
<td>Rating</td>
</tr>
<tr>
<td></td>
<td>32A (Minimum), Rated for 125% of full load motor rated current for DOL motor feeders and 150% of motor rated current for RDOL motor feeders.</td>
</tr>
<tr>
<td>6.0</td>
<td>Interrupting capacity</td>
</tr>
<tr>
<td></td>
<td>Ten times the rated current for rated size upto 100A and eight times the rated current for larger sizes.</td>
</tr>
<tr>
<td>7.0</td>
<td>Duty</td>
</tr>
<tr>
<td></td>
<td>According to IEC 158-1</td>
</tr>
<tr>
<td></td>
<td>- AC 1 duty: Non inductive or slightly inductive loads.</td>
</tr>
<tr>
<td></td>
<td>- AC 2 duty: Slip ring motors: starting, plugging</td>
</tr>
<tr>
<td></td>
<td>- AC 3 duty: Squirrel cage motors: starting, switching off motors during running</td>
</tr>
<tr>
<td></td>
<td>- AC4 duty: Squirrel cage motors: Plugging, inching.</td>
</tr>
<tr>
<td></td>
<td>Derated AC4 ratings shall be selected for inching and plugging operation of the drive (crane duty).</td>
</tr>
</tbody>
</table>
### Utilisation category

| 8.0 | Utilisation category | AC23A for unidirectional motors AC24A for bi-directional motors |

### Aux. contact requirement

| 9.0 | Aux. contact requirement | Minimum 4 NO +4 NC contacts with minimum rating of 10A, 415 V. 2A, 220 V for rated duty DC-11. Shall have the facility of adding add-on contact blocks. |

### Closing (pick-up)

| 10.0 | Closing (pick-up) | 85% to 110% |

### Dropout

| 11.0 | Dropout | Will not be higher than 75% and lower than 40% of rated control supply voltage |

### Miscellaneous

| 12.0 | Miscellaneous | For RDOL feeders the power contactors shall be mechanically interlocked. |

---

### Current transformers:

| 03. | Current transformers: |

| 1.0 | Type | Bar type primaries and 5A (max) secondary with thermal and dynamic ratings corresponding to the units with which they are used. |

| 2.0 | Accuracy class | Measuring CT accuracy class 1.0. Protective CT accuracy class 10 P 10. |

---

### Control transformers:

| 04. | Control transformers: |

| 1.0 | Type | Dry type, cast resin |

| 2.0 | Voltage | 415V/240V |

| 3.0 | Primary taps | +2.5%, +5% |

---

### Indicating instruments:

| 05. | Indicating instruments: |

| 1.0 | Basic details | Shall not damage by passage of fault current or existence of over voltage for the maximum permitted duration of fault conditions. Ammeters for drives above 30 kW shall be CT operated. Voltmeters protected by fuses placed as close to the busbar as possible. Maximum reading 600% of IFL for motor feeders. |

| 2.0 | Mounting | Flush mounting, square dial with zero adjusting device for external operation. |

| 3.0 | Accuracy class | 1.5 |

| 4.0 | Size | Size of voltmeter and ammeter for incomer 144 x 144 mm |
for incoming feeders.
- Size of ammeter for motor feeders 96 x 96 mm.

06. Thermal Overload Relays .

<table>
<thead>
<tr>
<th>1.0</th>
<th>Standard</th>
<th>IEC:292-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Basic details</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electronic type (with indication for 37 KW motors and above)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Triple pole</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ambient temperature compensated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Inverse time lag.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hand reset type.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Bimetallic with adjustable setting and builtin single phase protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reset PB shall be operable from outside</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Shall be able to withstand prospective short circuit current without damage or injurious heating till the motor protection MCCB clears the fault</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Auto tripping shall be indicated on MCC</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.0</th>
<th>Contacts</th>
<th>1 NO + 1 NC contacts with minimum rating of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>- 10A, 415 V for rated duty AC-11.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 2A, 220 V for rated duty DC-11.</td>
</tr>
</tbody>
</table>

07. Magnetic Overload Relays .

<table>
<thead>
<tr>
<th>1.0</th>
<th>Standard</th>
<th>IEC:292-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Basic details</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Triple pole</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ambient temperature compensated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Adjustable time lag feature or of instantaneous type.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Provided with a latch and hand reset feature or auto reset with flag indication</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Adjustable current setting and time delay calibrated between nominal current and twice nominal current rating</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.0</th>
<th>Contacts</th>
<th>1 NO + 1 NC contacts with minimum rating of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>- 10A, 415 V for rated duty AC-11.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 2A, 220 V for rated duty DC-11.</td>
</tr>
</tbody>
</table>

08. Push Buttons

<table>
<thead>
<tr>
<th>1.0</th>
<th>Standard</th>
<th>IEC 60947</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Basic details</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- All push button switches including illuminated push buttons shall be of sturdy design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Un-shrouded actuator for &quot;START&quot; application, Mushroom</td>
<td></td>
</tr>
</tbody>
</table>
actuator for "EMERGENCY STOP" application and key "STOP" application for "LOCK-OUT" application shall be provided.
- Mushroom actuator for Emergency Stop shall be latched type.
- Press to latch in operated position and turn-to-release in unactuated position.
- Double break parallel contact design or other suitable design feature enhancing contact reliability required in circuits with electronic interfaces involving low voltages and small currents shall be adopted.

3.0 Size
- 22.4 mm diameter

4.0 Contact rating
- Minimum 2 NO + 2NC contacts with following current ratings:
  - Continuous: 10 A
  - AC 11: 1.5 amps at 240V
  - DC 11: 0.5 amps at 110 V DC, L / R - 40 ms
- All contact faces of contacts shall be of silver or silver alloy.
- Facility of adding add on contact blocks to be provided

5.0 Colour
- Accept - Blue
- Test - Yellow
- Reset - Black

6.0 Protection class
- IP 66/67
- The P.B. switches shall be with higher contact reliability, electronics compatibility.

09. Indicating Lamps

1.0 Standard
- IEC 60947

2.0 Type
- LED Cluster type

2.0 Basic details
- Sufficient number of lamp grips shall be provided for easy replacement of lamps.

3.0 Size
- 22.4 mm diameter

4.0 Voltage level
- Suitable for any of the following voltages as per the system requirement:
  - 415V AC / 240V AC / 110V AC / 24V DC / 220V DC
- All indicating lamps shall be suitable for continuous operation at 90 to 100 percent of their rated voltage.

5.0 Colour
- For motor ‘ON’, valve/damper/gate ‘OPEN’, supply ‘ON’, breaker ‘CLOSE’: Red
- Fault indication, over load, alarm condition, ‘SERVICE & TEST POSITION’: Amber
indication.
- General purpose indication, : White
  motor `AUTO TRIP'.
Other colours may be adopted depending upon particular
application as approved by the Purchaser.

<table>
<thead>
<tr>
<th>6.0</th>
<th>Protection class</th>
<th>IP 66/ 67</th>
</tr>
</thead>
</table>
| 7.0 | Layout of indication lamps on boards / panels | • Indicating lamps shall be located just above the associated push-button / control switches.
  • Red lamps shall invariably be located to the right of green lamps.
  • In case a white lamp is also provided, it shall be placed between red and green lamps along the centre line of control switch/ push button pair.
  • Blue and Amber should normally be located above the Red and Green lamps.
  • When associated with push buttons, red lamps shall be directly above the green push button and green lamp shall be directly above the red push button. |
| 8.0 | Legend plates | Anodised aluminium |

10. Miniature Circuit Breakers (MCB)

<table>
<thead>
<tr>
<th>1.0</th>
<th>Type</th>
<th>Heat resistant plastic moulded type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Ref. Standard</td>
<td>IS: 8828 –1978</td>
</tr>
</tbody>
</table>
| 3.0 | Protections | MCB's shall be provided with
  • quick break trip-free mechanism
  • direct acting thermal overload
  • short circuit trip elements. |
| 4.0 | Short circuit capacity | Not less than 9000A at 0.8pf |
| 5.0 | Mounting | • DIN Channel mounting .
  • Single phase MCBs mounted adjacent to each other and connected to different phases will be provided with adequate insulated phase barriers. |
| 6.0 | Current Rating | • The MCBs shall be selected from standard current ratings.(As per SLD)
  • Motor duty MCBs will be provided, if specified.
  • MCB shall be of C curve . |

11. Selector Switches

<table>
<thead>
<tr>
<th>1.0</th>
<th>Standard</th>
<th>IEC 60947</th>
</tr>
</thead>
</table>
| 2.0 | Basic details | - All control selector switches shall be of sturdy design .
  - Shall have modular construction with number of switching contacts for each position operated by a single shaft.
  - Inscription for each position shall be provided.
  - Stay-put or spring return arrangement shall be provided |
as per the circuit and control/operational requirement.
- The contacts shall be designed for higher contact reliability and electronics compatibility involving low voltage and small value of currents.
- The operating handle shall be robust and strong.
- One number of potential free switching contact for each position shall be provided as spare.
- Control switches for circuit breaker ON/OFF control 3 position spring return to neutral with lost motion device and pistol grip handle.
- Other control and selector switches - stay put type with wing type knobs.

| 3.0 | Contacts | 2 NO + 2 NC contacts with minimum rating of |
|     |          | - All the selector switches shall be of 10 A rating |
|     |          | - 25A for sturdy applications |
|     |          | - 1 NO & 1 NC contact / poles shall be potential free for PLC inputs |

### LOCAL CONTROL STATIONS

<p>| 1.0  | Material | Sheet steel (CRCA) 2 mm thick |
| 2.0  | Mounting | Wall / structure mounted |
| 3.0  | Enclosure class | IP-54 (for indoor installation) |
|      |          | IP-55 with canopy (for outdoor installation) |
| 4.0  | Door opening | Hinged type front door opening |
| 5.0  | Cable gland | Removable undrilled |
|      |          | To be provided on both top and bottom |
| 6.0  | Internal wiring | 2.5 mm, single core, stranded, black PVC insulated copper conductor |
| 7.0  | No.of components like ON/OFF PB's, selector switches etc | As per scheme requirement |
| 8.0  | Contact details of components | All the components like ON/OFF PB's, selector switches etc shall have 2NO + 2NC contacts / poles of 10 A rating. 1 NO &amp; 1 NC contact / poles shall be potential free for PLC inputs |
| 9.0  | Stop push button details | Stop push button shall be :- RED in colour. Mushroom headed. Press to lock and turn to release type |
| 10.0 | Start push button details | Start push button shall be GREEN in colour |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11.0</td>
<td>Lamp details (if any)</td>
<td>Shrouded type</td>
</tr>
<tr>
<td>12.0</td>
<td>Location of selector switches</td>
<td>High density LED type</td>
</tr>
<tr>
<td>13.0</td>
<td>Terminal blocks</td>
<td>Local / Remote selector switches shall be installed in the LCS</td>
</tr>
<tr>
<td></td>
<td>- Shall be able to terminate wires of 2.5 sq.mm size.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Not more than two wires shall be terminated in a single terminal block.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Shall be mounted on D-channels.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 30 % spare terminals shall be provided.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Colour of TBs for different voltages shall be different.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Uniform color-coding to be followed for cabling, TB, etc.</td>
<td></td>
</tr>
<tr>
<td>14.0</td>
<td>Miscellaneous</td>
<td>LCS shall act as field junction box also for wiring termination from Limit switches, PCS, BSS and other field devices. Facility for termination of minimum 5 nos. 19X2.5 core shall be provided.</td>
</tr>
<tr>
<td>15.0</td>
<td>Provision of ammeter.</td>
<td>For motors of more than 45 KW ammeters along with 4 position selector switches shall be provided.</td>
</tr>
<tr>
<td>16.0</td>
<td>Earthing</td>
<td>Earthing studs shall be provided on two opposite sides. Internally the earthing studs shall be connected with the body through green colour PVC insulated copper flexible wire.</td>
</tr>
</tbody>
</table>

### 1.02.13 CONTROL DESK

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Material</td>
<td>- Sheet steel (CRCA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 2.5 mm thick</td>
</tr>
<tr>
<td>2.0</td>
<td>Mounting</td>
<td>- Free standing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Floor mounting pedestal mounting or trunion mounting.</td>
</tr>
<tr>
<td>3.0</td>
<td>Enclosure class</td>
<td>- IP-52 (for indoor installation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- IP-55 (for outdoor installation in bays)</td>
</tr>
<tr>
<td>4.0</td>
<td>Door opening</td>
<td>- Hinged type front door opening.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Hinged top cover with latching facilities in open position</td>
</tr>
<tr>
<td>5.0</td>
<td>Cable gland</td>
<td>- Removable undrilled.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- To be provided in bottom.</td>
</tr>
<tr>
<td>6.0</td>
<td>Internal wiring</td>
<td>2.5 mm, single core, stranded, black PVC insulated copper conductor.</td>
</tr>
<tr>
<td>7.0</td>
<td>Angle of inclination</td>
<td>8 degrees</td>
</tr>
<tr>
<td>8.0</td>
<td>Components like ON/OFF PB’s, selector switches etc.</td>
<td>- Control switches, push buttons and indication devices mounted on top cover and wired up to terminal blocks using extra flexible appropriately insulated wires.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Numbers of components shall be as per scheme</td>
</tr>
<tr>
<td></td>
<td>Requirement.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>• Construction and switch layout to provide comfortable operation.</td>
<td></td>
</tr>
<tr>
<td>9.0</td>
<td>Lamp test PB</td>
<td>To be provided</td>
</tr>
</tbody>
</table>
| 10.0 | Contact details of components | • All the components like ON/OFF PB's, selector switches etc. shall have 2NO + 2NC contacts / poles of 10 A rating.  
|   |   | • 1 NO & 1 NC contact / poles shall be potential free for PLC inputs. |
| 11.0 | Emergency stop push button details | • Emergency stop push button shall be installed on top right side of the control desk.  
|   |   | • Emergency PB shall be:  
|   |   | o RED in colour.  
|   |   | o Mushroom headed.  
|   |   | o Press to lock and turn to release type. |
| 12.0 | Start push button details | • GREEN in colour.  
|   |   | • Shrouded type. |
| 13.0 | Lamp details | High density LED type. |
| 14.0 | Terminal blocks | • Shall be able to terminate wires of 2.5 sq.mm size.  
|   |   | • Not more than two wires shall be terminated in a single terminal block.  
|   |   | • Shall be mounted on D-channels.  
|   |   | • 30 % spare terminals shall be provided.  
|   |   | • Colour of TB’s for different voltages shall be different.  
|   |   | • Uniform color-coding to be followed for cabling, TB, etc. |
| 15.0 | Spare switches | • At least 02 nos. of each types of switches and indication lamps are to be provided as spare in each desk.  
|   |   | • Two numbers of drilled holes are to be provided. The holes shall be plugged with rubber cap. |
| 16.0 | Earthing | Earthing studs shall be provided on two opposite sides. Internally the earthing studs shall be connected with the body through green colour PVC insulated copper flexible wire. |
| 17.0 | Paint | Shade no. 631 of IS : 5 – 1992 or RAL 7032 |

**1.02.14. CONTROL SYSTEM CONCEPT AND PHILOSOPHY**

01

The electrical control system shall be laid on distributed hierarchical concept with a great extent of decentralization of control functions so that individual system shall be autonomous in operation as far as possible.
The system shall be sufficient to perform all the functions required of them & shall be designed to achieve high degree of accuracy of control functions.

Two hierarchical levels has been envisaged as indicated below :-

• Individual drive control level (Level-0)
• Functional group control level (Level-1)

02 Individual drive control level (Level-0)

This shall comprise of motors, field devices, HT/LT Switchgears, Intelligent MCC's, Local control stations, speed control equipment etc. which are to be connected to Level-1 System.

03 Functional group control level (Level-1)

It shall comprise of Programmable Logic Controllers (PLC). The PLC’s shall be provided for control, interlocking and sequencing of different drives. This shall also include HMI, visualization, alarms logging, reporting, trend curves, controlling of set points, etc. for the plant units.

Necessary interface to Level-2/3 System shall be provided.

04 Drive Control Requirement

All process drives shall be generally be controlled from Central control room through Operator workstations / VDU’s and keyboards. Use of Control desks / Control Cabinets shall be restricted to specific drives / emergency operation only.

All drives shall be provided with sel.switch for local operation / maintenance. LCB’s shall be provided with start & stop PBs, Local / Remote Selector switch, any other devices / lamps for the operation of the equipment. Stop PB shall be lockable type with key to release.

For HT motors, ammeter shall be provided on LCB. Interposing CT of secondary 1A shall be provided with purchaser's switchgear at the middle phase for remote metering.

All pumps shall be provided with dry running protections.

For all motors, drive status (ON/OFF, open/close, forward/reverse) tripping due to O/L, earth fault, equipment fault, process faults etc. shall be displayed in VDUs.

Where speed control of process drives are envisaged, the speed indicator shall be provided in VDU.
1.02.15. Automation System :-

01. General

<table>
<thead>
<tr>
<th>A. Automation System Architecture</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 System Architecture</td>
<td>Client server architecture</td>
</tr>
</tbody>
</table>
| 2.0 Redundancy                   | Dual redundant CPU with hot standby mode (Application software based redundancy is not acceptable).
|                                  | Dual redundant communication bus with dual communication cards / dual redundant interface module for the communication bus and each I/O chassis to be installed in each I/O rack / scanner units and synchronizing modules. 
|                                  | Two numbers of servers shall be provided with hot redundant mode .
|                                  | Power supply redundancy .
|                                  | Respective I/O rack shall act as a node to the I/O bus for interfacing with processor rack and shall not be interfaced through back plane extension between two or more I/O racks. |
| 3.0 Speed of commn. interface at I/O level | Preferably 5 MBPS or better .
|                                  | Data loss shall not be more than 4 % . |
| 4.0 Connecting ports             | Cat.-5, UTP cable with provision for 2 nos. additional UTP ports .
|                                  | Two ports for connection to Level-2 network shall be considered for the network. |
| 5.0 Level-2 network communication bus | In place of industrial ethernet, any other deterministic network of 10 MBPS or better (Bus based on open protocols at minimum 4 OSI layers) may also be considered in which case, separate gateway interface with two UTP ports with TCP/IP protocol on Ethernet shall be provided for Level-2 network. |

<table>
<thead>
<tr>
<th>B. General</th>
<th></th>
</tr>
</thead>
</table>
| 1.0 Control Philosophy           | All process data acquisition & monitoring functions, process control (PID), interlocking, logic & sequence controls of drive and various systems shall be performed by the PLC.
|                                  | PLC’s shall be connected to two different bus levels in the network . It shall communicate with RIO’s , intelligent MCC’s, VFD’s, Soft starters, weigh panels etc. on Profibus / Modbus / Controlnet while with HMI’s and HMI cum ES on high speed Ethernet bus through server . The Ethernet switch provided shall be manageable type .
|                                  | The automation system shall cover all the sections of the entire plant .
|                                  | A separate server shall be provided for MIS terminals to be located in welfare building of the individual shop through communication link switch .
|                                  | Communication gateway shall be provided for communicating the system with plant network system of the plant .
|                                  | For displaying the alarms and faults in the mobile handset |
of the authorized person a modem for GSM shall be provided in the network.
- PLC installed in mobile equipments like stacker cum reclaimer etc. shall communicate with the main server through wireless communication. All the required hardware and software shall be provided for the same.

<table>
<thead>
<tr>
<th>2.0</th>
<th>Data signals exchangeability with PLC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The PLC envisaged in this package shall exchange signals with RIO / Instrument panel / VFD / MCC's / Weigh Feeder Panels / dedicated position control system panels (if any) / Level 2 system computers / other PLCs of the plant.</td>
</tr>
<tr>
<td></td>
<td>However all the critical equipment / drives shall be provided with hardwire interlocking in addition to the interlocks through PLC.</td>
</tr>
<tr>
<td></td>
<td>The Tenderer shall include multi-vendor connectivity with all requisite hardware, communication interfaces &amp; required software for exchange of signals with other PLCs of different make on high speed communication bus.</td>
</tr>
<tr>
<td></td>
<td>OPC server shall be provided for communication between the OEM PLC (of different make) and main system PLC.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.0</th>
<th>Operational control mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Provision of the visualisation of the system shall be through human-machine interface HMI, for the control and operation of the complete plant.</td>
</tr>
<tr>
<td></td>
<td>In addition to the normal workstations, at least two numbers of 42” or higher plasma/LCD display units and one overhead LCD projection system to be provided in each central control room.</td>
</tr>
<tr>
<td></td>
<td>Plasma/LCD display units along with AV switching unit to output AV signal from any machine in the control room</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.0</th>
<th>Operational facilities in HMI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The Graphic interface to the operator shall have the following minimum features with user friendly navigation keys.</td>
</tr>
<tr>
<td></td>
<td>It shall be possible to display dynamic graphic of different section of plant on the TFT screen &amp; large display system.</td>
</tr>
<tr>
<td></td>
<td>Graphic displays shall be field configurable only through engineering key-board with standard / user defined graphic symbols.</td>
</tr>
<tr>
<td></td>
<td>Different plant sections dynamics shall be displayed on different pages.</td>
</tr>
<tr>
<td></td>
<td>The graphic display on the HMI clients shall also include extensive process, system and equipment diagnostics in graphical form for troubleshooting. The PID and other such settings to be available on operator workstation for viewing and editing.</td>
</tr>
<tr>
<td></td>
<td>Graphic display shall be interactive type through which it shall be possible to control process. Following process control functions will be initiated via the HMI:</td>
</tr>
<tr>
<td></td>
<td>- Operation mode (Auto / Remote / Manual) selection</td>
</tr>
<tr>
<td></td>
<td>- Control mode (Auto / Semi-Auto / Local) selection</td>
</tr>
<tr>
<td></td>
<td>- Selection of drive and control loops</td>
</tr>
<tr>
<td></td>
<td>- Set point selection.</td>
</tr>
<tr>
<td></td>
<td>- It shall also be possible to send motor start / stop and shutdown, valve open / close command, control mode selection command from this display.</td>
</tr>
</tbody>
</table>
- It shall be possible to go from any graphic page to related graphic page or any group view or alarm summary in single keystroke using soft key function.
- Process diagnostic system to provide status & fault signals of the process along with process error displays.
- The details of graphic screens shall be finalised as required during detailed engineering and commissioning.

<table>
<thead>
<tr>
<th>5.0 Operational menus in HMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Opening page with project description, name of supplier, name of consultant .</td>
</tr>
<tr>
<td>• Sub-menus like command menu, report menu etc.</td>
</tr>
<tr>
<td>• Command menu in the form of buttons for start and stop of each equipment / group of equipment .</td>
</tr>
<tr>
<td>• Operation mode</td>
</tr>
<tr>
<td>• Display of auto / local selection of each mechanism .</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6.0 Reporting and data logging</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Summary of faults with description, date and time of occurrence .</td>
</tr>
<tr>
<td>• Shift wise, daily, monthly, yearly hierarchical logging of report/faults/data with process values / production figures and other process data. However, same shall be finalised by the Purchaser during detailed engineering process.</td>
</tr>
<tr>
<td>• Automatic log sheet – operation &amp; maintenance – shift &amp; day.</td>
</tr>
<tr>
<td>• The system shall comprise of a standard library of control, logic and computational functions that are preprogrammed and stored in memory. During the system configuration, user shall be able to select the appropriate functional blocks from the library, link them together, set the various inputs and tune parameters associated with each block.</td>
</tr>
<tr>
<td>• Real time recording of data for important equipment shall be provided (e.g high speed recorders etc.)</td>
</tr>
<tr>
<td>• All logging in ORDBMS. Logging and reporting also to be provided batch-wise, campaign-wise, etc. Reporting to include analysis tools.</td>
</tr>
<tr>
<td>• Historical data storage &amp; trending.</td>
</tr>
<tr>
<td>• Along with graphic generation, trending, and alarm generation, EVENT LOGGING also to be included. Event logging means data related to an event happening in the process or field. It will also include the user activities vis-à-vis operation through the automation system.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7.0 Mode of operation of the plant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local Mode :-</strong></td>
</tr>
<tr>
<td>• Operation of single drive / equipment</td>
</tr>
<tr>
<td>• Start / Stop from LCS shall be done only for test and repair purposes .</td>
</tr>
<tr>
<td>• To enable the testing of individual equipment all the interlocks which are not at all necessary shall be withdrawn in this mode .</td>
</tr>
<tr>
<td>• However all personnel / equipment safety interlock are effective for safety reasons also in local mode .</td>
</tr>
<tr>
<td>• LCS are provided for all motors, drives and</td>
</tr>
</tbody>
</table>
actuators for valve operation as near as possible.

B. Semi Auto :-
- Under this mode it shall be possible to monitor & control the plant based on set points / commands given by operator through keyboard (for individual equipments or individual group for group control drives) and the control, sequential operation of various mechanisms in the required sequence shall be executed by PLC i.e.; in this case all the changes are operator initiated.

C. Auto Mode :-
- This is the normal mode of operation of the plant. In this mode, the desired values (set point) of the parameters of process control loop will be set via keyboard of the HMI and sequencing and logic functions will remain operative through the PLC as per programme.
- There shall be a provision of group start of the individual sections.
- In the individual sections there shall be provision of interlocks, logic and sequencing between the individual drives

| 8.0 Screen menu display | • Over view  
• Group display  
• Loop display  
• Mimic display (dynamic)  
• Alarm over view  
• Alarm display  
• Trend display (Dynamic display)  
• Event displays(Dynamic display)  
• Diagnostic & maintenance displays |
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>However a dynamic mimic status pages shall be made available with security through web based portal for each respective packages. Location of the same shall be decided during detailed engineering (by BSP).</td>
</tr>
</tbody>
</table>

| 9.0 Process graphic displays with dynamic process variables | • Process status overview (On/Off status of process and plant)  
• Operation status of Drives (Position and status of drives)  
• Group display of Loops  
• Control Loop display & Configuration of Control Loops  
• Real time trending (Bar graph displays and / or numerical display)  
• Historical trending. Historical trending for 7 days for 1 minute scan rate for all analog inputs  
• Fault message indications  
• Operational/ event message indication.  
• Data and time synchronization on the complete HMI system shall be ensured. |
High speed (1msec scan) recorder of 12 channels to be provided for real time recording of data for important equipment (at least 02 nos. for each packages).

10.0 Process graphic display operation

- Graphic Display will contain static and dynamic components. The dynamic components display the actual state of the plant section. Dynamic components will be actual binary states (e.g. drive “on”) or actual values. Values will be represented as bar charts and / or numerical.
- Critical plant status will be highlighted by different colours or by blinking. Description in clear text will be provided to simplify Operator understanding.
- Double clicking on any of the control valve in any of the menu / submenu pages shall invoke the corresponding PID loop display screen with real time trend. PID loop display screen shall show controller facia and displaying status and parameters of each controller. Each facia shall be able to display process value, set value and the manipulated variable. The remote manual functions and change of set points under auto mode shall be possible to be performed from these facias.
- Graphics should also include very comprehensive diagnostics on process, plant, equipment, system etc., enabling the user to pinpoint exact reason of any problem faced.
- In case of Cascade/ Ratio control, it shall show all the controllers facia with the facility of maximising one of them. PID parameters can be changed only after validation of software password.
- Clicking on any mechanism like valve will invoke a small screen showing following (software lamps) indications for remote manual operation:
  - Local
  - Remote
  - Auto
  - Open (Blinking with opening color during opening)
  - Closed (Blinking with closing color during closing)
  - O/L Tripped
  - Torque switch actuated
  - Control supply Healthy
  - Valve Open Timer Time Out
  - Valve Close Timer Time Out
  - Local Stop
- Clicking on any mechanism like fan / pumps will invoke a small screen showing following (software LED) indications for remote manual operation:
  - Local
  - Remote
  - Auto
  - Run Feed-back
  - Elect. Fault

11.0 Colour Codes

- The display of the process will occur on full graphic color
process terminals.

- In Graphic display sheets color of the process line shall be as per the color code followed by the Purchaser.
- However all fans / pumps color will be RED in ON condition, color will be GREEN in OFF condition and valves will be PINK (with blinking) in the intermediate position.
- Client approved standard color-coding to be followed for graphics.
- Uniform color-coding to be followed for cabling, TB, etc.

12.0 Trending

In any menu/ sub menu page double clicking on any tag will invoke the trend menu of that particular tag. Based on the selection by the Operator either Historical or Real Time Trend menu will be displayed. Provision shall be there so that Operator can add trends by entering the tag nos. for another 7 nos. of tags in the same page using the same time base for comparison purpose.

The Automation system must support historical process information recording and retrieval. This historical information shall be available for use in logs, trends, etc, requested at any operator console. Recorded process information shall include:
- Measured value
- Alarm status
- Setpoint or desired value
- Output value
- Control mode

A distributed approach to historical recording is preferred to a dedicated unit. For both logging and historical trending the operator/ engineer must be able to specify the points to be recorded, the frequency with which the data is to be collected and the time base. Historical data should support the following protocols:
- OPC (Open Process Control)
- OLE (Object Linking and Embedding)
- OBDC (Open data base connectivity)
- API (Application Programming Interface)

Sufficient online storage shall be included to accommodate the data base and alarm, event and historic data logs for monitoring 75% of analogue data for 24 hours at 10 sec. Trend rate. Display of trend shall have:
- Operator scalable X-axis from 60 seconds to 24 hours (for 24 hours history, trend shall be stored as 10 seconds scan for each variable)
| 13.0 Interlocking | The interlock scheme shall be as per the technological requirement based on process flow diagram, P&I diagram and functional chart.
  | • All emergency conditions like stop push button, emergency stop command, torque switches, level switches etc. shall be interlocked to the main power contactors of the drives.
  | • Provision of providing interlocking of different equipment (which are controlled from different PLC) based on I/O exchange from that PLC.
  | • Further the system shall be provided with pre-starting audio-visual alarm at equipment platform before starting of mobile equipments like conveyors, turret, tundish cars etc.
  | • Interfacing with subsystems: All outside auxiliaries and supporting units for process related system shall be interfaced.
  | However, all facilities to be provided in the central control room which shall be finalised during detailed engineering stage keeping in view the process/technological requirement.

| 14.0 Alarms and alarm management | The use of multi-media system in HMI shall be envisaged for audio-visual signaling for faults & alarms.
  | • There shall be dedicated key as a provision for acknowledging the faults. The usability of the operator interface shall be further enhanced with features such as sound cards, touch screen, track balls etc.
  | • Alarm list/event list and operator action list and its logging for minimum one month.
  | • Alarm Performance
  | • Irrespective of Operator activity and choice of display, an alarm situation shall always have priority and shall be brought to the attention of the Operator, quickly and automatically.
  | • The display containing the alarm shall be selected by a single keystroke action. Alarms should automatically
update in the event of an alarm operating i.e. it should not require operator intervention to update alarms either on process mimics or alarm summary format.

- Alarm messages shall be time tagged to within 100 milliseconds (from detection at input card or receipt from data link) or less and are required to be displayed within two seconds of the field device operating. System resolution for the orderly detection of successive alarms shall enable those alarms to be displayed in order of occurrence, and/or priority.

- In order to facilitate easy recognition of alarm status by operators, annunciator colours and audio tones shall be easily distinguishable. All alarms and trips shall be annunciated by a screen message and an audible alarm.

- Critical process alarms shall come in the form of small size popup window on the HMI screen. Individual area wise alarm shall display in the corresponding HMI station.

- The alarms and trips shall flash in a highlighted form (e.g. reverse video) until acknowledged. When acknowledged from any HMI, the flashing and audible tone shall stop on all HMIs. When an alarm returns to normal, flashing shall return to normal on all HMIs provided the alarm has been acknowledged.

- Alarm Category Colours

- The following colours shall be used for the process control system screen alarms, on a black of gray background:

  - Fire & Gas : Red
  - ESD : Magenta
  - Fault alarm : White
  - Process alarm : Orange

- These are proprietary colours and shall be confirmed during detailed engineering. The use of yellow colour (traditionally a gas alarm) and green colour (associated with normal conditions) shall be avoided for alarms.

- Audible Alarm Category

- There shall be audible differentiation between the fire and gas alarms (noise X), and process alarms and faults (noise Y and Z), where X, Y and Z noises have to be defined.

- Analogue Alarms

- All process variables and composed points shall have the possibility of being assigned at least two levels of high and two levels of low alarm values. All control loops shall have the possibility of being assigned high and low
deviation alarm values. All alarms shall have a user-definable dead band. An alarm shall be provided when analogue signals are less than 3.8 mA or greater than 20.2 mA. Rate of change alarms and set point deviation alarms shall be provided.

- Filtering based on plant, equipment, time-span etc. shall be possible
- The system will be engineered such that it is anticipated that at least 4 levels of alarm priority will be used:
  - Low
  - Medium
  - High
  - Critical
- According to guidelines, which will be developed in detail engineering, the Alarm/ event logging facilities will be provided using Automation System based logging rather than printers.
- Discrete Alarms
  - All discrete inputs shall have the possibility of being assigned a change of state alarm. Discrepancy alarm indicating failure of control action shall be provided.
- Alarm Analysis
  - It shall be possible to inhibit alarms by point of priority when the initiating device is faulty or being maintained. While inhibited, the point must still be scanned and archived. The removal of the inhibit shall be logged. A summary display containing all inhibited points shall be provided on demand. Alarm inhibition shall be permitted from any of the work stations with level 3 or 4 access level only. Facilities shall be provided to mask out alarms from equipment (such as pumps) that is shutdown. These alarms shall be automatically or manually via keyboard, reinstated when the equipment is put back into service. Initiation and removal of inhibition shall be logged as an event and printed.
- Alarm Display
  - Alarm displays shall take the form of a summary display of all points in alarm, and/or integrate the alarm message with associated item, group or overview data. Alarms shall be listed in order of occurrence, and for specific alarm displays the most recent alarm shall be shown at the top of the display. All alarms shall be identified by tag, description and the date and time of the occurrence, in hours, minutes and seconds. A banner type display
showing a summary of alarms shall always be present at the top of the screen irrespective of main display.

- **Alarm Grouping and Priority**
  - Alarms from an area shall be capable of being grouped in one or more Alarm Groups. A minimum of 30 Alarm Groups shall be provided. At least four levels of alarm priority shall be available, with configurable presentation/ background colour. A global alarm acknowledge and reset facility shall be available. If unacknowledged, Alarm message stays on display until it is cleared.

- **Diagnostic Alarms**
  - The Automation System shall have a comprehensive self-diagnostic alarm information shall identify the faulty device down to board level, with its location and provide a diagnostic code. Individual circuit boards shall be provided with LED indicators or equivalent, to positively identify a faulty board. The failure of any single item of equipment shall not generate erroneous alarms.

- **Alarm Handling Capacity**
  - In addition to the alarms included in the point count, the Automation System shall be capable of handling alarms and status points received via any data link to which it is connected.

- **Alarm Flooding**
  - The Tenderer shall outline his approach, to overcome the problem of alarm flooding.

### 15.0 Configuration

- For Instrumentation system a separate dedicated PLC shall be provided (as mentioned in TS).
- If the PLC is common for the process a separate dedicated remote I/O panel shall be provided for the instrumentation system.

## 02. Programmable Logic Controller (PLC)

### General Features

<table>
<thead>
<tr>
<th>1.00</th>
<th><strong>Power supply system</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.01</td>
<td><strong>Power supply system</strong></td>
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</tbody>
</table>

PLC system shall have two independent Input supply voltage:
- Two source of 240V AC single phase, 50 Hz from UPS for CPU and other required control modules, interrogation voltage and output voltage.
- Two nos. of redundant power supply modules in each chassis with diode ORing.
- One source of 240 V AC single phase, 50 Hz from MCC for
auxiliary power supply e.g fans, panel lamps, power sockets etc.
- Both UPS power supply units shall have auto changeover facility as well as manual changeover facility through selector switch.
- Redundant 24 V DC regulated power supply unit shall be provided for interrogation voltage and output voltage.
- Separate power supply bus shall be provided for interrogation voltage supply for all inputs and output respectively (even if the input interrogation voltage and output voltage is same).
- Power supply unit shall be provided with diode multipliers for input interrogation & output voltage for driving outputs (interposing relays, solenoid valves, lamps etc.).
- DP MCBs shall be provided for each rack of the PLC system.
- 20% spare DP MCB shall be provided in each panel.

<table>
<thead>
<tr>
<th>1.02</th>
<th>Built-in power supply units</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Suitable for the power supply system as specified above.</td>
<td></td>
</tr>
<tr>
<td>- Following power supply unit shall be provided for following units:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Redundant 24 V DC power supply units (with multiplying diodes for powering field instruments (2-wire transmitters).)</td>
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<tr>
<td></td>
<td>- Separate power supply modules, to be supplied by the Tenderer for each segment of Foundation Field bus system, shall be of Type 132: Non-I.S. power supply intended for feeding a non-I.S. barrier. Output voltage shall be 32 V DC maximum. Power supply module shall have in-built power conditioner. DP MCBs shall be provided for each segment of the Foundation Field bus system.</td>
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<tr>
<td></td>
<td>- Redundant regulated power supply unit of proper rating shall be provided for special control module (if any required).</td>
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</tbody>
</table>

Following features shall be provided in the power supply unit mentioned above:
- Insulation level 2.5 KV for 1 minute.
- Protection against surge protection & short circuit.
- Electronic over current protection with feedback feature.
- Thermostat protection against over temperature.
- Over voltage protection.
- Fuse protection in the input and output circuit.

<table>
<thead>
<tr>
<th>2.0</th>
<th>Central processor unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Modular and plug-in type</td>
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<tr>
<td>- 32 bit microprocessor based</td>
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</tr>
<tr>
<td>- PLC shall be able to scan and execute all close loops (approx. 40 PID loops) in less than 100 milliseconds and scan digital inputs in 50 milliseconds simultaneously.</td>
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</tr>
<tr>
<td>- Execution time between 1 milliseconds to 3 milliseconds per 1K instruction or better.</td>
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<tr>
<td>- Provision to latch desired outputs.</td>
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</tr>
<tr>
<td>- Provided with redundant hot standby CPU (with...</td>
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</tr>
</tbody>
</table>
The CPU system shall have facility of bumpless transfer in case of failure of one.
- CPU shall have crystal clock generator.
- Redundant CPUs to have extensive in-scan synchronization. Time synchronization from designated time server
- Peer to peer communication through I/O channels shall be possible.
- Backup system communication (redundant communication bus) shall be provided.
- The processor shall have proper communication modules (for each CPU) for communicating with redundant processor, remote I/O modules and for communicating with other communication bus protocols like ethernet bus / profibus / modbus / controlnet / field foundation bus etc. (no proprietary bus, for any sort of communication including fieldbus, to be used.
- The processor shall have in-built provision for software timers, counters, examining input conditions, compare, compute, logical, conversion from/to BCD, bit manipulation, block memory manipulation, diagnostic, shift, sequencing, conditional jumping, subroutine instructions etc.
- CPU shall be capable of handling PID functions including mathematical functions, weighing and batching functions.
- CPU shall be capable of handling 30% additional (future) I/Os over and above 20% spares (installed) I/Os indicated in basic configuration diagram. Maximum CPU loading shall be limited to 60% for the intended applications.
- The CPU shall have the facility of initializing a synchronizing pulse to the server periodically (Minimum once in a day).
- CPU loading shall not exceed 60%.

### 3.0 Timers

- The timers shall be OFF delay, ON delay, retentive type timer with a range from few milliseconds to few hours. Accuracy shall be +/- 0.1% of the set value.

### 4.0 Counters

- The counters shall be of counter up and counter down type. It shall have the range from 0000-9999.

### 5.0 Memory units

- Modular and plug-in type
- Word length 32 bit
- Expandable in blocks of 4K Words
- Minimum size 20MB
- EPROM/RAM with battery power back-up
- Back-up battery shall be as follows:
  - Rechargeable Ni-Cd batteries with necessary charging circuit / Lithium or any other internationally acceptable type.
  - Able to retain memory for a minimum of 1 year with no power applied to the controller.

### 6.0 Input Units

- High density, modular, rack based (channel based I/O not acceptable) and plug-in type.
- Insulation level of 1.5 KV
- Input interrogation voltage 24 V DC.
- Individual fuse for each unit shall be provided for protection against cable fault/earth fault.
- For critical applications all inputs (analog, digital, others) to have individually isolated channels.

6.1 Digital Input Modules

Digital input units shall have the following features:-
- 16 / 32 inputs per module.
- Time delay of about 10 millisecond to filter out noise and contact bounce.
- Optocoupler to galvanically isolate each input device from the decision making logic of the controller
- LED status indication
- BCD input units suitable for four digit input
- Pulse inputs (Incremental encoder / digital tacho)
- Absolute / incremental encoder inputs.
- High speed counter type inputs
- All the cards shall be compatible of receiving digital signals from field sensors and switches directly.
- All the control modules / cards shall be lacquered.

6.2 Analog Input Modules

Analog input units shall have the following features:
- Shall be 8 channels, rack based & plug-in type.
- Suitable for 4-20 mA / 0-10V DC / RTD / thermocouple / weighing signal inputs.
- With necessary A/D converter having at least 12 / 14 bit resolution based on application.
- Suitable for J/K/S type thermocouples & for PT100, 2- wire / 3 wire
- Galvanically isolated differential inputs with insulation level of 1.5 kV.
- For 4 – 20 mA analog inputs, fused TB with blowing fuse shall be provided.
- Healthiness of every input shall be monitored & LED indication shall be provided.
- Analog module shall have the facility to be configured in voltage or current mode and differential or single ended inputs mode.
- Pulse/ frequency input module shall have range upto 50 kHz. For very high frequency applications, the range shall be upto 1 MHz.
- All the cards shall be compatible of receiving analog signals from field sensors and switches directly. If not suitable converters shall be provided.

7.0 Output units

- High density, modular, rack based (channel based I/O not acceptable) and plug-in type.
- Insulation level of 1.5 KV
- Individual fuse for each unit shall be provided for protection against cable fault/earth fault.
- For critical applications all outputs (analog, digital, others) to have individually isolated channels.
7.1 Digital Output modules

Digital output units shall have the following features:
- 16 / 32 digital outputs per module.
- High Density modular and plug-in type.
- Isolated outputs with two separate terminals for each output.
- Rated for 24 V DC
- With insulation level of 1.5 KV
- The output module shall be able to drive interposing relays (24V DC coil), solenoids, annunciation lamps, LEDs, Instrumentation control equipments etc.
- Power devices like contactors etc. shall be actuated through interposing relays. The interposing relays shall be mounted in the same panel. Proper surge suppressor shall be mounted across the coil of the output relays. However as far as possible interposing relays to be avoided.
- Any special requirement e.g position control to control field devices shall be met by using separate interface modules.

- BCD output units shall be as follows:
- Suitable for four-digit output.
- Rated to drive seven segment LED displays
- With insulation level of 1.5 KV

7.2 Analog output modules

Analog outputs shall have the following features:
- Shall be of 4 / 8 analog output channels.
- Suitable for 4-20 mA / 0-10V DC / +/-10V DC outputs
- With necessary D/A converters having 12 bit resolution
- With insulation level of 1.5 KV
- Each output shall be galvanically isolated.

8.0 Foundation Field Bus Interface modules (FIM)

- The Foundation Field bus interface modules (FIM) of the PLCs shall be chasis based modules. These modules shall completely integrate Foundation Field bus devices with the PLC controller & HMI software. These FIM modules shall deliver system wide integration of data access, control, connections, diagnostics and alarms with the PLC system. LED indication of power, error condition & status shall be provided in each FIM module.
- PLC shall provide graphical support to the Field Bus Interface module to perform the functions of Link Active bus scheduler for a network. This will allow the system configuration engineer to see what’s going on and shall provide complete flexibility to adjust schedules based upon the needs of the control scheme. PLC shall also support Back-up Link active scheduler.
- All Foundation Field bus (FF) devices (to be procured under separate Instrumentation package) shall be
registered with the Field bus Foundation at level ITK 4.0 or higher. Field bus interface modules & Field Bus Library manager shall be compatible with ITK 4.0 or higher version compliant devices. Tenderer shall also provide Field bus usage license. All FF devices provided shall be polarity insensitive. All FF cables shall be of Type A.

- The PLC offered shall be certified for the Foundation Field bus Host Inter operability Support Testing (HIST) from Foundation Field bus organisation. HIST procedures provide a common methodology for assessing host inter-operability with registered devices.
- PLC Software shall have the capability either to directly read Device description (DD), files from the Field bus devices and add these DDs/ Files to the library for Off-line & On-line configuration, or it shall perform this task through a separate software tool, Field bus library manager. It shall be possible for PLC based automation system to upload field device configuration changes implemented in the field. Once the configuration information is stored in the automation system, it shall be possible to download it to any other similar device, whether a new or replacement device.
- In case of a new device added to a Foundation Field bus segment, its presence shall be immediately shown in that segment. Important information about the new device including tag name, address, model and revision shall be immediately available.
- Downloading new software to Foundation Field bus devices shall be possible from the PLC. There shall be no need to physically change the firmware and to disconnect or remove devices for updating to the latest available revision. It shall be possible to simultaneously download the latest firmware to multiple field devices.
- Each Foundation Field Bus interface module shall support minimum two segments.
- The Terminators shall be impedance matching modules to be used at or near each end of a segment. There shall be two terminators per segment. The terminators prevent distortion and signal loss and shall be supplied as a pre- assembled, sealed module. Tenderer shall provide the Terminators as per the requirement.
- The power for each Foundation Field bus segment shall be provided through a power conditioner to prevent the communication signal from being attenuated by the power supply & to eliminate cross talk between FF segments through a common power supply.
- Power supply modules to be supplied by the Tenderer shall be of Type 132: Non-I.S. power supply intended for feeding a non-I.S. barrier. Output voltage shall be 32 V DC maximum.
- For Field bus use, a power supply impedance matching network shall be provided. This shall be a resistive/inductive network and built into the Field bus power
Supply module.

- Connectors as coupling devices shall be employed to connect the wire medium to a fieldbus device or to another section of wire. Standard fieldbus connectors shall be used. Specification shall be as per annexure A of the ISA physical layer standard and annexure A of the IEC physical layer standard.
- Couplers shall be the physical interface between segment and spur or segment and Field bus device. Field bus couplers shall be as specified in the IEC/ISA physical layer standard and provide one or several points of connection to a fieldbus segment.
- Grounding: The instrument signal conductors shall not be used as a ground. Instrument safety ground shall be made through a separate conductor outside of the signal cable. The conductor may be in the same cable as the instrument signal conductors and shield, but shall be located outside the shield within this cable. Fieldbus devices shall not connect either conductor of the twisted pair to ground at any point in the network. The Fieldbus signals are applied & preserved differentially throughout the network. Network cable shield shall be earthed grounded in one location only, at the field termination assembly (Host) end. At any field instrument, cable shield shall not be connected to the instrument earth/ground or chassis. The cable shields from different networks shall not be attached together in a field junction box. This will create ground loop & noise onto the network.
- Lightning/ Surge protection: Surge protection shall be provided for all field devices. The surge protection shall consist of low capacitance silicon avalanche diodes or spark gaps, wired for both normal & common mode protection and connected to the electrical safety ground grid. Surge suppressors shall be so selected that they shall not measurably attenuate the FF signal. To avoid any chance of short circuit, surge suppression devices shall be connected through a series fuse.

Foundation Fieldbus Network/segment naming convention

The following recommended network/segment naming convention shall be followed:

# NN MM P
- #: Indicates the plant/area number to which the segment shall be connected.
- NN: Indicates the node number/controller name.
- MM: Indicates model number/card number.
- P: Indicates segment or port number.

Loop & Instrument Naming convention:-
- Loop & Instrument naming convention shall be decided during detail engineering.
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</thead>
<tbody>
<tr>
<td><strong>Spur Naming convention:</strong></td>
<td>All spurs shall be labeled with Instrument tag name.</td>
</tr>
<tr>
<td>9.0</td>
<td><strong>Additional features</strong></td>
</tr>
<tr>
<td></td>
<td>- On-line replacement of any module shall be possible in such a way that the removal and addition of any module shall be possible without de-energizing the system. Further there shall not be any interruption in the system while replacing a faulty module except for the inputs / outputs which are being handled by the module.</td>
</tr>
<tr>
<td></td>
<td>- Fully pre-programmed connection of field devices with input units through ordinary multi-core copper control cables of 1.5 sq. mm size (twisted pair), up to a length of 500 m.</td>
</tr>
<tr>
<td></td>
<td>- Communication with computer in distributed hierarchical control system and operator consoles / display units.</td>
</tr>
<tr>
<td></td>
<td>- High speed communication among PLC and operator consoles/ display units shall be provided through dual redundant TCP/IP Ethernet using ethernet cards (no propriety cards) on HMI station.</td>
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<td></td>
<td>- Switch to disable all outputs of the controller during start-up / debugging.</td>
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<tr>
<td></td>
<td>- All the automation equipment shall be user configurable to a fail-safe state to avoid dangerous situations in case of any failures caused by power failure, communication failure, etc.</td>
</tr>
<tr>
<td></td>
<td>- Test sockets on input modules for input simulation</td>
</tr>
<tr>
<td></td>
<td>- Facility to be provided to hook up engineering station at each location of I/O (preferably).</td>
</tr>
<tr>
<td></td>
<td>- Serial Interface, RS232C and better shall be provided</td>
</tr>
<tr>
<td></td>
<td>- Any special requirement to control field devices shall be met by using separate interface modules.</td>
</tr>
<tr>
<td></td>
<td>- The PLC system shall be immune to the following:</td>
</tr>
<tr>
<td></td>
<td>- Radio frequency interference</td>
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<tr>
<td></td>
<td>- Electromagnetic interference (EMC compatible)</td>
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<td></td>
<td>- Power system spikes</td>
</tr>
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<td></td>
<td>The methods and standards followed for these features shall be furnished.</td>
</tr>
<tr>
<td></td>
<td>- All network cabling to be structured and to be tested and certified.</td>
</tr>
<tr>
<td></td>
<td>- Network teams from multiple switches to be employed for all the important machines (computers).</td>
</tr>
<tr>
<td>10.0</td>
<td><strong>Mounted spares</strong></td>
</tr>
<tr>
<td></td>
<td>- Min of 20 % of I/O modules used (with at least one module of each type) for input and output shall be offered as spare for each programmable controller and the same shall be mounted and wired to the terminal block in the cubicle suitably.</td>
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<tr>
<td></td>
<td>- No. of spare Channel per card shall be 20 %.</td>
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<td></td>
<td>- 20 % spare memory capacity shall be provided</td>
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<td></td>
<td>- Provision shall be provided with empty slots for future expansion for 20% I/O modules. Minimum 50 % spare memory capacity shall be built in the system after loading of application and system software.</td>
</tr>
</tbody>
</table>
| 11.0 Self diagnostic features | - Parity errors, cycle errors and under voltage  
|                               | - Failure in central processor unit, memory and power supply.  
|                               | - Indication of type of failure  
|                               | - Automatic turning OFF of all outputs or optionally holding of all outputs in their last state on failure detection.  
|                               | - Fault detection upto card level.  
|                               | - Communication failures – all types  
|                               | - Fuse failure indication for outputs  
| 12.0 Monitoring functions | - Monitoring of internal voltages  
|                          | - CPU Status monitoring  
|                          | - Memory status monitoring  
|                          | - I/O Status monitoring  
|                          | - Address monitoring  
|                          | - Bus & communication signal monitoring  
|                          | - Broken sensor detection  
|                          | - A milliammeter with selector switch shall be provided on panel front to monitor the earth leakage current.  
| 13.0 Terminations | - All inputs and output wired up to easily accessible terminal blocks rated for 660V  
|                    | - Screened cables for mA signals from Instrumentation I/O rack and other field sensors to terminal blocks of PLC.  
|                    | - Control cables for contact signals from Instrumentation I/O rack to terminal blocks of PLC.  
|                    | - Suitable for terminating up to 2.5 sq. mm. copper conductor industrial control cables.  
|                    | - Fuse terminals for all input & output signals (with LED indication).  
|                    | - Required test and maintenance equipment to be provided for maintenance and troubleshooting of FO and wireless communication.  
|                    | - Uniform color-coding to be followed for cabling, TB, etc.  
|                    | - As far as possible cross-ferruling to be used for all connections.  
| 14.0 Earthing | - Separate earthing bus for power / panel earthing and electronic earthing shall be provided. Minimum two numbers of electronic earth pits shall be provided for each set of PLC.  
|                  | - Electronic earthing bus shall be suitably insulated. Earthing requirements / earthing schemes for the equipment supplied shall be clearly indicated in appropriate drawings.  
| 15.0 Constructional features | - Unitised construction.  
|                        | - Floor mounted, free standing and indoor type.  
|                        | - Bottom cable entry through gland plate.  
|                        | - Sheet steel clad |
- Dust and vermin proof
- Anti vibration pads to be provided to withstand vibrations as per application.
- All modules plug-in type.
- Panel illumination with door interlock limit switch.
- Switch-socket outlet for maintenance.
- Suitable fans & inlet air filters shall be provided at the bottom/ top of each panel for proper air circulation.
- Empty slots of the racks shall be provided with dummy cards for protection against dust & damage.
- Colour shade outside and inside shall be RAL 7035.
- All panels shall be of Rittal make.

### 16.0 Enclosure
- Conforming to IP-42 class in PLC room/control room.
- Conforming to IP-54 class for remote I/O cubicles located in shops/ bays.
- Programmable controllers, even if housed in air-conditioned enclosure, shall be suitable for normal industrial environment and ambient temperature upto 50°C.
- Temperature while operating
  - Lower limit : 0 degree C
  - Upper limit : 60 degree C
- Temperature while not operating (storage)
  - Lower limit : 20 degree C
  - Upper limit : 75 degree C
- Relative humidity
  - Daily average 80 to 90% (8 hrs.) and 65 to 90% (16 hrs.)
  - Maximum 98%, not occurring simultaneously with maximum temperature.

### 17.0 Data sheet to be furnished by the tenderer
Tenderer shall submit the data sheet of the PLC system. The following informations shall be at least mentioned in the data sheet:
- CPU processing speed
- I/O handling capacity
- CPU in built communication port
- CPU programming memory capacity
- Minimum scan time achievable
- CPU self and diagnostic features.

### 03. Human Machine Interface (HMI) Work Station & Engineering Station
| 1.0 | Type | - Shall be console type PC based colour graphic Work Station  
- Commercial grade latest available in the market.  
- Industrial grade latest available in the market (for installations in the plant bay e.g. on casting platform in MOP)  
- In addition to the normal workstations, at least two numbers of 42” or higher plasma/LCD display units and one overhead LCD projection system to be provided in each central control room. |
| 2.0 | Interfacing card / module required | Proper interfacing card / module with related communication protocol shall be installed in the programming unit so that it can communicate with the network (i.e. PLC processor, server, HMI, printers) smoothly. |
| 3.0 | Programming Facilities | - Programming unit shall be suitable for developing programs in ladder diagram / block diagram / statement form / SFC.  
- Programming unit shall have facility for loading the program from CD & DVD.  
- The programming terminal shall be capable of developing multiple programs offline without connecting to the programmable controller. Upload and download of the program between PLC and program unit shall not require ‘compile’ before ‘download’.  
- Engineering station shall have an integrated and development and configuration setup for all the drives, instruments, PLC/DCS, HMI etc. |
| 4.0 | System Configuration | - Industrial grade PC with Pentium CPU  
- 19” TFT color monitor with 0.28 mm dot pitch 1280 * 1024 resolution  
- Dual Ethernet interface with LAN accessories for all PC based operator station  
- 64 bit, 256 MB RAM, 80 GB Hard Disc drive & controller  
- Combo Drive, Graphics Accelerator Card with minimum 8 MB on board RAM, Keyboards, Track ball / Mouse, Tape / Data backup drive suitable for plugging in USB port.  
- The computers shall be provided with minimum 3 serial ports & one parallel port, ethernet interface with accessories. |
| 5.0 | Functions | - Error detection and reporting.  
- Fail safe / broken sensor information and alarm and their reset.  
- Selection of highest / lowest signal from a group of accepted inputs and displaying the same  
- Linearisation and other arithmetic calculation. Provision shall be kept for pressure and temperature correction to be computed for flow measuring loops.  
- Built-in ambient temperature compensation for thermocouple inputs from field.  
- Trending real time and historical (Trending shall be
provided for all analog inputs).
- Report generation and periodic logging.
- Developing of graphic symbol library as per
  ISA – 5.1 and 5.3. in addition to standard industrial
  symbols.
- Printing of alarm conditions with parameter identification.
- Online editing of :-
  - Scan sequence
  - Identification number
  - Engineering units
  - High and low alarm limits
  - Alarm dead bands
  - Addition / Deletion signals
  - Removal / introduction of analog and digital points in
    scanning.

6.0 Miscellaneous

- Networking via Ethernet with Network diagnostic
displays
- Ability to add optional packages (e.g. for data analysis)
- All the important drives should be provided with suitable
  CBM systems such as vibration monitoring, current
  signature, temperature etc. Information from CBM
  systems to be interfaced to HMI system as well as plant-
  wide CBM system.
- All equipment to have extensive diagnostic capability.
  This information to be used for generation of relevant
  diagnostic information on working and problems in the
  system.
- Extensive BOM covering all hardware, software, etc.
  should be provided.

7.0 Printer

Latest appropriate model of HP Laser Printer to get hard
copy of the program dump / data logging / alarm logging /
event logging / data trending etc.

04. Server :-

1.0 System Configuration

- Industrial grade .
- Server grade Intel Xeon, Dual CPU (Resultant speed 3.06
  GHz)
- 4 MB Cache memory.
- 512 MB RAM.
- 2 X 72 Hot swap SCSI HDD (RAIR level-1 Disc mirroring).
- 1X1.44 MB FDD.
- Combo drive
- 2 Serial ports, 1 parallel port, 2 USB port (for all client as
  well server).
- Graphic accelerator card with minimum 8 MB onboard
  RAM)
- Dual Network interface.
- 19” TFT colour monitor
- Keyboard and Mouse.
- Operating system Windows 2000/NT.
2.0 Make
- Servers shall be of COMPAQ/DELL/IBM make.

3.0 HMI server
- HMI servers shall be redundant. Separate clustered/redundant servers to be considered for data servicing. The server to be of latest & proven specification at the time of implementation.

4.0
- Only client-server, multi-tier system to be used. No standalone workstations apart from emergency workstations. Number of operator stations and emergency workstations to be finalized during engineering stage and should have at least two and one hot spare respectively.

05. Software :

| 1.0 | System software (Windows Programming) | The PLC programming software shall be latest, Windows based, menu driven and shall support the following minimum:
- Cyclic, Time Controlled, Interrupt controls.
- Retentive/Non Retentive Timers, Bi-Directional counters, latches, etc.
- Internal Flag generated by the PLC.
- All Boolean Logic Functions
- Data Transfer, Block Transfer
- Sub Routines
- Arithmetic functions & formula Calculations
- Communication functions with Remote I/O as well as Work stations
- Closed loop PID control functions including nested and cascaded loops.
- Output of PID controllers shall be 4-20 mA DC.
- Control valve position (in 4 – 20 mA) shall be made available in PLC.
- PID Controller shall have auto tuning facility
- Totalisation of flow inputs.
- Linearisation function blocks and other useful function libraries
- Linearisation function block shall be such that a table of values (X against Y) can be entered in a menu driven manner and for any particular field input X, the value of Y can be calculated using the values of table by interpolation method. Maximum 30 point linearisation function block shall be considered. Below 30, point of linearisation shall be user selectable.
- Built-in ambient temperature compensation for thermocouple inputs from field.
- Broken sensor detection etc.
- Simulation facility / software shall be supplied for programme testing without disturbing the working PLC.
- Minimum no. of PID Control Loops: 40.
- The complete PID blocks shall be transferred to HMI work station in place of split bits.
- All computer shall have anti – virus software.
The Software shall be suitable for PC based Programming Unit. |
### 2.0 Application Programme software
- Shall be as per process control requirement.
- The application programme software shall be written in Ladder logic / block diagrams / statement form.
- Online programme editing facility shall be available.
- Troubleshooting manual for all application software, system software, configuration, hardware, network, etc. to be provided, spelling out possible causes, checks and measures for corrective action.

### 3.0 HMI software
- Window based, latest version (at the time of implementation) of HMI software.
- HMI software package shall have the facility to perform multitasking, data acquisition, supervisory control, monitoring, control development and routine software.
- HMI software shall also have the features for alarming, trending, data logging, production backup history, operator action list, creation of shift reports after every shift, online printing of events.
- Number of graphic pages shall not be a limit.
- HMI software shall have the facility of handling unlimited tags (Digital as well as analog).
- HMI software shall be capable of curve fitting, co-relation & regression functions.
- In the engineering workstation & servers, development version of HMI software & Foundation Field bus system software (licensed versions) shall be provided.
- In the operator workstations, runtime version of HMI software & Foundation field bus system software (licensed versions) shall be provided.

### 4.0 Database Software
- ORACLE & DEVELOPER 2000 / As required & supported by the system offered.
- All logging (data, event, etc.) of HMI in ORDBMS.

### 5.0 Operating System
- WINDOWS NT / 2000 (Service Pack – Latest at the time of supply)

### 6.0 Testing
- All tests on software, hardware, network, communication, etc. shall be carried on the basis of a pre-agreed protocol clearly listing out steps involved in testing with its responsibility and minimum expected results as per specifications, engineering and other documents.
- Purchasers’ involvement in design of control philosophy development, application software and hardware combined, drawing up of software specifications, software development, off-line testing, etc. for both Level-I and Level-II system.
- Provisions to be made for off-line testing of Level-I and Level-II systems prior to actual deployment.

### 7.0 Miscellaneous
- All software required for design, development, testing, reporting-by-exception to be included. Troubleshooting, simulation, etc. should be supplied with requisite number of licenses.

06. Special tools and tackles for maintenance and troubleshooting:
Test equipments, tools, software, etc. for all relevant hardware and/or software systems/subsystems shall be provided.
Special tools to include tools in sufficient number for tracing, location, testing, jointing, fault location & rectification, termination etc. for all cables including special cables (network and FO cables) in all major units of the expansion projects.
Tenderer shall indicate the list of special tools and tackles.

07. Documentation:

All drawings, designs, configurations, software, numbers, models etc. listed in TS and GTS are indicative and minimum only. Bidder may suggest a better and more comprehensive solution.

08. Standardization:

- Minimum make / type shall be considered to minimize inventory.
- All automation hardware, including that employed in various machines, analyzers etc., from single manufacturer. No more than two models to be used for systems with more than 24 I/Os. Both models to have same programming environment. All the hardware in individual systems should be from the same product series. All the automation hardware shall be interfaced to Ethernet network connecting the systems to HMI.

09. Training:

Training to be provided for at least the following levels:
- Hardware of Automation System (PLC) and its programming & troubleshooting.
- Training on Electro-Hydraulics – Servo, proportional, etc.
- HMI system – configuration, programming & troubleshooting.
- Client-server hardware, architecture, operating system, etc.
- Fieldbus communication – configuration, programming & troubleshooting.
- Networking & communication systems – Relevant toolkits, protocol analyzes, scopes, loggers, etc., for maintenance and troubleshooting, to be included.
- All the training to be conducted by OEM or its authorized training partner at a fully equipped training center with facilities where extensive hands-on exercises can be performed with system, identical to one under supply. Curriculum of each program to be finalized in consultation with client. Required number of trainees (minimum 15) to be covered through multiple programs on each topic. Most of the training to be conducted before use. (number of trainees shall be as per commercial contract)

10. Conference Room Gadgets:

All the shops shall have a conference room in the new welfare building. Following gadgets shall be provided in the conference room by the tenderer:-

- In conference room, ceiling mounted projector with automatic screen and good quality music system, also to be included. Projector and music system also to be interfaced thru AV switching unit to all the computers in the room.
1.02.16 Large Screen Display System :-

Large screen display screen system shall be provided in the control room of the plant. The display system shall have linear setup in the control room. The display system shall consist of a matrix of rear projection modules for high overall resolution, a controller unit based on either MS-Windows or Linux, and optional wall management software. Rear projection modules shall have DLP (Digital Light Processing) technology.

The system shall have following features :-

- High resolution to show large applications with several video or RGB sources.
- The system shall not be susceptible to environmental factors like heat, humidity, or vibration, which can cause an image to degrade over time. The system shall be zero hassle and minimal maintenance. All components are carefully chosen to provide high mean time between failure and minimal mean time to repair.
- The system shall have excellent module to module color uniformity.
- The system shall have high contrast image.
- Modular Design
  The system shall be able to deliver a highly reliable and superior quality image display to the operator. The displays can be seamlessly integrated into any center. The modular concept shall also be applied within each module. System shall have separate fan- module, projection unit and illumination unit so that maintenance from the rear of the system is very easy. Filter and lamps can be replaced from the outside.
- Image optimization
- Built-in redundancy with hot standby configuration
- On screen menus

Size of the display system shall be 5m (length) x 3 m (width). Distance from the screen to operator shall be minimum 5 metres. The cube configuration shall be considered based on the above size of the screen. The display unit shall have following features:

- Full viewing angle : 180 degrees.
- Half gain angle (Horz. / vertical) : 35 deg. / 35 deg.
- Seam size screen : less than 0.2 mm
- Aspect ratio : 4 : 3

Operating condition:

- Humidity : upto 90 % non condensing
- Temperature : upto 50 deg. C.
- Optical dimming with dynamic feedback : Yes
- Power supply : 240 V AC, 50 Hz.
- EBU Colour triangle
• Inputs : Shall have all options of multi input module: DVI-D, DVI-I, Multi Sync RGB input (VGA upto UXGA), Video Input (PAL, NTSC, SECAM)

Projection unit shall have : -
• Single chip DLP technology .
• High resolution
• High contrast .
• Ergonomic luminance
• Integrated optical dimmer

1.02.17. UNINTERRUPTED POWER SUPPLY

<table>
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<th>1.0</th>
<th>Basic particulars for design :-</th>
</tr>
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<td>Input Voltage</td>
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<tr>
<td>(ii)</td>
<td>Input Frequency</td>
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<tr>
<td>(iii)</td>
<td>Output Voltage</td>
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<tr>
<td>(iv)</td>
<td>Output Voltage tolerance</td>
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<tr>
<td>(v)</td>
<td>Output Frequency</td>
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<tr>
<td>(vi)</td>
<td>Output Voltage wave form</td>
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<tr>
<td>(vii)</td>
<td>Harmonic Distortion</td>
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<td>(viii)</td>
<td>Voltage Distortion</td>
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<td>(ix)</td>
<td>Phase Displacement</td>
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<tr>
<td>(x)</td>
<td>Transient recovery</td>
</tr>
<tr>
<td>(xi)</td>
<td>Maximum ambient</td>
</tr>
</tbody>
</table>

2.0 Basic details

<p>| (i) | Duty type                      | True online continuous |
| (ii) | Reference standard             | Features and performance in line with IEEE 446 |
| (iii) | Overload                       | 125% of the rated output for 10 minutes 150% of the rated output for 30 sec |
| (iv) | Configuration                  | With isolating transformer, rectifier, inverter unit and necessary DC batteries |
| (v)  | Power device                   | Inverter power circuit shall comprise of IGBT using PWM control technique |
| (vi) | Redundancy                     | The system shall be of dual redundancy type in hot standby mode |
| (vii) | Static bypass                  | Automatic static bypass and common DC battery bank . The load shall normally be fed from the inverter. |</p>
<table>
<thead>
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<tbody>
<tr>
<td>(viii)</td>
<td>Maintenance bypass</td>
</tr>
<tr>
<td></td>
<td>In addition to static bypass switch , a manual changeover switch (MCCB) of adequate rating shall be provided to supply the load directly (bypassing the rectifier/charger, inverter, and static transfer switch) from the mains instead of through the UPS system .</td>
</tr>
<tr>
<td>(ix)</td>
<td>Battery bank</td>
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<tr>
<td></td>
<td>Maintenance bypass shall be provided in parallel to the static bypass line with an isolation device . The contacts of the isolation device shall be of ‘make before break’ type .</td>
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<td>• Sealed maintenance free (SMF) batteries shall be provided for the battery bank .</td>
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<td>• The batteries shall be housed in a separate battery cabinet located adjacent to the UPS panel .</td>
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<tr>
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<td>• The battery power pack shall include SMF battery housed in a separate cabinet . Battery cells shall be mounted on slide-out trays for ease of maintenance .</td>
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<td>• A battery disconnect circuit breaker with undervoltage release (UVR) shall be included for isolation of the battery pack from the UPS module .</td>
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<tr>
<td></td>
<td>• The UPS shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level .</td>
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<tr>
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<td>• Casters and leveling feet shall also be provided with the battery power pack cabinet for ease of installation .</td>
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<td>• The battery bank shall be installed in separate panel beside the UPS panel in the airconditioned environment located in the control room itself .</td>
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<tr>
<td>(x)</td>
<td>Battery backup</td>
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<td></td>
<td>Battery shall be suitable to maintain the power supply for at least 30 minutes (throughout the total duration) in the event of mains failure with rated capacity of the UPS at full load .</td>
</tr>
<tr>
<td>(xi)</td>
<td>Battery management system</td>
</tr>
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<td>UPS shall have latest ‘Battery Management System’ to charge / discharge the entire battery automatically .</td>
</tr>
<tr>
<td>(xii)</td>
<td>UPS management</td>
</tr>
<tr>
<td></td>
<td>UPS shall have latest ‘UPS Management System’ to load / unload the UPS automatically .</td>
</tr>
<tr>
<td>(xiii)</td>
<td>AC DB</td>
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<td>Necessary distribution board for distribution of power from UPS output to individual consumers .</td>
</tr>
<tr>
<td>(xiv)</td>
<td>Loading capability</td>
</tr>
<tr>
<td></td>
<td>UPS shall be capable of taking 100 % non linear loads .</td>
</tr>
<tr>
<td>(xv)</td>
<td>Interchangeability of sub assemblies</td>
</tr>
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<td></td>
<td>The UPS shall be constructed of replaceable subassemblies . PCB’s shall be plug-in type . Like assemblies and like components shall be interchangeable .</td>
</tr>
<tr>
<td>(xvi)</td>
<td>Noise level</td>
</tr>
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<td>Maximum noise level shall be less than 60 dB at a distance of 1 m from the body of the UPS .</td>
</tr>
<tr>
<td>(xvii)</td>
<td>Efficiency</td>
</tr>
<tr>
<td>(xviii)</td>
<td>Isolation transformer</td>
</tr>
</tbody>
</table>
| (xix)   | Grounding   | - The AC output neutral shall be electrically isolated from the UPS chassis.  
- The UPS chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.  
- Component mounted doors shall be separately earthed through 2.5 sq.mm PVC insulated green/green-yellow color flexible copper wire. |
| (xx)    | Communication port | The UPS shall have inbuilt RS 485 port for display of online status of UPS on HMI. |

3.0 Rectifier  
- Dual rectifier with each unit rated for supplying both inverter load and battery charger load in different modes.  
- Rectifier unit shall consist of minimum six pulse bridge connection.  
- Active front end rectifier set to reduce the harmonic distortion.  
- With necessary smoothing reactor and filters  
- Automatic boost and float charging control.  
- Equalizing mode for compensating the charge lost by the battery after a discharge automatic changeover from equalizing mode to float mode and vice-versa. |

4.0 Protective features  
- Maximum current limiting.  
- Automatic reduction of current limit in the event of cooling fan failure.  
- Boost charging and float charging current limiting  
- Surge suppressor in output side of the UPS. |

5.0 Inverter  
- With input circuit consisting of battery contactor, battery filter and smoothing reactor.  
- DC/AC converter for voltage control.  
- Inverter proper and control electronics.  
- Series reactor and parallel filter.  
- Output transformer |

6.0 Protection  
- Abnormal output voltage (over voltage & under voltage).  
- Abnormal link voltage.  
- Over current on output.  
- Over current on input or commutating failure.  
- Low battery voltage.  
- High transformer temperature.  
- Auxiliary supply failure.  
- Fan failure.  
- Logic failure.  
- Clock failure.
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
</table>
| 7.0 Static by-pass switch | - Fast acting HRC fuse for inverter circuit and control circuit  
- Reverse power protection for parallel inverters .  
- Static switch automatically switches the load to the reserve power supply for the mains whenever there is failure in inverter supply to the load .  
- Fast acting inverter contactor shall connect the inverter output to the load.  
- High speed fuses shall be provided for protecting the thyristor against accidental overload. |
| 8.0 Indicating meters to be provided on the ACDB panel | - Input voltmeter with selector switches .  
- Input ammeter with selector switches  
- DC voltmeter with selector switches  
- Centre zero type DC ammeter for measurement of charging/discharging current from the battery .  
Digital type meters shall be provided for the following :  
- AC output voltmeter with selector switch  
- Separate frequency meter to see Input and Output frequency .  
- AC output ammeter with selector switch  
- AC voltmeter with selector switch for bypass circuit .  
- AC ammeter with selector switch for bypass circuit .  
- Frequency meter for bypass circuit . |
| 9.0 MIMIC on UPS panels | - MIMIC of the system power flow diagram as single-line diagram of the UPS shall be provided on UPS panels front door with long-life LED's integrated within the single line diagram to indicate the operating status of different components/sections of the UPS. |
| 10.0 Display and Operating system | - The UPS shall be provided with a microprocessor based keypad and display unit mounted on UPS panels front door for operating and viewing the UPS status for convenient and reliable user operation .  
- The monitoring functions such as metering, status and alarms shall be displayed on an alphanumeric LCD display.  
Additional features of the monitoring system shall include:  
- Menu-driven display with text format  
- Real time clock (time and date)  
- Alarm history with time and date stamp (minimum upto 16 faults in memory with FIFO sequence)  
- Battery back-up memory / condenser charged back up memory . |
| 11 | Metering | The following parameters shall be displayed:  
|    |          |   • Input AC voltage line-to-line and line-to-neutral for each phase.  
|    |          |   • Input AC current for each phase  
|    |          |   • Input frequency  
|    |          |   • Battery voltage status  
|    |          |   • Battery charge/discharge current  
|    |          |   • Output AC voltage  
|    |          |   • Output AC current  
|    |          |   • Output frequency  
|    |          |   • Percent of rated load being supplied by the UPS  
|    |          |   • Battery time left during battery operation.  |
| 12 | Alarm Messages | • Input power out of tolerance  
|     |           | • Input phase rotation incorrect  
|     |           | • Incorrect input frequency  
|     |           | • Charger in reduced current mode  
|     |           | • Battery charger problem  
|     |           | • Battery failed test  
|     |           | • Low battery voltage warning or blown battery fuse  
|     |           | • High battery voltage  
|     |           | • DC bus overvoltage  
|     |           | • Bypass frequency out of range  
|     |           | • Load transferred to bypass  
|     |           | • Excessive retransfers attempted  
|     |           | • Static switch failure  
|     |           | • UPS output not synchronized to input power  
|     |           | • Input power single phased  
|     |           | • Input voltage sensor failed  
|     |           | • Inverter leg overcurrent in X-phase  
|     |           | • Output undervoltage  
|     |           | • Output overvoltage  
|     |           | • Output overcurrent  
|     |           | • System output overloaded  
|     |           | • Load transferred to bypass due to overload  
|     |           | • Fan failure  
|     |           | • Overtemperature shutdown  
|     |           | • An audible alarm shall be provided and activated by any of the above alarm conditions.  |
| 13 | Status Messages | • Normal operation  
|     |            | • Load on maintenance bypass  
|     |            | • Load on UPS  
|     |            | • Load on static bypass  
|     |            | • System shutdown  
|     |            | • UPS on battery  |
| 14 | Controls | • UPS start-up / shutdown shall be done by push button / rotary control switch  
|     |           | • Normal operation / bypass operations shall be done by a single rotary control switch.  
|     |           | • An advisory display and menu-driven user prompts writeup sticker (pasted inside the
panel door) shall be provided to guide the operator through system operation without the use of additional manuals.
- Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms.

15.0 Constructional features

<table>
<thead>
<tr>
<th>(i) Isolation devices</th>
<th>The UPS system shall consist of a dedicated ACDB panel consisting of Incoming and Outgoing terminal blocks, MCCB’s, power and auxiliary contactors, isolation transformers.</th>
</tr>
</thead>
</table>
| (ii) Installation    | MCCB (upto 630A) in incoming side  
|                      | TPN/SPN MCB (of adequate rating) in outgoing side.  
|                      | Power circuit isolation device to have pad locking in the OFF position with the door closed |
| (iii) Mounting       | Metal clad , indoor installation |
| (iv) Enclosure protection | Totally enclosed dust and vermin proof.  
|                      | IP - 42 |
| (v) UPS housing      | Each UPS system shall be housed in a separate cubicle, complete with an individual front and back access door with concealed type hinges.  
|                      | For UPS panel all the switches, indication lamps and meters shall be flush mounted on the respective compartment door.  
|                      | For ACDB panel the input MCCB’s and output MCB’s shall be operated from outside the panel door |
| (vi) Back access     | Each panel shall have a door on back side . All the doors shall have neoprene gasket .  
|                      | Natural rubber gasket shall be provided between adjacent panel doors and removal covers . |
| (vii) Lifting hooks  | Lifting hooks for each panel shall be provided |
| (viii) Designation plate for UPS | Inscription plate for each panel :-  
|                      | Name plate shall be provided at top centre of the UPS panel .  
|                      | Name plates will be of Anodised Aluminium with white letters engraved on black background and in English language .  
|                      | Letter height for UPS designation plate shall be in the range of 25-50 mm .  
|                      | Individual components shall be identified with identification plate and shall match with the identification tags mentioned in the drawing .  
|                      | Danger board shall be provided on front and rear side of the UPS both in Hindi , English languages . |
| (ix) Thickness of sheet steel (CRCA) | Load bearing members : 2.0 mm  
|                        | Non load bearing member : 1.6 mm |
### Door earthing
- Hinged door at front and back with flexible earthing connection.

### Cable entry
- **Incomer**: Bottom cable entry
- **Outgoing**: Bottom cable entry

### Gland plates
- Undrilled removable bottom gland plates (3 mm thick)

### Output power indication
- Auxiliary contactors shall be provided in output side of the UPS for potential free contacts for indication of UPS and non UPS power supply at different location.
- Proper transducers shall be provided for voltage and frequency indication at different locations.

### Cooling of panels
- Panels shall have fan installed vertically at top for forced air draft and louvers with screen protection in bottom.
- Fans shall be powered from input supply of the UPS. Low velocity fans shall be used to minimize audible noise output.
- The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.
- The UPS shall be installed in air conditioned environment.

### Bolts, nuts & cable glands
- All bolts and nuts for terminations shall be cadmium coated.
- Double compression cable glands for receiving external power & control cables.
- Compartment door interlocked with the isolating device for safety with provision for defeating it by authorised person.

### Indicating lamps
- All indicating lamps shall be of LED cluster high density type.

### Finish
- Interior and exterior: RAL 7035

### Terminal block
- Terminal block for incoming cable shall be located in back side and outgoing cables shall be in front side of the ACDB panel.
- All incoming terminal blocks shall be fully insulated for the working voltage.
- The terminal blocks shall be sleeved color coded Red, Yellow, Blue, Black for R,Y,B,N respectively using heat shrinkable PVC sleeve.
- All outgoing terminal blocks shall be sleeved color coded Red and Black for line and phase respectively using heat shrinkable PVC sleeve.
- Colour coding shall be provided for TB's and wires for different voltages level.
- All the terminal blocks shall be shrouded.
- Not more than two connections shall be made at one terminal.
- Terminal blocks shall be suitable to connect.
### Minimum air clearance for bare busbars
- Phase to phase: 25.4 mm
- Phase to earth: 19.0 mm

### Output power bus
- The solid output power bus shall be of bare copper with a minimum rating of 100 A at 240 V AC (1 pair).

### Earth bus
- The main earth bus shall be of 50 x 10 mm GI with extension at both ends of switchboard for connection to safety grounding network. Earth busbar shall run continuous throughout the UPS panel at bottom.

### Panel internal wiring
- The panel internal wiring shall be carried out by 1100 V grade, single core, black color PVC insulated, stranded copper wire of following size:
  - Current transformer circuit: 4.0 sq.mm
  - Control and potential circuit: 2.5 sq.mm
  - Identification of wire shall be numbered by plastic/ceramic ferrules.
  - Ferrules shall be self locking type.

### Incoming Feeders
- 3 pole MCCB.
- Ammeter with 4-position selector switch (three phases & OFF).
- Voltmeter with 4-position selector switch and fuses (three line-line & OFF).
- Current transformers (for metering).
- 3 nos. indicating LED type lamps (R,Y,B).
- 3 nos. indicating LED type lamps (CB ON-Red, CB OFF-Green, CB TRIP-Amber).
- Following protections are required for the MCCB controlled:
  - Incomers:
    - Overcurrent releases.
    - Short circuit.
    - Earth fault.

### Outgoing Feeders
- Each outgoing feeder shall have followings:
  - Outgoing feeders shall have SPN MCB.
  - MCB of 09 kA rating with Thermo-magnetic releases.

### Testing
- All routine tests shall be as per IS-8623 (Part-II) 1993.
- Type test certificate shall be submitted.

### Documentation
- Operation & maintenance manual.
- Wiring diagram (internal panel showing individual components and flow of wires).
1.02.18 Electronic Weighing System

This section covers electrics for belt weigh feeders, loss in weigh feeders, load cell based bunker level measuring system & belt weigh scales.

1.1 Microprocessor based Individual Weighing Controller (IWCs) with digital display and keyboards – for Belt weigh feeders/ Loss in weigh feeders

1.2 VFD drive for speed control of AC motors of belt weigh feeders with necessary switchgears, incoming choke, output reactors if required, protective devices, communication links with IWC, input/output for remote start/stop, interlocking, indication lamps, controls, metering, potential free contacts for remote status indication like ON/OFF/TRIP/ converter fault (to be wired to PLCs), motor protective devices at field etc. Technical features of VFD drive shall be as per General specification for electrical system(GS-03).

1.3 Individual Belt Weigh feeder panels housing IWC (Intelligent weighing controllers) controller & VFD drive, DOL starters for vibrating hoppers interlocked with belt weigh feeders.

1.4 Microprocessor based Bin weight measuring panels with digital display and keyboards with auto taring and auto calibration facility. Bin Measurement panels housing IWC controller (IWC Controllers for mote than one Bin can be combined in one panel.

1.5 Belt weigh scale panels (if any as per Mechanical scope) housing microprocessor based measuring indicator with digital display and keyboards with auto taring and auto calibration facility.

1.6 Provisions for Communication with PLC / DCS.

Belt Weight feeder IWC, Bin weigh measuring controller & Belt Weigh Scale IWC shall be able to communicate 100% with purchaser’s PLC/DCS on the plant communication bus as selected (like Profibus DP) by Tenderer.

1.7 Load cells, techogenerators, field junction boxes, limit switches etc. for Belt weigh feeders, Bin level measuring systems, Belt weigh scales (if any).

1.8 Common local control station for Belt weigh feeders & Vibrating hoppers (as applicable) housing Local /Off/Auto selector switches, Start/stop push buttons, speed increase/decrease, TPH indicators etc.

1.9 Local Indicator panels for Bin weighing control & Belt weigh scales (if any)

1.10 LT AC motors for belt weigh feeders & vibrating hoppers.

1.11 Calibration weights for belt weigh feeders.

1.12 Supply of dummy load cells for various Bunkers (BLMS system)

1.13 Features for Belt slip detection in case of weigh feeders, like tail end tacho or other suitable measures shall be provided by Tenderer.
2.1 DESIGN BASIS FOR BELT WEIGH FEEDER/LOSS IN WEIGH FEEDER

The weighing system shall be designed, manufactured, assembled and tested in accordance with relevant OIML/NTEP Standard. Equipment shall comply with statutory requirement of Weights & Measures Deptt. Govt. of Chhatisgarh and Govt. of India. The equipment shall be of proven designed, imported and reputed make.

The consistency of the feed rate shall be guaranteed within +/- 0.5% of the set value within the operating range of 10% to 100% of rated capacity.

The weighing control shall be totally automatic with close loop control. The feed rates of different materials shall be calculated by the computer and set points of Belt weigh feeder shall be set by the computer through PLC. In case of computer failure manual setting (remote manual) and operation of feeders shall be possible.

Load cell shall be globally reputed make, confirming to OIML/NTEP Standard and preferably digital type, side mounted and easily replaceable type.

Weighing system shall be mounted in the horizontal portion of the conveyor with multi idler/weigh carriage system.

Equipments shall be provided with anti sway, anti sagging and anti slip devices.

Auto zero track, annunciation and diagnostic facility shall be provided.

Surge, radiation, EMF & RF protection devices shall be provided.

Test weights for different range of calibration should be provided with each equipment.

Redundant electronics shall be provided.

Special tools & tackles shall be provided with the equipment. Such as HBM/Molen load cell calibrator – 2 nos., Portable think Pad based software programmer – 2 nos.


Two years maintenance spares shall be included.

Compress air and high pressure water injection facilities to be provided for cleaning of weighing area.

Training on maintenance aspect is required for Inst. & Weighment personnel.

2.2 CONTROLLER PANELS OF BELT WEIGH FEEDERS/LOSS IN WEIGH FEEDER PANEL

The IWCs for control of Belt weigh feeders/ LIWs shall be microprocessor based having automatic weighing and calibration facilities. The system shall be complete with protection against overloading. Accuracy of Belt weigh feeders shall be +/-0.5% or better of preset feed rate.

It shall be possible to operate the Belt weigh feeders under the following modes:

Local - Volumetric
Local - Gravimetric
Remote - Gravimetric (remote manual/PLC automatic)

Under remote mode of operation, following control shall be possible.

Remote - From IWC panel
Remote - From HMI station at individual shop control room.
Microprocessor shall be provided with each IWC as per standard design/ system requirement. IWC shall generate signal for material feed rate in t/hours. The IWC shall compare the actual feed rate with the set point feed rate and generate a suitable correction for the VVVF converter of belt drive. The signal shall change the belt speed and accordingly provide the desired feed rate. It will be complete with auto calibration, auto tare, auto belt slip/ drift monitoring facilities etc. The stored values after calibration shall not change due to power failure.

Belt Weigh feeder panel housing above IWC & VFD drive shall also be provided with following control equipment /facilities.

- Main incoming MPCB/MCCB (50kA) for incoming power supply
- Control transformer (415/110V) with MPCB (50kA) at primary, MCBs at secondary.
- MPCB, Power contactor (min. 25A), thermal overload relay, necessary auxiliary contactors, ON/OFF/TRIP indication lamps for each motor of bin vibrating hoppers.
- Necessary Power supply units, conversion equipment.
- DP MCBs for incoming UPS power supply and its distribution to all panels.
- Panel illumination lamps (fluorescent tubular).
- Start/stop push button, selector switches as required.
- Power ON indication.
- Power and control terminals.

The IWC shall have following features (minimum)

- Actual flow rate indicator.
- Set rate feed indicator.
- Totalised amount indicator.
- Belt load indicator.
- Belt speed indicator.
- Deviation indicator.
- Fault messages (separate lamps).
- Operational mode selector switch for gravimetric/volumetric/calibration/ Automatic and Constringency mode selection.
- Auto taring & calibration.
- Load cell/Tacho filter time
- No motion alarm set.
- Material starvation signal
- Load sensor break
- Material over/under load alarm
- Gravimetric / volumetric deviation alarm
- Proportional band, Integral time, Derivative time (for Gravimetric / volumetric mode) for PID.
- Tantalizer value
- Tare value
- Load electrical value
- Speed electrical value

Following displays and messages shall be possible for all the operating and calibrating functions:

- Set point.
- Normal/Maintenance/Calibration modes.
- Actual feed rate.
- Belt load (Platform load).
- Belt speed.
- Totaliser value.
- Deviation error between set and actual feed rate.
- Service data such as measured value, controller output, control signal level etc.
- Event messages/fault messages.

The above shall be available on each IWC on digital display unit in central control room. Display and messages listed above shall also be made available on VDU of PLC/DCS.

Panel Construction features.

- Floor mounted, free standing.
- Dust and vermin proof.
- CRCA sheet steel clad.
- Minimum 2.0 mm thick for panels.
- Suitable to withstand vibrations to be encountered in steel plant applications.
- Cubicles with illumination lamps door switches, space heaters and adequate sockets for soldering.
- All control blocks plug-in-type with necessary test sockets.
- Units shall be self contained and serviceable.
- Power wiring – Min 2.5 sq.mm. Cu
- Control wiring – Min 1.5 sq.mm. Cu
- The panel door shall be provided with toughened glass in front of controllers for viewing of display units without opening the panel door. All control devices and indicators shall be mounted on the front. Two numbers earthing studs shall be provided with the panel for external earthing. All power, control, and signal terminals of different voltages shall be segregated. 20% spare terminals shall be provided in the panel.

3.1 BIN/WEIGH HOPPER LOAD CELLS AND LEVEL MEASURING SYSTEM:

Design Basis for Bin Level Measuring System

Equipment shall comply with statutory requirement of Weights & Measures Deptt. of Govt. of India. Load cell shall be of globally reputed make, confirming to OIML/NTEP Standard & preferably digital type. Load cell shall be easily replaceable type, provided with safely devices from impact load, vibration and lifting arrangement facility. Lightning & Surge protection devices shall be provided in load cells, JBs, electronics & main electrical power supply. Load cells shall be of high precision strain gauge type, hermetically sealed, robust in design, shock proof and insensitive to overload, temperature, vibration, electrical noise etc. Enclosure class shall be IP 67 / IP 68.

Load cell shall be provided with ambient temperature compensating device upto 55 deg. C. Provision shall be kept to neutralise the error caused due to application of transverse forces. Max. Measurement error permitted is +/- 1%

Weighing system shall be auto zero & auto calibration facilities.

Test weight for calibration shall be provided.

The weighing system shall be hooked up with customer host computer and shall support remote monitoring on BSP’s Existing Plant Wide Network.

3.2 CONTROL PANEL FOR BIN LEVEL MEASUREMENT (BLM)/HOUSING IWC

Bin level measurement system shall be microprocessor based having automatic weighing, taring and necessary calibration facilities. The system shall be complete with protection against overloading. Accuracy of weighing +/-0.1% or better.
The controller shall have digital display and keyboards, indication, alarm, annunciation etc. It will be complete with auto calibration, auto tare facilities etc. The stored values after calibration shall not change due to power failure.

The controller shall be complete with built in power supply unit, CPU, program memory, A/D & D/A converters, etc. The above will be of modular design using standard PCBs and connectors.

It should communicate actual weight/level, conditions for bin empty, level low, level high etc to Automation system.

One no. large display unit for outdoor display shall be provided.

Compress air and high pressure water injection facilities to be provided in weighing area.

4.1 BELT WEIGH SCALES

The IWPs for control of belt weigh scales shall be microprocessor based having automatic weighing and necessary calibration facilities. The system shall be complete with protection against overloading. Accuracy of belt weigh scale shall be +/-0.25% or better of flow rate.

Microprocessor as per standard design/ system requirement shall be provided each IWC. Microprocessor shall multiply load cells and conveyor speed signal in digital form to generate signal for material conveying rate in T/Hours. It will be complete with auto calibration, auto tare etc. The stored values after calibration shall not change due to power failure.

The following displays and messages shall be available for all the operating and calibrating functions:

- Conveying rate in TPH.
- Belt load (Platform load)
- Belt speed.
- Totaliser value.
- Service data such as measured value, controller output, control signal level etc.
- Event messages/fault messages.
- Auto taring & Error corrections.

The above shall be available on each IWC on digital display unit. Display and messages listed above will be made available on VDU of in central control room.

Panel Constructional feature

Shall be same as for Weigh feeder panels.

5.0 DIGITAL TECHGENERATORS

It will be of robust construction and designed to give guaranteed accuracy of feed rate. It shall generate consistent output pulses of positive or negative polarity as applicable by accepting shaft rotation. The output pulses shall be suitable for feeding into high impedance electronic circuit/instrument for digital measurement and control. The enclosure class shall be IP 67. It will be provided with ambient temperature compensating device.

Arrangement of mounting of techogenerators and its coupling with AC motor shall be decided considering ease of maintenance.
Each belt Belt weigh feeder/Loss in weigh feeder shall be supplied with a local box with following features.

- Sheet steel (2.0mm thick) construction.
- Wall/structure mounted type.
- Hinged door, dead front type.
- Enclosure class IP-55.
- To be painted as per standard procedure agreed.
- Internal wiring with 1.5 sq.mm copper conductor.
- The box shall be wall/structure mounted type and be complete with cable glands and lugs.

The LCB shall be provided with the following:

- Local – Off – Remote selector switch.
- Start/Stop push buttons
- Emergency stop push button (press to lock turn to release type)
- Increase/decrease PB for speed setting
- Feed rate actual (TPH meter – digital type).
- Start/stop push button for bin vibrator
- Indication lamps.
- Any other device required for satisfactory operation of BWFs to be decided during detailed engineering.

Each local indication box for BLMS/Weigh Scales shall have digital indication of Bunker level/feed rate.

7.0 LOAD CELLS

- Load cell shall be imported reputed make as per OIML / NTEP standards with surge protection.
- Compression type suitable for weigh hoppers and material presence detectors on charging conveyor.
- Enclosure class IP 67 / IP68
- Hermetically sealed, stainless steel precision strain gauge / digital type.
- Maximum usable load: 200%
- Destruction load: >500%
- 300% over load capacity.
- Suitable for maximum 70°C.
- Temperature compensation range: - 40°C to 70°C
- Capacity of the Load cell for BLMS system shall be as per details given under mechanical part. However, final rating of load cells shall have safety margin of minimum 150% of the rating calculated.
- Load cell accuracy 0.04%
- Combined error: ± 0.03%
- Excitation: 10 to 50 V dc
- Zero balance: ± 1% of R.O.
- Insulation resistance: >5000MΩ
- Complete with excitation source, transmitter, amplifier, junction boxes, special cables, etc.

1.02.19 CABLES:

1. HT Cables
   (i) 11 kV (UE) XLPE cables
<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage Grade</td>
<td>11 kV (UE)</td>
</tr>
<tr>
<td>2.0</td>
<td>Duty type</td>
<td>Heavy duty</td>
</tr>
<tr>
<td>3.0</td>
<td>No. of cores</td>
<td>3 cores</td>
</tr>
</tbody>
</table>
| 4.0   | Reference standard                    | IS:8130 – 1984  
IS:5831 – 1984  
IS:3975 – 1988  
IS:1554, part-1, 1988  
IS:7098 Part-I & II  
IEC-60502                                                                 |
| 5.0   | Conductor type                        | Compact circular stranded (rm/V) aluminum conductor, with conductor screening of extruded semi conducting material. Conductor construction class-2 as per IS 8130-1984. |
| 6.0   | Insulation type                       | XLPE insulated and insulation provided with shielding of extruded semi conducting compound over individual core followed by lapped semi conducting material and copper tape (non magnetic) metallic screen, cores stranded together with a holding tape provided with a common covering of extruded inner sheath of type ST2 compound. Thickness of the insulation shall be 5.5 mm for size 3x185 sq.mm as per table-2 IS 7098 (part-II) 1985. |
| 7.0   | Armour                                | Galvanized steel wire armoured. For multi core cables, armouring shall be applied over the inner sheath by flat steel wires strips (formed wire). Round steel wire armouring can also be offered. For single core armoured cables non-magnetic armour consisting of hard drawn flat or round aluminium wires shall be provided. |
| 8.0   | Outer sheath                          | Overall PVC outer sheath of type ST-2 compound as per IS 5831/1984. Outer sheath should be applied with extrusion only cables to be ISI marked. Thickness of the outer sheath shall not be less than 3.6 mm for size 3x185 sq.mm as per table –5 of IS:7098 (part-II)/1985 & IS:10462 (part-I)/1983. The sheath shall be black in colour. Suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack. |
| 9.0   | Miscellaneous                         | Copper screen shall be suitable to carry 1 KA E/F current for one second. |
| 10.0  | Temp. rise on continuous load         | 90 deg.C                                                                                                                                    |
| 11.0  | Oxygen index of outer sheath material for XLPE Cable | Shall not be less than 29 at 27 ± 2 deg. C.                                                                                               |
| 12.0  | Temperature index                     | Not below 250°C.                                                                                                                             |
| 13.0  | Max. conductor withstand temperature during short circuit. | 250°C                                                                                                                                 |

(i) 6.6 kV (UE) XLPE cables
<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage Grade</td>
<td>6.6 kV (UE).</td>
</tr>
<tr>
<td>2.0</td>
<td>Duty type</td>
<td>Heavy duty</td>
</tr>
<tr>
<td>3.0</td>
<td>No. of cores</td>
<td>3 cores</td>
</tr>
</tbody>
</table>
| 4.0   | Reference standard               | IS:8130 – 1984  
IS:5831 – 1984  
IS:3975 – 1988  
IS:1554, part - 1, 1988  
IS:3961 (Part-II) - 1967.  
IS:7098 Part-I & II  
IEC-60502                                                                 |
| 5.0   | Conductor type                   | Compact circular stranded (rm/V) aluminum conductor, with conductor screening of extruded semi conducting material. Conductor construction class-2 as per IS 8130-1984. |
| 6.0   | Insulation type                   | XLPE insulated and insulation provided with shielding of extruded semi conducting compound over individual core followed by lapped semi conducting material and copper tape (non magnetic) metallic screen, cores stranded together with a holding tape provided with a common covering of extruded inner sheath of type ST2 compound. Thickness of the insulation shall be 5.5 mm for size 3x185 sq.mm as per table-2 IS 7098 (part-II) 1985. |
| 7.0   | Armour                            | Galvanized steel wire armoured. For multi core cables, armouring shall be applied over the inner sheath by flat steel wires strips (formed wire). Round steel wire armoring can also be offered. For single core armoured cables non-magnetic armour consisting of hard drawn flat or round aluminium wires shall be provided. |
| 8.0   | Outer sheath                      | Overall PVC outer sheath of type ST-2 compound as per IS 5831/1984. Outer sheath should be applied with extrusion only cables to be ISI marked. Thickness of the outer sheath shall not be less than 3.6 mm for size 3x185 sq.mm as per table –5 of IS:7098 (part-II)/1985 & IS:10462 (part-I)/1983. The sheath shall be black in colour. Suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack. |
| 9.0   | Miscellaneous                     | Copper screen shall be suitable to carry 1 KA E/F current for one second.                                                                 |
| 10.0  | Temp. rise on continuous load     | 90 deg.C                                                                                                                                 |
| 11.0  | Oxygen index of outer sheath material for XLPE Cable | Shall not be less than 29 at 27 ± 2 deg. C.                                                                                           |
| 12.0  | Temperature index                 | Not below 250°C.                                                                                                                          |
| 13.0  | Max. conductor withstand temperature during short circuit. | 250°C                                                                                                                                     |

2. LT CABLES
### 1.1 kV Power Cable

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage Grade</td>
<td>1.1 kV grade</td>
</tr>
<tr>
<td>2.0</td>
<td>Duty type</td>
<td>Heavy duty</td>
</tr>
<tr>
<td>3.0</td>
<td>No. of cores</td>
<td>- 3.5 / 4 core cables shall be used for motor feeders.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- For other consumers or for power supply to other panel 4 core (upto conductor size of 50 sq.mm) or 3.5 core (for conductor size beyond 50 sq.mm) cables shall be used.</td>
</tr>
<tr>
<td>4.0</td>
<td>Reference standard</td>
<td>IS:8130 – 1984</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS:5831 – 1984</td>
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<td></td>
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<td></td>
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<td>IS:7098 Part-I &amp; II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC-60502</td>
</tr>
<tr>
<td>5.0</td>
<td>Conductor type</td>
<td>- Pain aluminium conductor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- All power cables of size 10 sq.mm and above shall have standard sector shaped (sm) or compact circular stranded (rm/V) or circular stranded (rm) aluminium conductors as applicable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The conductors will be H2 or H4 grade.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The solid conductor shall be class - 1 and the stranded conductor will be class - 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The conductors shall be solid for conductor of nominal area upto and including 6 sq. mm. and stranded beyond 6 sq. mm. Conductors of nominal area less than 25 sq. mm. shall be circular or shaped. Cables with reduced neutral conductor shall have sizes as per Table 1 of IS 1554 (Part-1) -1988.</td>
</tr>
<tr>
<td>6.0</td>
<td>Insulation type</td>
<td>- XLPE insulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The insulation compound shall be conforming to IS:7098 (Part I) - 1988.</td>
</tr>
<tr>
<td>7.0</td>
<td>Inner sheath</td>
<td>- For armoured / unarmoured cables a tough inner sheath of heat resisting PVC compound (wrapped / extruded as per size) ,Type ST2 as per IS 5831 .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Black in colour.</td>
</tr>
<tr>
<td>8.0</td>
<td>Armour</td>
<td>- Galvanised steel wire armour shall be used for 3Cx10 sq.mm / 4Cx6 sq.mm cable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Galvanised flat steel wires (strips) armour shall be used for bigger size cables.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Single core armoured cables are provided with non-magnetic armour consisting of hard drawn flat or round aluminium wires.</td>
</tr>
<tr>
<td>9.0</td>
<td>Outer sheath</td>
<td>- For armoured / unarmoured cables a tough outer sheath of heat resisting PVC compound (Type ST2 as per IS 5831) .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Black in colour.</td>
</tr>
<tr>
<td>10.0</td>
<td>Miscellaneous</td>
<td>- Minimum cross - sectional area of the power cable shall be 6 sq.mm in case of aluminium conductor and 2.5 sq.mm in case of copper conductor.</td>
</tr>
</tbody>
</table>
- Power cables shall be selected from core sizes of 6, 10, 16, 25, 50, 70, 120, 150, 240 & 300 sq.mm (Aluminium conductor).

11.0 Temp. rise
Shall be limited to 90 deg.C.

12.0 Core identification
- Cable identification will be provided by embossing on the outer sheath the following:
  - Manufacturer’s name & trade mark
  - Voltage grade
  - Year of manufacture
  - Type of insulation
  - R,Y,B for phases.
  - Black for neutral (fourth core)

(ii) 1.1 KV Grade Control Cable :-

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage Grade</td>
<td>1.1 kV grade</td>
</tr>
<tr>
<td>2.0</td>
<td>Duty type</td>
<td>Heavy duty</td>
</tr>
<tr>
<td>3.0</td>
<td>No. of cores</td>
<td>As per requirement.</td>
</tr>
<tr>
<td>5.0</td>
<td>Cross sectional area</td>
<td>Shall be 1.5 / 2.5 sq.mm. (as per TS)</td>
</tr>
<tr>
<td>6.0</td>
<td>Conductor type</td>
<td>Solid annealed circular stranded copper conductor.</td>
</tr>
<tr>
<td>7.0</td>
<td>Insulation type</td>
<td>XLPE insulated</td>
</tr>
<tr>
<td>8.0</td>
<td>Inner and outer sheath</td>
<td>- Type ST-2 PVC shall be used for inner sheath .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Type ST-2 PVC shall be used for outer sheath .</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Both inner and outer sheath shall be extruded type upto 7 core and after 7 core inner sheath shall be wrapped.</td>
</tr>
<tr>
<td>9.0</td>
<td>Armour</td>
<td>- Galvanised steel wire armour shall be used for cables upto 14 cores.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- For cables having larger number of cores galvanised formed wire (steel strip) shall be used.</td>
</tr>
<tr>
<td>10.0</td>
<td>Spare Cores</td>
<td>- 3, 5 and 7 cores cables shall have at least one spare core, cables with 10 core and above shall have at least 2 spare cores.</td>
</tr>
<tr>
<td>11.0</td>
<td>Miscellaneous</td>
<td>- The Tenderer shall furnish necessary calculations to show that the selected cable satisfy the criteria including for voltage drop.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Cables for temperature detectors shall be screened type of required technical parameters with core size not less 1.5 sq.mm.</td>
</tr>
<tr>
<td>12.0</td>
<td>Core identification</td>
<td>- Cable identification will be provided by embossing on the outer sheath the following:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Manufacturer’s name &amp; trade mark</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Voltage grade</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Year of manufacture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Type of insulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Cores of the cables upto 5 cores shall be identified by</td>
</tr>
</tbody>
</table>
- The colouring of insulation.
  - For cables having more than 5 cores, core identification shall be done by numbering insulation of core sequentially.
  - All the numbers shall be of same colour, which shall contrast with the colour of insulation.
  - Numbers shall be written in figures and words both.
  - The numerals shall be legible and indelible.
  - The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other.
  - When number is a single numeral a dash shall be blacked underneath.
  - If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral.
  - The spacing between consecutive numbers shall not exceed 100 mm.

(iii) 1.1 KV Grade Screened /Special Cable :-

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage Grade</td>
<td>1.1 kV grade</td>
</tr>
<tr>
<td>2.0</td>
<td>Duty type</td>
<td>Heavy duty</td>
</tr>
<tr>
<td>3.0</td>
<td>No. of cores</td>
<td>As per requirement</td>
</tr>
<tr>
<td>4.0</td>
<td>Cross sectional area</td>
<td>Shall be 1.5 sq.mm.</td>
</tr>
<tr>
<td>5.0</td>
<td>Conductor type</td>
<td>- Solid annealed circular stranded copper conductor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- For twisted pair cables, the conductors shall be of stranded tinned copper having proper flexibility to provide limpness and extended flex-life as required for these small diameter cables.</td>
</tr>
<tr>
<td>6.0</td>
<td>Insulation type</td>
<td>- PVC insulated, Type A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Type ST-1 PVC shall be used for inner sheath.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Both inner and outer sheath shall be extruded type.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Outer sheath made of PCP (Chloroprene rubber), abrasion resistant, oil resistant and flame retardant conforming to IS:434 –1964 (Part - I), as amended upto date.</td>
</tr>
<tr>
<td>7.0</td>
<td>Screen</td>
<td>- Tinned annealed copper mesh over metallised tape, in a close woven braid.</td>
</tr>
<tr>
<td>8.0</td>
<td>Shielding</td>
<td>- Special aluminium foil to provide 100% shield coverage for optimum protection against radiated interference and ingress of audio and radio frequencies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- It shall have shorting fold for metal to metal contact and isolation fold to prevent adjacent shields from shorting to one another, so as to improve the voltage breakdown characteristics. The drain wire shall be of stranded tinned copper wire of 0.518 sq. mm. (20 AWG) cross-section.</td>
</tr>
<tr>
<td>9.0</td>
<td>Spare Cores</td>
<td>- 20% spare cores but not less than 2 spares shall be provided in all the multi core cables.</td>
</tr>
<tr>
<td>10.0</td>
<td>Reference standard</td>
<td>As per relevant IS with latest amendments</td>
</tr>
</tbody>
</table>
11.0 Miscellaneous

- The Tenderer shall furnish necessary calculations to show that the selected cable satisfy the criteria including for voltage drop.
- Cables for temperature detectors shall be screened type of required technical parameters with core size not less 1.5 sq.mm.
- The special twisted paired cables shall be of the type to provide balanced signal transmission and shall have good noise immunity.

12.0 Core identification

- Cable identification will be provided by embossing on the outer sheath the following:
  - Manufacturer’s name & trade mark
  - Voltage grade
  - Year of manufacture
  - Type of insulation
- Cores of the cables upto 5 cores shall be identified by colouring of insulation.
- For cables having more than 5 cores, core identification shall be done by numbering insulation of core sequentially.
- All the numbers shall be of same colour, which shall contrast with the colour of insulation.
- Numbers shall be written in figures and words both
- The numerals shall be legible and indelible.
- The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other.
- When number is a single numeral a dash shall be blacked underneath.
- If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral.
- The spacing between consecutive numbers shall not exceed 100 mm.

(iv) Heat resistant cable

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage Grade</td>
<td>1.1 kV grade confirming to IS: 9968 (Part-II)- 1988</td>
</tr>
<tr>
<td>2.0</td>
<td>Reference standard</td>
<td>IS: 6380</td>
</tr>
<tr>
<td>3.0</td>
<td>Duty type</td>
<td>Heavy duty</td>
</tr>
<tr>
<td>4.0</td>
<td>No. of cores</td>
<td>Single or multicore as per requirement</td>
</tr>
<tr>
<td>5.0</td>
<td>Cross sectional area</td>
<td>As per requirement</td>
</tr>
<tr>
<td>6.0</td>
<td>Conductor type</td>
<td>Annealed tinned copper conductor</td>
</tr>
<tr>
<td>8.0</td>
<td>Insulation type</td>
<td>Silicone rubber insulation</td>
</tr>
<tr>
<td>9.0</td>
<td>Shielding</td>
<td>Asbestos or glass braid and lacquered protection</td>
</tr>
<tr>
<td>11.0</td>
<td>Outer sheath</td>
<td>Flame retarded Oil resistant</td>
</tr>
<tr>
<td>12.0</td>
<td>Miscellaneous</td>
<td>As per requirement for working at higher temperature, nickel coating shall be done</td>
</tr>
<tr>
<td>13.0</td>
<td>Armouring</td>
<td>GI strip armoured as per requirement (as specified in</td>
</tr>
</tbody>
</table>
### (v) Trailing cable

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage Grade</td>
<td>1.1 kV grade confirming to IS: 9968 (Part-II)- 1988</td>
</tr>
<tr>
<td>2.0</td>
<td>Reference standard</td>
<td>IS: 9968</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS: 8130</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS: 6380</td>
</tr>
<tr>
<td>3.0</td>
<td>Duty type</td>
<td>Heavy duty</td>
</tr>
<tr>
<td>4.0</td>
<td>No. of cores</td>
<td>Single or multicore as per requirement</td>
</tr>
<tr>
<td>5.0</td>
<td>Cross sectional area</td>
<td>As per requirement.</td>
</tr>
<tr>
<td>6.0</td>
<td>Conductor type</td>
<td>Highly flexible stranded tinned annealed high conductivity copper conductor</td>
</tr>
<tr>
<td>8.0</td>
<td>Insulation type</td>
<td>EPR (Ethylene-propylene Rubber) For higher temperature zone, silicone rubber (trailing duty)</td>
</tr>
<tr>
<td>9.0</td>
<td>Shielding</td>
<td>Each individual core protected and covered and overall</td>
</tr>
<tr>
<td>11.0</td>
<td>Sheath</td>
<td>Poly-chloroprene rubber or chlorosulphorated polyethylene cable shall be conform to IS: 9968 (Pt-I) - 1988. Flame retarded (for higher temperature area) Oil resistant</td>
</tr>
<tr>
<td>12.0</td>
<td>Miscellaneous</td>
<td>Shall have one additional core for earthing .</td>
</tr>
<tr>
<td>13.0</td>
<td>Armouring</td>
<td>GI wire armoured as per requirement and size (as specified in respective TS)</td>
</tr>
</tbody>
</table>

### (vi) Flame Retardant Low Smoke (FRLS) Cables

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Voltage Grade</td>
<td>1.1 kV grade</td>
</tr>
<tr>
<td>2.0</td>
<td>Reference standard</td>
<td>Category AF as per IS : 10810</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM-D  2863 (Critical Oxygen Index)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM-D  2863 (Temperature Index)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM-D  2843 (Smoke density)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 754-1  (Acid gas generation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE-383  (Flammability test on group of cables)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Swedish chimney test SS 424175, class F3. (Flammability test)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 332-1  (Flammability test)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 332-3  (Flammability test)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS 5831  (Flammability test)</td>
</tr>
<tr>
<td>3.0</td>
<td>Duty type</td>
<td>Heavy duty</td>
</tr>
<tr>
<td>4.0</td>
<td>No. of cores</td>
<td>Single or multicore as per requirement</td>
</tr>
<tr>
<td>5.0</td>
<td>Cross sectional area</td>
<td>As per requirement.</td>
</tr>
<tr>
<td>6.0</td>
<td>Conductor type</td>
<td>Annealed tinned copper conductor</td>
</tr>
<tr>
<td>8.0</td>
<td>Insulation type</td>
<td>XLPE insulation</td>
</tr>
<tr>
<td>11.0</td>
<td>Sheath</td>
<td>Specially designed with thermoplastic or thermosetting materials , superior resistance to ignition and flame propagation with smoke emission and toxicity or corrosive characteristics Flame retarded Oil resistant</td>
</tr>
<tr>
<td>12.0</td>
<td>Armouring</td>
<td>GI wire / strip armoured as per requirement and size (as specified in respective TS)</td>
</tr>
<tr>
<td>13.0</td>
<td>Test values</td>
<td>Critical Oxygen Index : Minimum 29</td>
</tr>
</tbody>
</table>
01.02.20  EOT Cranes

01.  Trolley lines and power supply arrangements for cranes (DSL System)

Power to all the bays shall be fed from crane LTSS through PDB’s installed in respective bays. Number of panels shall be decided as per requirement (to be indicated by the tenderer). Isolator (MCCB) for each feeding section will be provided in each bay.

All the PDB’s shall have 02 incomers and 01 buscoupler. Normally both the incomers will be charged and buscoupler will be OFF. In case of power failure or any fault power will be fed from either of the incomers. Incomers, buscoupler and busbars shall be designed to take care of entire load of the cranes.

Crane trolley lines feeding cranes in major production units shall be sectionalized with two separate feeding points. Two fully rated MCCB / ACB shall be provided for each incomer feed point to crane DSL. Sectionaliser shall be provided between the two incoming ACBs with necessary padlocking arrangement.

Isolator (MCCB) panels shall be provided for the repair section for maintenance by the tenderer.

In case of circuit breaker rating more than 630A, ACB’s shall be provided. All the ACB’s shall be installed in a PDB which shall in turn be installed in the bay / shop floor. In case of circuit breaker rating is 630A or less, than the MCCB (as isolator) with earth fault protection and magnetic over current release shall be mounted in the respective column of the feeding bay in a separate enclosure at manheight level.

Signal lamps shall be provided just below the trolley lines at 60m intervals as well as at the beginning and end of each section/repair section to indicate whether the trolley lines are energized or not.

Insulation air gap between two sections of a sectionalised trolley line shall be minimum 50 mm for voltage levels upto 500V, but in no case should be greater than the length of the current collector on the crane.

Maintenance Bay

When two or more cranes are fed from the same trolley line, maintenance bays (repair sections) shall be provided with sectionalizing isolator so that repair or maintenance of any crane can be carried out without disturbing the operation of the other cranes. Necessary DSL arrangement for repair section shall be provided by Tenderer.

Isolator panels shall be provided for each repair section for maintenance. Dead zones shall
be provided with isolator arrangements to prevent collision between cranes and momentary paralleling to two incomer supplies. Incomer ACB's shall be provided with earth fault protection and magnetic over current release. The DB,s shall be located suitably on the shop floor.

For end zones, minimum length of maintenance bay shall be 2 m plus the crane width. For middle zone, the length of hospital bay shall be 4 m plus the width of crane.

Repair section shall be provided with red lamp steady/flash fixtures at four corners. These fixtures shall be located at crane gantry with manual ON/OFF provision.

Boarding or access platform shall be arranged within the limits of each repair section for approach to be crane.

02. Trolley power conductors

The Power conductors or down shop lead (DSL) shall have 4 conductors, 3 phase, 4 trolley line system (3 power + 1 earth).

Trolley power conductors shall be of mild steel angel sections / rails.

For cranes/hoists up to 10 t capacity, the DSL shall have 50 x 50 x 6 mm MS angle. For cranes above 10t up to 100 t, the DSL shall have 75 x 75 x 6-mm MS angles. For cranes above 100 t, the DSL shall have to maintain rail size of 75 lb.

Expansion and section gaps shall be provided in rails at every 30m. The gaps shall be cut at an angle of 30 degree to the rail and shall be 50mm wide. The gaps shall be provided with flexible joints. The conductors shall be supported at 3000 mm intervals by insulators mounted on brackets welded to crane girders.

Looping cables shall be used in parallel with the conductor rails and aluminium equalising strips shall be provided, wherever necessary, for limiting the voltage drops. However, aluminium equalising strips shall not be used in the hot areas like slag / liquid steel / slab / slab yard etc. In such areas, copper cable looping shall be used.

In order to provide electrical continuity across the expansion joints the power conductors on both sides of the joints shall connected by stranded aluminum conductor jumper, fitted with steel Aluminum strap and lugs suitable for the steel angle sections.

The power supply feeder and trolley line conductors/looping cables shall be selected so as to limit the voltage drop to within 15% of the rated voltage at the crane motor terminals for the short time peak current corresponding to the starting of the largest capacity motor and the maximum continuous operating current of the rest on the system.

Expansion and section gaps shall be provided in rails at every 30m. The gaps shall be cut at an angle of 30 degree to the rail and shall be 50mm wide. The gaps shall be provided with flexible joints.

The section shall be straight, unbranded and smooth on the running surface. Joints between lengths of angles shall be welded and all welds shall be finished flush with parent metal. The conductors shall be painted with anticorrosive paint, except for contact surface. Parallel aluminum buses shall be provided as specified. The jointing of standard
lengths shall be made by 100% but welding and top surface finished smooth by grinding to get free movement of the current collectors.

03. Insulators and trolley line holders

The insulators used for the manufacture of trolley line holders shall be preferably steatite, tufnol or porcelain insulation material having substantial mechanical strength specifically against blows and vibrations. They shall be capable of withstanding the impact and shocks resulting from operation of the machine. The creepage distance of the insulators shall not be less than 80 mm.

The insulators used in the LT/AC system shall have the following minimum flashover value and mechanical strength:

- Dry flashover voltage: 25 kV
- Wet flashover voltage: 12 kV
- Ultimate mechanical strength: 1000 kg.

The trolley line holders shall generally conform to the design shown in the drawing to be furnished to the successful Tenderer. All sharp edges shall be ground smooth. The porcelain insulators shall be manufactured and tested as per IS: 1445 – 1997

04. Supporting brackets

The trolley line conductors shall be mounted on holders. The holders shall be bolted on to brackets which in turn shall be welded on to crane girder at stiffeners at regular intervals. In normal run, intermediate type of brackets shall be used, but when sectionalizing gaps or expansion joints are provided, sectionalizing type of brackets shall be provided.

05. Steel to Aluminium straps

These are meant for connecting parallel aluminium bus, at expansion joints, power supply cables from load break switch. They shall be complete with MS cadmium coated bolt nuts, spring washers, lugs etc.

06. Signal lamp assembly

Signal lamp assembly shall be industrial, heavy duty dust tight and water proof in construction suitable for indoor or outdoor locations. The units shall comprise three lamps for three phase with red glass lens and reflectors. The lamp shall be provided with dropper resistance connected in series with the lamp and the resistance shall be rated for continuous inclusion in the circuit. Alternatively, a built-in transformer may be provided to suit the lamp voltage.

07. Aluminium parallel bus

These buses shall be of E.C. grade aluminium. They shall be free from any deformity in profiles.

08. Current Collectors

2 nos. current collector shall be provided per trolley line each rated for 100% of total rating. The collector shoe will be of heavy duty design and chamfered at both ends, each rated
for 100% of total crane rating. Double collectors on each earth trolley line shall be provided and these shall be different from those on power trolley line. Collector shall be multi hinged for self-aligning. Collector will be designed in such a way that load is transmitted not on the insulators but on the insulator stud to avoid damage to insulators.

09. Power distribution on crane

One adequately rated isolator (MCCB/ACB) with locking facility shall be provided immediately after current collectors on incoming line on the crane. The isolator shall be capable of carrying current of two largest motors.

Power from the isolator shall be taken to the air circuit breaker to be provided in operator’s cabin. In case of pendant operated cranes, this circuit breaker shall be located in protective panel located at bridge platform.

The breaker shall be provided with under voltage, over load and short circuit releases. The breaker shall also be with earth fault protection. The breaker can be closed only when:

- All master controller handles are in neutral position.
- None of the stator or directional contactors are in closed positions.
- Emergency corner switches not operated.
- Door/Gate switch are not actuated and gravity limit switch for hoist motion not operated. Power for lighting and magnet circuits shall be tapped from the incoming side of isolators near current collectors.

10. Power supply for CT. motion

Flexible trailing cable systems mounted on retracting support system shall be used. The system shall consist of insulated multi-conductor or several single conductor cable with permanent termination on the bridge and on the trolley. The flexible trailing cables shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cable. Provision later stage in case of necessity. The flexible cable shall be butyl rubber or EPR insulated CSP sheathed type.

For rotating trolley cranes, power supply shall be through festoon cable arrangement slipring or cable basket. Cable reeling drum or cable basket shall be used for power supply to the magnet from the trolley. Two spare turns of cable provided on cable reeling drum. The cable reeling drum shall be directly driven by hoist mechanism, a clutch shall also be provided to disconnect the drum from hoist mechanism.

Flexible cables system mounted on latest PVC linked chain system in normal area & metallic chain systems in hot area. (New point)

11. Meters

Ammeter and voltmeter with selector switches shall be provided on the incoming line in operator’s cabin.

Ammeter and voltmeter shall be provided on DC side for Electromagnets.
12. **Control features**

All controls shall be fully magnetic, operated through master controllers. All travel motions shall be provided with plain rotor resistance control with plugging. For long travel drives, the electrical control shall be grouped for the individual pair of motors separately in case of four motor drive and each pair of motors shall be able to drive the crane at reduced acceleration and speed. As an anti-skewing measure, out of a pair of motors for LT., if one drive motor trips, the other drive motor shall also be switched off. For pendant control, plugging shall be avoided for travel motion.

Brakes shall not be used for speed control.

Synchronization of separate drives where required shall be done with the used of solid state thyristor control.

For all hoist motions, except where creep speed is required, plain rotor resistance control shall be provided on all master controller notches in the hoisting direction. The rotor resistance shall be cut out gradually when moving from lower to higher notches such that current peak of 2 times the rated current is not exceeded. In the lowering direction of the motion, controlled lowering shall be provided using one / two plugging notches, one single phasing notch and one / two super synchronous power lowering notches. For obtaining creep speed, conventional methods like planetary gear system, DC. injection (where requirement calls for creep speed in lowering direction only) etc. may be offered.

Hoist control circuit shall also be provided with anti-drop feature i.e., whenever the master controller is brought back to zero position from higher notches in both directions, the motor shall automatically be connected to hoisting direction for some time (time adjustable through timers) to avoid the downward drift of the load. Brakes shall be clamped in zero position of the master controller.

13. **External control of auxiliary hoist and CT of LRS Crane**

Tenderer shall supply one no. of Ground Control Post in Pedestal for installation in PCM control room. The control post shall have following facilities:

a) Control on PB- This shall transfer the control of CT and auxiliary hoist from cabin, master controller to ground control post and will not allow LT motion from cabin.

b) For CT and aux. Hoist 4 push buttons each (total 8 PBs) shall be provided on ground control post for following application:

c) 10% speed of hoist & lower

d) 30% speed of hoist & lower

e) 10% speed of CT forward & reverse

f) 30% speed of CT forward & reverse

The control post shall be connected to the main control of cabin on crane through hear resistance flexible cable with copper conductor arrangement and plug and socket system. The socket shall be fixed to the cabin. The no. of pins for socket, no. of additional aux. Contactor, no. of cores for flexible cable to achieve the above control shall be decided by the Tenderer during detail engineering and shall be included in the scope of supply of Tenderer.
Further, Tenderer shall quote radio control system to achieve the above control requirement as an optional feature. Cost for the radio control option shall be indicated separately.

14. **Thyristor control drives**

Thyristor control shall be provided for all the cranes operating in areas where ambient temperature is more than 50 deg. C. Control shall be achieved through master controllers for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting and lowering. Creep speed shall be 10% or lower as per operational requirements of rated speed.

The thyristor regulator shall be fully controlled and suitable for four quadrant operation.

Speed control of the slipring motor shall be achieved through regulation of stator voltage with resistance in the rotor circuit, if necessary. The reversal of direction shall be through magnetic contactors which shall open and close at zero current.

The continuous rating of the thyristor converter shall be at least 2.0 times the motor rated current at the mechanical KW and the converter shall be designed and rated for load requirement taking care of peak currents during acceleration, normal operation and regeneration conditions. The dv/dt and di/dt rating of the thyristors shall be suitably selected.

The repetitive PIV rating of semi conductor devices shall not be less than 2.5 times the peak of normal system voltage. Thyristor bridges shall include R.C. snubber circuits across the thyristor, high speed semi-conductor fuses with micro-switches for monitoring of failure. Closed loop regulation suitable for the system with various feed back such as speed, current etc. shall be provided. Speed feed back shall be through tacho-generator of permanent magnet type mounted on the non-driving end of the motor shaft. The regulation shall include ramp generators, potentiometers for various setting, various regulators, signal conditioners, logic command module sequence, module, trigger module, zero and over speed monitor, torque less protection module etc. as per the requirements. The control and regulation equipment shall be able to maintain their rated performance and control quality even under conditions of variation of +10% and - 15% in voltage and +5% in frequency. A zero current sensing device shall be incorporated. The reversing of stator contactor shall be done at zero current. Braking down to zero speed shall be electrical with mechanical brake setting only at zero speed. Protective features like anti-drop etc. shall be incorporated to prevent load setting. The circuitry shall also provide for the protection against failure of motor torque such that the mechanical brake sets in such cases. All other features of conventional crane controls shall also be built into the scheme. The following shall also be provided on the A.C. side.

- Surge suppressor
- Over current protection
- Overload protection
- Single phase protection
- Phase sequence protection
- Ammeter and voltmeter with selector switches
- Isolating switches

Control and auxiliary supply shall be provided with separate transformer and under voltage protection.
The test shall be performed as per IEC : 146.

Details of the system offered shall be furnished along with necessary single line diagrams and block diagrams.

All the control modules shall be grouped in a sheet steel enclosure. The control module cards shall be made of epoxy glaze and suitable for plugging into the racks. The cards shall be locked into the rack, which carries a sealing bar and assists locking of the cards thereby cutting down on the wear of the printed circuit connector contacts which can be subjected to high rate or vibration and further avoid the disconnection of cards from the connector. The thyristor panel shall be suitably mounted so that little vibrations are reflected to the components and connection.

The cables for the thyristor controller and associated equipment shall be laid and clamped separately on the crane.

15. VFD control drives

VFD control shall be provided for cranes operating in areas where operating temperature is 50 deg. C. Control shall be achieved through master controllers for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting and lowering. Creep speed shall be 10% or lower as per operational requirements of rated speed.

The VFD shall be fully controlled and suitable for four quadrant operation (active front end type). Other details of VFD shall be as per respective clause for VFD in the GTS.

16. Panels

There will be separate panels for each motion in addition to the protective panels and resistance panels.

All panels shall be of free-standing floor-mounting construction, suitable to withstand vibrations encountered on crane. Hinged doors shall be provided for closed type panels. Panels shall be front wired. Front wired live points of bottom most equipment shall be mounted at least 350 mm above the bottom cover of the panel. Panel shall be fabricated from 2.0 mm thick steel sheet.

Power and control terminals shall be segregated. 10% spare terminals shall be provided in each panel.

Equipment in the panel shall be so mounted that their removal or replacement from the front is easy.

Separate control panel for each motion shall be provided.

Panels shall be of closed type when mounted on bridge platform.

The panels shall be mounted along the girder facing the hand railing. Sufficient clearances shall be provided between the panels. A minimum clearance shall be provided in front of the panels for walkway and approach as per I.E. Rules. The panels shall be supported in the back from the girder to avoid vibrations. Open type panels may be used for installation.
inside the box girders. In this case, adequate lighting and ventilation shall be provided for the room.

17. Switchgears

Each mechanism motor shall be provided with MCCB, contactors on stator and rotor sides, Electronic over load relays and suitably rated rotor resistances. In case of thyristor controlled drive, each mechanism motor shall be provided with breaker / switches, transformer, thyristor, rotor resistances, contactors on stator and rotor side etc. Each motor shall be fitted with a tacho-generator for speed feed back. The speed range shall be 0-160% of rated speed.

MCB shall be provided in the control circuit of each motion.

Each brake circuit shall be provided with a suitable contactor.

Rating of contactor selected for any mechanism shall be at least 50% higher than the respective motor full load current for the mechanism at 40% duty cycle. The minimum rating of the contactor used shall be 32A and the life of each contactor shall not be less than 10,000 hrs. of operation.

Reversible directional contactors shall be inter locked both mechanically and electrically.

18. Motors

Heavy duty reversible crane service, totally enclosed fan cooled, foot mounted, wound rotor motor conforming to latest edition of IS:325-1996 shall be used for various drives. Class of insulation shall be F/F (Stator/Rotor) with temperature rise limited to that for ‘B’ Pullout torque to the not less than 225% and 275% of full load torque corresponding to 40% CDF for class 1 & 2 and class 3 & 4 duty cranes respectively.

The main motor shall have following speed ranges :

a) Class M3 & M5 duty cranes :
   Main & auxiliary hoist : 750 rpm
   Long & cross travel    : 1000 rpm

b) Class M7 & M8 duty cranes :
   Main & auxiliary hoist : 600 rpm
   Long & cross travel    : 750 - 1000 rpm

All motors shall have the terminal box at top. Frame sizes shall conform to IEC Standards.

Horizontal foot mounted and with tapered shaft extension.

While selecting the motor rating following shall also be taken into consideration :

- Duty type S4 & S5
- Cyclic duty factor
- Number of switchings per hours
- Type of controls used
- Inertia of the motor and mechanism
- Ambient correction factor
- Service factor
- Derating for thyristor control
- Wind pressure

Maximum permissible operating speed shall be 250% of synchronous speed or 2000 rpm whichever is less. Over load capacity 150% of full load current for 2 minutes without damage or permanent deformation.

19. Brakes

Brakes shall be D.C. electromagnetic type, confirming to AISE standard. The brake coils shall be made of copper and of insulation class 'F'.

Brakes shall be designed to fail safe whenever the current is interrupted either intentionally or by failure of the main supply.

Brake circuit forcing shall be provided for D.C. brakes. D.C brake circuit shall be switched off on D.C. circuit for quick operation of brake.

A separate set of parking brake for L.T. motion shall be provided for each out door crane. Power supply for these brakes shall be obtained from protective panel.

20. Limit switches

Roller lever operated, resetting limit switches shall be provided for all travel motions. For each hoist motion, a rotary cam type over hoist and over lower, self resetting limit switch shall be provided. This limit switch shall have independently adjustable cams for hoisting and lowering motion. The cams shall have adjustability such that end limit can be set to within 100 mm of the hoisting or lowering motion. In addition to this, a back up ultimate limit switch of series/shunt gravity type shall be provided to prevent over hoist. The later shall be of manual reset type. In case of cranes handling hot metal, the gravity limit switch shall preferably be of series type. Provision shall be made to bridge the gravity type limit switch contact by push button/switch or any other means to lower the load. An indication shall be provided to the operator whenever this limit switch has operated. Suitable limit switch shall be provided for slack rope, gate/door opening, slew mechanism, grab closing/opening etc. wherever necessary. Protection class of the limit switch shall be minimum IP 65.

21. Anti-Collision Devices

In cranes where two or more cranes are operating in the same bay (at same or different level) all cranes shall be provided with suitable Anti-collision system. Anti-collision device shall be electronic type.

A sound signal shall be provided to the crane operator when they are at certain safe distance apart (distance to be adjusted as a function of speed at site) and crane shall stop. After few seconds, it shall be possible to run the cranes towards each other (or only one crane can move towards the other) till buffers of the cranes meet by providing "by pass" in the operators cabin.

Anti-collision shall also be provided on trolley for twin trolley cranes along with suitable by pass arrangement.
22. **Resistances**

Air cooled, robust, heavy duty, corrosion resistant fechral edge wound resistance. Resistance shall be in single phase execution. In a particular box the rating of resistances shall be the same. Resistance shall have vibration proof only.

Rated for 10 minutes duty. Continuous duty rating of resistances shall be provided in case of hoist motions controlled by thyristor converters.

Maximum temperature (absolute temperature) of resistor elements shall be limited to 335 deg C at desired duty. Suitable tapping points shall be provided.

Resistance boxes shall be mounted in racks that permit independent removal of any selected box.

23. **Master controller**

Cam type master controller with joy stick type lever shall be used.

Separate master controllers for hoist, LT & CT shall be provided.

Duel master controller operated with single handle shall not be used.

Master controller for each motion controls shall have four/five notches in each direction. Master controller for electro- shall have three positions i.e Lift- Off-Drop. It shall have spring return from drop position to Off position.

24. **Lighting, socket outlets, bells etc.**

Lighting shall be provided in operator’s cabin, stair cases, platforms and working areas.

Minimum 4 nos. 400 watts high pressure sodium vapour flood lights equally spaced (under crane girders) about the crane span shall be provided along with shock absorbing and anti-swing suspension arrangements. More numbers of fittings shall be provided if required for cranes with longer span and/or longer height of lift.

Fluorescent lamps with necessary fittings shall be used for operator’s cabin, staircases, platforms etc.

Adequate number of hand lamp socket outlets (2 Pin, 10A, 24V) and power socket outlets (3 Pin, 20A, 240V) shall be provided along with switches socket & switch shall be interlocked suitably. A hand lamp(160W SLS lamp with enclosed type battery and wire guard) along with sufficient length (15m) of cable with a plug shall also be provided for each crane.

An alarm bell shall be provided on each crane.

25. **Electromagnets**

All magnets shall be suitable for steel plant application and shall be welded construction.
Magnets shall be rated for 230 V DC and suitable transformer – rectifier units shall be provided for feeding them. Rectifiers shall also be suitable protected by suitable protective device.

Magnets shall be class ‘H’ insulated, at least 50% rated, copper conductor would and shall have surge suppressor box and separate in terminal box for termination of cable. Magnets for production cranes handling hot products shall be 75% rated. Surge suppressor shall be compact, non-linear resistor silicon carbide thyrector, variator or metrosil type.

Each magnet shall be provided with suitable plug socket unit.

One earth terminal on magnet to be connected to spare core in magnet cable.

Wherever specified, a set of batteries, a battery charger, one annunciation system and other accessories shall also be provided along with magnet so that the magnet can hold the full load for at least half an hour in case of power failure.

25. Equipment in operator’s cabin or on pendant unit

a) In case of pendant controlled crane following shall be included on the pendant unit:

| Push button for | Hoist slow, hoist fast, lower slow, lower fast, left cross traverse, right cross traverse, forward long travel, backward long travel, emergency stop conditions. |
| Switch for | Lights and bells |
| Lamps for | Power ‘ON’ indication and emergency corner switch operation. |

b) In case of cabin operated cranes:

The operator’s cabin shall contain the following:

- Master controllers for all the motions and magnet (wherever applicable).
- Emergency stop push button.
- Foot switch for alarm or bell.
- Switches for all lighting equipment on crane.
- Switches for air conditioner, exhaust fan and for cabin fan.
- A fire extinguisher.
- Insulating mat and operator’s chair.
- Cabin light.

Annunciation panel with indication lamps for power ‘ON’ control ‘ON’ emergency corner switch operated, ammeter and voltmeter with selector switches.

c) In case of master controller operated cranes:

In this case there should be the facility of controlling the crane from the control pulpit.

All the control facility available in case of operating from the operator’s cabin is duplicated in the control pulpit through the cable.
d) **Radio remote control :-**

In this mode of control system, all the 3 motions
- Hoist .
- Cross travel.
- Long travel.
can be controlled .

The system shall have capability to provide range of 1.5 times the long travel distance of the crane .

In the case of signal failure, all motion shall come to a safe stop.

The system shall have facility of controlling speed in two steps :-

(i) Slow speed on the first step of the breaker contact / pushbutton of the radio remote control representing the first or second notch of the master controller.

(ii) Full speed on the second step of the breaker contact / pushbutton of the radio remote control representing the final notch of the master controller.

**Transmitter :-**

Transmitter shall have following features :-
- Constructed with sophisticated microprocessor technology and surface mounted electronics .
- Transmission type :- FM FSK
- Transmission speed :- 9.6 Kbps .
- Built in self test for all functions .
- Transmitter shall consist of switching breaker , dial switch and push buttons .
- Switching breaker shall be non locking to zero position or maintained function .
- Indications :-
  - Operation status
  - Battery status
  - Indicators that display information from crane .
- PIN-code (Personal Identification Number)
- Internal antenna .
- Rechargeable battery .
- Battery 7.2 V NiCd
- Operating time :- About 8 hours .
- Different operating frequencies (minimum 16 nos.)
- Two hand upstart.
- Stop push button .
- Operating conditions :- Areas having large temperature variations , dusty , more vibrations , oil and humidity .
- Operating temperature range :- Min. 10 deg.C to Max. 60 deg.C
- Protection class : IP - 54.
- Casing material : Polycarbonate / ABS plastic .

**Receiver :-**
Receiver shall have following features:-
- Upto 20 functions exclusive safety relays (for transmitting preset reference values to VFD in the crane).
- 2 safety relays (for control of main contactor)
- Power supply suitable for 240 V AC , 6 A.
- Minimum 16 different operating frequencies.
- Two redundant microprocessors for monitoring each others.
- Cyclically redundancy check check for high secutity of transmitted radio messages.
- Frequency scanning in the receiver.
- Memories last 10 users.
- Interlocking of the relays.
- Momentary or latched relay functions.
- Two hand up start (to avoid unintentional start).
- Protection class : IP - 65.
- Casing material : Aluminium profile for fast mounting on DIN rail.
- Operating temperature range :- Min. 10 deg.C to Max. 60 deg.C

26. Enclosure Class

a) For indoor operations
- Resistance boxes : IP : 11
- Motors : IP : 55
- All other electric equipment : IP : 54

b) For outdoor operations
- Resistance boxes : IP : 33 with canopy
- Motors & panel : IP : 55 with canopy
- All other electrical equipment : IP : 65 with canopy

27. Cables

Power cable suitable for 3 Phase, 4 wire, AC power supply system.

All cables shall have stranded copper conductors. Control wiring shall be with 2.5 mm2 copper; minimum size of power cable shall be 6.0 mm2. Fixed wiring on cranes shall be carried out with PVC insulated. PVC sheathed armoured cable or EPR insulated CSP sheathed cable or better.

All flexible cables (i.e. cables for magnet, trolley, feed, pendant unit etc.) shall have copper conductor, EPR insulation and CSP sheathing or better.

All cable shall be suitably de-rated for grouping and higher ambient temperature.

All cables shall be of 1100 Volts grade.

All accessories like cable glands, clamps, pipes, wire and terminal marks etc. shall also be provided.

Cable laying and terminations shall be such that the chances of cables getting damaged is remote.

Cable sizes shall be selected considering motor rated current.
In all passages and on trolley the cable shall be laid in trays and shall be covered by similar trays and properly clamped & fixed.

01. LT Power Cable

1.1 kV, heavy duty power cable, 4/3.5 core with stranded sector shaped (sm) or with compact circular stranded (rm/V) or circular stranded (rm) Copper conductors as applicable, PVC insulated suitable for 70°C operation as per IS:5831-1984, core stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi core conforming to IS:1554 (Part-I – 1988) Type TWY.

02. Control Cables

1.1 kV, circular stranded (rm), annealed copper conductor, PVC insulated suitable for 70°C operation, as per IS:5831-1984, cores stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi-core similar to IS:1554- (Part-I)-1988, Type YWY.

03. Flexible Trailing Cable


28. Earthing

A ring earthing system shall be provided on the crane. Each and every electrical equipment shall be connected to this earthing at least at two points. However the electronic circuit insulated earth wire shall run in panel and terminate at main earth connection only at one point. The earthing shall be connected to the fourth trolley line in DSL system through 2 nos of current collector. Additionally current collectors shall also be provided on crane rails for earthing on crane. All these collectors shall be connected to earthing ring.

An earth core shall be provided in trolley feed cable and the magnet. The cable reeling drum shall have a separate slipring for earthing purpose.

It shall conform to general specification for earthing.

Rubber mattings shall be provided in front of the protective and control panels.

All bonds between earth conductors and crane parts shall be welded if possible, or rivetted and soldered. Where screwed bonds are made, care shall be taken that there is satisfactory contact surface and nuts shall be locked to prevent their loosening. Earth connections to equipment shall be made by means of multi strand flexible conductor to adequate section.

The earth ring on the crane/ machine shall be connected to the plant earthing system through to gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system.

In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks.
Flexible copper bonds shall be provided across any gap in the running gantry rail.

For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

29. Crane weighing system:

Electronic weighing system including calibration equipments, cables, load cells and panel mounted associated electronics (microprocessor based) with communication capability with PLC on bus.
Cranes & hoist (as per scope of supply) including their complete electrics & control (as given in relevant chapter) including power supply, power conductor lines (DSL), Load break isolators (to be located in bay) & cables.

Crane weighing system to be connected to ground station by Radio link module. Necessary hardware & software including cables for above as well as communication of ground station with main automation network of shop automation system to be considered.

Other details of crane weighing system:

1. The Weighing system shall be designed, manufactured, assembled & tested in accordance with relevant OIML / NTEP standards.
2. Load cell shall be of globally reputed make, confirming to OIML/NTEP Standard & preferably digital type. Load cell shall be easily replaceable type, provided with safely devices from impact load, vibration, heat & dust.
3. Weighing system shall be auto zero & auto calibration facilities.
4. Redundant electronics shall be provided.
5. Test weight for calibration shall be provided.
6. Two nos. large display unit shall be provided.
7. The requirement of the system are:
   i) The Weighing system will be sufficient to measure, display and telemeter the loading material weight, meet all operating requirement and necessary safety provision including alarms for abnormal conditions. Design should support better tolerances in the mechanical system.
   ii) The equipment selected for the purpose will be suitable for a continuous and reliable functioning in environment generally prevailing in steel plant area. Signal transmission will be through radio communication. The frequency used shall be in license free bands as per prevailing standards in India.
   iii) The designed will include all necessary precautions and provision for the safety of operating and maintenance personnel and equipment.
   iv) Accuracy of the system will not be less than ± 0.5% of FSD.
   v) The Crane Weigh unit will be able to tolerate sudden shock loads caused by the lifting and traveling of crane. Weigh unit will be suitable for continuous loading for long durations. Electronics will be resistant to vibration prevalent in cranes.
   vi) Weight signal shall not be affected by the height at which load is weighed.
   vii) The Weighing system shall have protection against strong magnetic field, electrical surge, RF interference and heat & dust.
   viii) Data updation on real time basis in the central computer.
8. The scope of work includes Supply, Erection, Testing and commissioning of Crane Weighing systems as per following:
   i) Crane Weighing units complete with top & bottom crane mounting accessories, weighing electronics, wireless communication interface, anti heat shielding for the equipment, protection against EMI, batteries and chargers, one standby battery for
each weigh unit, power supply unit etc. the Amp. Hour of the battery shall be adequate enough for minimum one month working.

ii) Hand held unit based on radio frequency signal with toggling facility for current and cumulative weight display complete and charger, long range antenna (as per site requirement), wireless communication interface, provision for entering product and customer details. This unit will have calibration facility with password protection.

iii) Wireless Transreceiver at PC end (with IP65 enclosure), power cable, antenna (if required as per site condition)

iv) Commercial grade PCs.

v) The required tools and testing instruments for normal maintenance and operation of the equipment.

vi) The weighing system shall have real time connectivity to the plant MES / ERP through plant wide network.

vii) Supply of following tools and testing equipments:

a) Digital Multimeter 4 ½ digit- 2 nos. (make: Philips / HP / Fluke)

b) Portable Think pad based software programmer (make: HP / IBM / SONY) - 1 no.

c) Universal calibrator (make: HP / Fluke)-1 no.

d) Professional tool kit (make: RS / Philips)

viii) Integration of subunits.

ix) Supply of complete data, design calculations, technical literature and documents, erection / maintenance and operation manuals, erection drawings, Quality Assurance Plan (QAP) and as built drawings.

x) Supply of special tools and tackles, commissioning spares.

xi) Component level training to maintenance staff of BSP at the tender’s works.

xii) Earthing.

xiii) Stamping and verification at the manufacturer’s works by the tender as required under Weights and Measures Act.

xiv) Suitable safety devices for the protection of the weighing and processing system against impact loading.

1.02.21 Erection Specification

1.02.21.01 Guidelines for design of system and engineering the layout of electrical equipment.

001 General

The tenderer shall prepare the layout drawings for civil assignment and civil drawings for construction of the substation buildings and civil buildings for other electrical premises taking into consideration the requirement listed below. In case of total turnkey contract the civil aspects mentioned in following specification shall be adhered to while planning / executing civil work.

002 Electrical premises

- All electrical premises shall have adequate space to accommodate the electrical equipment from the point of view of operation and maintenance, and conform to IE Rules & Regulations.
The clearance between the ceiling of the electrical room and top of the tallest equipment shall not be less than 1m, 2m where the equipment are to be maintained from top and additional height of lifting tackle wherever required.

Lifting/handling facilities shall be provided. Rolling shutters shall be provided to facilitate transportation of the equipment into and out of the electrical room, MCC rooms.

Electrical room located on the top floors shall have erection openings and landings.

All electrical rooms shall have cable basement/cable galleries /cable trenches as per equipment layout in the electrical rooms. The clear height of the basement/cable gallery walkways shall be minimum of 2.2 m for cable tunnels and 3 m for basement/galleries.

The wall of the basement shall have water proofing and draining facilities below ground level.

All electrical rooms shall be constructed with heatproof material at the roof if it is exposed to sunlight.

Cable basement/galleries shall be provided with suitable lighting/ventilation facilities.

24V AC sockets fed from dry type L.V. transformers shall be provided for hand lamp connection throughout the premises including basement and cable tunnels.

Airtight double door arrangement shall be provided for electrical rooms and basement. The stairs to the basement shall be from inside the electrical room.

Welding power socket outlets shall be provided within basement at intervals of 60m with minimum of one, where basement is less than 60m long.

Electrical room and cable galleries/basement shall be considered fire hazardous.

Roofs of the electrical premises shall be fully watertight and moisture proof.

Erection openings with removable cover plates shall be provided on the floor of the electrical rooms connecting the basement/cable gallery.

003 Control rooms/pulpits

Location of control posts shall be decided taking care of clear visibility.

All control rooms shall be air-conditioned and temperature shall be 24 deg. C.

Air lock rooms shall be provided for all the control room /pulpits.

Inner walls shall be sound proof.

Granite flooring shall be provided.

Window glass shall be toughened, heat resistant and of greenish tint, hinged glass to be opened from inside.

Double glass panels, wherever required, shall be provided to make the control post heatproof.

Suitable wire mesh shall be provided for the glass windows for protection against mechanical damage wherever required.
004 Cable tunnels

Standard cable tunnel size:

- Full tunnel: 2200 mm (W) x 2200 mm (clear height)
- Half tunnel: 1500 mm (W) x 2200 mm (clear height)
- Partition door between basement and the cable tunnel shall be air tight and of fire retardant material. Cable tunnel shall be provided with fire / smoke detectors as per norms.
- Gradient of the floor at transition from one elevation to another shall not exceed 15 deg. Gradient shall be in the form of ramp.
- Floor gradient towards the water collecting pit shall not be less than 0.3%.
- Plate inserts (200 x 100 x 6 mm) at an interval of 1500 mm shall be provided on the wall along the length of the tunnel. Three rows of inserts shall be provided at suitable intervals along the height.
- Plate inserts shall be provided at an interval of 1.5 m under the ceiling for lighting fixture.
- Entries to the cable tunnel shall be provided generally at 70 m interval along the length of the tunnel inside the shop or at least 2 entries in case of small tunnels.
- Tunnel walls shall be waterproof design.
- For interplant cable tunnels, long tunnel shall be split into compartment not exceeding 150 m with fire proof partition doors.
- All cable tunnels shall be properly ventilated.
- Atleast two evacuation exits should be provided in each of the cable gallery and cable tunnel. The distance between any point and exit should not be more than 35m. The distance from dead end of cable gallery/cable tunnel to the exit should not be more than 25m.
- All the cable tunnels and cable galleries shall be provided with sump pumps for pumping out seepage water. Sump pumps shall be provided with high level/low level switches for automatic operation.

005 Cable shafts

- Cable shafts shall be of either civil or structural design as per requirement.
- Landing platform shall be provided at every 5 m of height.
- Suitable cat ladders shall be provided in the cable shaft.
- Suitable ventilation/lighting facilities shall be provided for the cable shafts.

006 Clearances inside the electrical rooms

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Clearance</th>
<th>Min. Distance</th>
</tr>
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</table>

1.0 Back clearance         1250
2.0 Front to front clearance between drawout / semi-
drawout panel boards         2500
3.0 Between two panel boards installed in a row         1000
4.0 Between front of the panel to the wall of the room         2000
5.0 Between the wall and end of the switchgear / MCC         1000
6.0 Back to back clearance         1500
7.0 Back to front clearance         2000
8.0 Between the bottom of the ventilation duct and top of
the electrical equipment         As per statutory requirement and
regulation

- Resistance boxes shall be floor mounted and shall be placed on the floor near the respective MCC.
- Disposition of control desk, mimic boards, instrumentation panels shall be properly located for visibility and operational convenience.
- Profile & dimension and painting of control desk / mimic panels shall be same as for control room for aesthetic design.
- In any other case, the layout shall confirm to provide clearances as per Indian Elect. Rules.

007 Transformer rooms

All mineral oil filled transformers shall have oil soak pit around it. These soak pits in turn shall be connected to a common catch pit for collection of oil. The capacity of catch pit shall be equal to 1.2 times of the oil content of the biggest transformer.

In case oil filled transformers are located inside the shop, the catch pit shall be outside the shop connected to soak pits by pipes. Also the transformer room shall be enclosed on three sides. Access side may have steel framed gate with expanded metal jali doors with wicket door provision.

All mineral oil filled transformer shall be separated from switchgear/electrical rooms with partition wall. All transformers and heavy equipment shall have adequate transportation and lifting facilities.

There shall be minimum 1m clearance all around the transformer. The ceiling height of the rooms shall be 1.5 m above the conservator. The minimum dimension of transformer room shall be 6mx6mx5.0m(H).

1.02.21.02 Guide-line for erection of Electrical equipment and accessories

001 General

All the electrical equipment shall be installed with proper care and as per layout drawings. Minor modifications required at site shall be made by the contractor with
approval of purchaser representative/Consultant for installation of the equipment. Care shall be taken for proper handling of equipment and undue vibrations shall be avoided particularly in case of sensitive (instrument mounted on panels) equipment.

The contractor shall have valid electrical contractor's license valid for State Govt. and as well supervisory licence. He shall have in his employment sufficient number of electricians and supervisors holding valid licenses for HV and LV installations. It will be the responsibility of the Contractor to get the installation cleared and relevant drgs. Certified / approved by Electrical Inspectors, Factory inspectors, Insurance agencies and other statutory authorities. The Govt. fees and necessary commercial aspects will be taken care by the Contractor.

002 Rotating machines

The erection work of motors shall include checking of all motors before installation including thorough cleaning and checking of bearings, replacement / rectification of defective items, greasing of bearing, if required, making minor modifications in its mounting arrangement, wherever required, assembling and its mounting on the motor base plate or on mechanical equipment, as the case may be, including levelling and alignment, checking insulation resistance and improving the same, if necessary, checking of internal connections etc.

All work associated with revisioning of motor shall also be included such as uncoupling and removing of motor from mechanical equipment, disassembling, cleaning, checking of insulation resistance and improving the same, if necessary, regreasing and replacing defective items/bearings on foundation, wherever required, reassembling, placing, levelling, aligning and fixing of coupling of the revisioned motor with mechanical equipment.

The contractor shall check different parts and assemble the motor at site in correct sequence wherever the motors are delivered in a dismantled state i.e. base frame, bearing pedestals, armature, field frame etc. in separate packages.

Erection, alignment and securing shall be done under expert technical supervision. Straight edges, feeler gauges, dial gauges etc shall be used for aligning purpose.

The height of the shaft of the motors shall correspond to the machine to be driven, if discrepancies are encountered these shall be compensated by inserting machined metal sim plates under the supports of the motor.

The motors mounted on the movable base frames / base plates shall be connected via intermediate terminal boxes with flexible cables.

After the complete installation of the motors, all bolts and bolted joints of the mechanical and electrical equipment shall be checked to ensure that they are done up
tightly by torque wrench. A further check shall be made to ensure that the armature can be easily rotated.

The insulation resistances of the coils and connecting leads within the machine shall be checked against earth by a suitable megger. Insulation resistance if found less, the machine shall be dried to achieve the desired value. Space heaters of main drive motor required to be installed in motor foundation pits shall be suitably and firmly mounted. For handling the machine with the crane, the slings, lifting cables etc. shall not be secured around the shaft. However, the armature of disassembled machines may be lifted or supported by the shaft. The machine shall be lifted or lowered without shocks or quick jerks to avoid any damage. Handling facilities of the motors shall be provided at places where direct crane approach is not possible.

The system components delivered in separate packages like tank, gear pumps, filters, pressure switches, thermometer, flow regulators, centrifuge etc. shall be assembled at site and installed as per supplier's drawings. The supply and return pipelines along with their supporting structures from the lubrication system to the motor bearing shall be laid/erected by the contractor as per the relevant pipeline routing drawings. Meters and gauges shall be fixed and wired.

Sheet metal enclosed panels, open control panels, control desks and boxes
The base frames of all panels, desks, posts etc., shall be welded to structures or to the civil inserts provided on the floor/walls. Fabrication of supports/frames, wherever required, shall be done by the contractor. The shipping section shall be placed in position before removing the protective covering to eliminate scratch/damage. The shipping section shall be moved by using rollers under the shipping skids wherever lifting cranes are not available. The contractor shall do the assembly at site as per manufacturer's general arrangement drawings and installation instruction. While assembling a complete board comprising several unit type cubicles, the board as a whole shall be aligned. The panels shall be properly leveled prior to grouting the holding down bolts or welding the panels to the inserts. All interconnection of busbars and wiring between the panels shall be done as per manufacturer's instructions and drawings. Welding work on the panels shall only be carried out after consultation with the purchaser. Damage to the paint due to welding shall be rectified by the contractor.

After mechanical installation of the board is completed, loose instruments shall be installed, wherever required, and wires shall be connected to the instrument. The
wiring of intermediate terminal strips between two panels, wherever disconnected for transport, shall also be connected.

Each post shall be mounted at the place of installation in such a way that the operator has both the plant and the post before him.

The installation of control posts / boxes on mechanical equipment must be approved by the purchaser.

In cases where the control posts / boxes are separately mounted near the equipment, the contractor shall manufacture a structural support for the same before mounting the control posts/box.

004 Static converters

The installation shall be carried out as per manufacturers’ instructions & equipment layout drawings.

The preservative grease from the metallic parts shall be removed by petrol and with clean markin cloth. Grease from copper parts shall be removed with ethanol and wiped with clean dry markin cloth.

The base frame of panels shall be welded to the civil inserts.

The panels supplied in separate shipping units shall be assembled at site as per manufacturer’s drawings / instructions. The unit installation shall be started with the main converter. All the cabinets shall be aligned in a perfectly straight row and each of them exactly leveled. All inter-connections shall be done as per manufacturer’s drawings/instructions.

005 Transformers and reactors

The transformer and its accessories and mountings like radiators, conservator, thermometers, silicagel breathers, marshalling box, rollers etc., delivered at site in separate packages, shall be assembled at site after cleaning by the contractor in proper sequence as per manufacturer’s drawings.

Jacks shall never be placed under valves or cooling tubes.

Suitable stopper shall be provided both in front as well as rear of transformer to keep the transformer stationary in its position. For the front wheels such stoppers shall be screwed on the rails.

The oil conservator and the pipes shall be erected as shown in the manufacturer’s drawings. All radiator tubes shall be cleaned before installation.

Before the transformer is filled/topped with oil, oil samples shall be checked by the contractor from each container. The oil shall possess the dielectric strength as per relevant IS/CEA. Oil shall be filled upto the mark shown.

The contractor shall also test the oil from each transformer to determine its suitability for use. If required, the contractor shall carry out drying and filtering operations as per
IS code of practice to ensure that moisture is completely removed and the oil is free from impurities. This may be carried out by using oil filtering equipment to be provided by the contractor having vacuum as well as heating arrangement. Only after the dielectric strength of oil and other parameters are checked and approved, the external connections shall be made to the transformers.

The dial thermometers shall be screwed to the thermometer pockets after removal of the blind plugs.

All necessary cabling shall be connected before charging of the transformer. This will include signaling cables upto marshalling box and from marshalling box to meters, if not already done, as well as inter cabling between surge suppressor cubicle and transformer secondary.

Any modifications to HT and LT terminal box to accommodate the number of cables to be terminated shall be carried out by the contractor.

Naked light and flame shall never be used near the transformer.

Reactor shall be suitably shielded to avoid magnetic interference to electronic circuit.

**006 Battery installation**

All batteries shall be installed in a separate room. It shall have a water tap and adequate ventilation facilities for acid/alkali fume extraction. Battery for UPS (SMF type) shall be panel mounted located by the side of UPS.

Rooms having battery installation shall have acid resistant floors.

Walls will have acid resistant tiles on the side walls upto 1.5m height.

**007 Busbar**

Busbar installation shall be commenced from the middle section and the buses shall be fastened without tightening the bolts. The buses shall lie freely on the insulators without warping and if necessary, suitable packing shall be provided at the insulators.

Final tightening of the bolts shall be done after the complete laying of buses. Approved means shall be used for tightening of the bolts.

Bimetallic strips/ washers shall be used wherever aluminium busbars or aluminium cables are terminated on copper busbars.

**008 Crane Trolley Lines**

While sectionalising, one middle safety section shall be arranged slightly in excess of the crane braking distance so that it can act as a buffer and prevent the danger of crane collector bridging the isolator gap and leading to accidents on other section under repair or maintenance.

Boarding or access platform shall be arranged within the limits of each repair section for approach to the crane.
In the middle of the run between two expansion joints and at sectionalising gaps, the rails shall be rigidly fastened/supported.

009 Resistance boxes

The resistance boxes shall be installed on frames to be welded to civil inserts already provided.

010 Cables Installations

Interplant cabling shall be done in cable tunnel. Overhead cable bridges / concrete cable channels can be considered in case of lesser number of cables. Cables laid overhead using separate structural cable bridge with suitable walkway of minimum 800mm wide for laying of cables. Cables of small in numbers and cables for drives/field switches inside shop units shall be laid along the structures and columns of the shop / buildings. Cables may run partly in walkable cable tunnels or underground trenches and/or surface ducts in the shops and partly along the structures and columns of the buildings.

In case of space constraints/restrictions, cable shall be laid in walkable cable tunnels. Where the number of cables to be laid calls for walkable tunnels and cable shafts, same shall be provided. Underground walkable cable tunnels shall have hydro sealing to prevent water seepage.

For multi-layer installation, overhead cable bridge/walkable cable tunnels shall be used depending upon the number of cables to be laid.

Laying of cables directly in underground or in trenches shall be avoided. However, it may allowed in special case with permission from site in charge. In such case, cable shall be laid in one layer only, more than one layer is not permissible.

Cables in trenches shall be laid on 8 cm of riddled sand and covered with 8 cm of riddled sand. RCC slabs shall be provided for covering these trenches. The maximum trench depth shall normally be 1.5 m and thickness of top cover of 75 mm. If the trench is to cross railway tracks/roads or any load bearing area the cables shall be taken through suitable GI conduits/pipes/ducts.

For crossing the road / rail track, cables shall be laid in concrete cable ducts, heavy duty GI pipes . 25% spare conduits / pipes / duct openings shall be provided.

Installation of cables directly buried in ground shall generally conform to the requirements given in IS: 1255 –1983.

011.1 Laying in tunnels/surface ducts/on structures

Cable racks for cable trays shall be fixed at a maximum interval of 1.5 m.

Cables leaving the ground/floor shall be protected upto 2-m height by conduits/metallic guards.
Ladder type cable racks and trays shall be provided to lay cables in tunnels/shafts/cable basements. Cables shall be laid in separate racks according to the voltage / application classification. Fireproof partitions such as asbestos sheets shall be provided between trays carrying LT & HT power cables, control and screened cables, communication cables, instrumentation cables & telecommunication cables. The cables shall be laid from top to bottom in order of HT on top rack followed by LT cables and other cables on lower racks.

All communication cables shall be laid through separate conduits to be installed in different routes with suitable separation from the other electrical cables. Conduits carrying special cables shall be painted, coded, marked as per plant norms. All necessary frame works and fixings for the support of cables and accessories shall be supplied.

Cables shall be suitably protected against heat, and mechanical damages.

Cables at fire partition wall crossings shall be painted with heat resistant paint 2 m on either side of wall.

011.2 Structures for cable laying

Power cables shall be laid on ladder type cable trays. Ladder type cable trays shall be selected from sizes 300 mm, 450 mm & 600 mm and shall be fabricated from 50x50x6 mm MS angles for longitudinal members and 25x5 mm flats for cross members placed at an interval of 250 mm along the length of cable tray. Control cables shall be laid on perforated trays.

Supporting vertical racks and horizontal hooks shall be of 50x50x6 mm MS angles. Cable racks and hooks shall be of welded construction.

To avoid damage during cable laying, cable structures shall have no scales, abrasive or rough surfaces or cutting edges.

The over head cable bridge structure shall be designed considering future cable laying and shall have 30% spare space for installation of future cable trays.

Walkway of minimum 800mm wide shall be provided for laying of cables.

Two numbers additional cable trays and 20% extra space on each cable tray for future use shall be provided as far as possible.

Cable shall be fixed to racks or trays or cleats as required for proper support, accessibility and neatness of installation. Hanging of cables racks over panels shall not be permitted rather no cable shall be laid/pass over any electrical equipment e.g. transformer, switchboards etc. Cable tags shall be provided at a regular interval of 30M. For cable run shorter than 30M one cable tag shall be provided in the middle. These tags shall be in addition to end cable tags. The cable tags shall be marked with cable number, size and voltage grade. Middle tag shall be indicated with destination. The end tag shall be with second terminal point.
Cables shall be clamped rigidly at an interval of not more than 1000 mm in horizontal, and 500 mm in vertical & inclined run and at bends.

In the cable basement/cable galleries, cable structures shall be properly arranged giving sufficient clearance for movement of personnel from one part of the basement/gallery to the other. It shall also be possible to escape easily in case of fire. Cable passing through water/scale pit/acid fume etc. shall be laid in PVC pipe with PVC junction boxes and pull boxes etc. Where cable racks or trays cannot be erected or the number of cables on the route does not justify their use, cables shall be cleated direct to walls or structural steel work. Perforated trays shall only be used where necessary for the support of a number of small cables. Each tray shall be firmly supported at suitable intervals and shall carry the weight of its cables without sagging. Trays shall be painted and where the surfaces or edges are cut or otherwise impaired during erection, they shall be made good by coating with aluminium paint.

Small cables may be bunched together under one saddle provided that in any bunch all cables have sheaths of the same material. The number of cables shall not exceed four wide and two deep.

Not more than one cable shall be drawn into one conduit unless otherwise agreed. After the cable has been drawn in, the conduit shall be sealed by an approved means.

After complete installation of racks and trays etc. it shall be painted with a primer of red oxide(zinc chromate) and a top coat of finishing paint as approved.

Fire protection barrier as approved by purchaser shall be provided between HT cables on racks laid on top and LT cables on racks below the HT cable rack.

All cables shall be tested for proper insulation before start of laying work. Cables shall be laid in conduits, racks/trays, cable tunnels/trenches, along with structures or buildings, as per cable routing drawing and cable list.

Suitable adjustment shall be made in cable routes, if required at site, with a view to avoid any interference with any part of building, structures, equipment, utilities and services with the approval of the purchaser.

While laying cables, care shall be taken that kinks, twists or mechanical damage do not occur to the cable.

All bends in cables shall be made with due consideration to the minimum permissible bending radius of the cables.
Loops shall not be allowed to be formed during the laying of the cables. When being pulled, the cable shall not be allowed to drag drawing along the ground or over a second cable already laid. Special care shall be taken while pulling through an opening where other cables have already been laid. Only approved cable pulling devices shall be used.

No joints shall normally be made at any intermediate point in through run of cables unless the length of the run is more than the standard drum length. In such cases where jointing is unavoidable, the same shall be made inside proper bases having plastic moulds and shall have moulded epoxy resin construction. Provision shall be made for earthing continuity at the joint. Cable splicing and jointing shall be done in accordance with the relevant IS, code of practice and manufacturer’s instructions. Insulation resistance of cables shall be checked before cable jointing.

Adequate length of cables shall be pulled inside the switch boards, control panels, control desks, etc. so as to permit neat termination.

All cables shall be neatly dressed without interlocking or cross overs. While laying the cable vertically, these shall be clamped at suitable intervals. Horizontal runs shall be rigidly secured to trays on racks/hangers in all the places where the direction of the route changes as well as at cable terminations or joints. The clamps shall not be done up so tight that the insulation is damaged or deformed.

Cable markers shall be provided on either side of road crossing at each turning and at 30 m intervals at straight runs for underground cables.

Where cables are required to cross roads, surface drains and water, oil, gas or other pipe lines, they shall be taken through reinforced spun concrete or steel pipes.

Entry of cables from underground to the buildings or trenches shall be through pipe sleeves. After laying of cables, the sleeves shall be sealed with bitumen or epoxy compound with sand matting and cement plaster to make them fully water tight. Special consideration shall be given for protection of cables against chemical and mechanical damage.

All cable entry openings in the equipment shall be sealed and made vermin proof. All cable openings in walls and floors shall be sealed after laying of cables by a weak mixture of asbestos and cement mortar.

All cables shall be provided with identification tags indicating the cable number in accordance with cable lists. Tags shall be fixed at both ends of the cable and at 15 m spacing for straight runs as well as on both sides wherever cables are crossing walls/floors. The tags shall be of aluminium/PVC with numbers punched/painted on them and securely attached to the cables by non-corrosive wires. The shape of tags
shall be round, triangular and rectangular for control, medium voltage and high voltage cables respectively.

Glanding shall be done for direct entry of both power and control cables into the panels by the contractor. Compression type brass or aluminium alloy cable glands shall be used.

The cables shall be terminated in accordance with relevant connection diagram. Termination and clamping shall be carried out in such a manner as to avoid strain on the terminals.

All power cable terminations shall be by means of crimping type cable lugs. For flexible conductors, soldered termination shall be adopted. In case of aluminium power cables termination on copper bus bars, suitable aluminium copper bimetallic washers shall be used. Corrosion inhibiting grease shall be used for aluminium cable terminations. All 1.5 sq.mm screened cable/ 2.5 sq.mm control cable termination shall be made by crimping using pin / fork type (as decided during engineering stage) insulated copper lugs. The 1.5 / 2.5 sq.mm copper lugs shall be supplied by the contractor.

Suitable numbered and coloured letter interlocking type ferrules shall be provided for end termination of power and control cables. Cross ferruling shall be used for control termination as far as possible.

Control cable entering switch boards, control panels, control desks etc. shall be neatly bunched and strapped with PVC perforated straps and suitably supported to keep it in position at the terminal blocks. All spare cores of each cable shall be segregated, marked spare, neatly dressed and suitably tapped at both ends.

When the cores of two or more multicore cables take a common route in side equipment, cores of each cable shall be separately bound and the separate bundles neatly bound together.

Individual cores of control cables shall have plastic interlocked type coloured ferrules with engraved numbers at both ends of the circuit for identification.

The contractor shall be responsible for correct phasing of motor power connections and shall interchange connections at the motor terminals box, if necessary, during each motor is test run.

The trays shall be earthed and rendered electrically continuous by welding the trays to the grounding strip at not less than two places from both sides of the tray.

011.3 Cable Joint/termination accessories

The cable accessories shall include end termination kits, straight through joints and also any special tool and tackles and accessories required for making the joints/terminations.
The straight through joint/termination arrangement shall be complete with all fittings and consumables. The joint shall have electrical and mechanical withstand capability, same as that of the associated cable. For all cables, a minimum extra length of 2 metres will be left before jointing.

The termination kit shall be of heat shrinkable type only.

The termination kits/straight through joints shall have the following features:

- Electrical stress control to be provided at the cable insulation shield terminus.
- An external leakage insulation to be provided between the cable conductors and ground.
- Adequate protection to be provided at the end of the cables against the entrance of the moisture and, provision to maintain the constant pressure in the cable.

**Exposed conduits**

Exposed conduits shall be laid along walls, floors, ceilings, on steel supports etc. as per working drawings/site requirements in consultation with the supervisory personnel. The conduits shall be neatly run and evenly spaced.

Fixing of conduits to the supports on wall, column, structure shall not be done by welding. Exposed conduits shall be adequately supported by racks, clamps, straps etc.

Jointing of conduits shall be done only in straight portion and not in bend portion.

The contractor shall have available at site bending facilities for conduits as well as dies for threading conduits of diameters and threads corresponding to the standards. The threaded ends of conduits shall be painted with anticorrosive paint. The outer ends shall be smoothened free of burrs and sharp edges. Bushings shall be fitted at both ends of conduits.

Flexible metallic conduits shall be used for termination of connections to motors and other electrical equipment like pressure switches etc. which need to be disconnected at periodic intervals.

All conduits shall be effectively connected to the earth terminal of the equipment where it terminates.

Both ends of conduits shall be suitably earthed. Earthing continuity to be maintained by means of flexible wire wherever two conduits are joined with sockets.

Approved conduit bending machines to be arranged by the contractor shall be used for bending conduits at site. The radius of any conduit bend shall be as per standards for cabling. Bends shall be free from cracks, crimps or other damage to the pipe or its coating.

**Earthing and lightning protection**

**Earthing**

Entire system shall be earthed in accordance with the provisions of the relevant IEC recommendations/ IS code of practice IS 3043-1987 and Indian Electricity Rules, so that the values of the step and contact potentials in case of faults are kept within safe permissible limits.
Parts of all electrical equipment and machinery not intended to be alive shall have two separate and distinct earth connections each to conform to the stipulation of the Indian Electricity Rules and apparatus rated 240 V and below may have single earth connections.

All shops and buildings as well as the electrical sub-stations and electrical rooms shall be provided with a ring main earthing system each. Individual ring main earthing systems shall again be interconnected as a network.

The ring earthing system around each building shall be laid at a distance of approximately 1.5 m from the building and at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structures, reinforcement of building columns and also to pipes, wherever they are crossing. The earth ring shall further be connected at intervals to deep earthing electrodes to achieve a combined earth resistance of less than one ohm.

For the purpose of dimensioning the earthing lines/conductors, the duration of the earth fault current shall be taken as 0.3 seconds.

For different floors in a building, localized ground mats shall be formed and connected to the ground earthing ring through vertical risers. The earthing mat shall be common to both power and lighting installations.

For protective earthing separate conductor shall be used for flow of earth fault current as elaborated below.

The LV side neutrals of the Power distribution transformers shall each be connected to two separate earthing electrodes. They shall also be connected with the neutral bus of the corresponding switchgear and the switchgear neutral bus shall be connected to the earthing ring at two different and distinct points. The fourth core or armour of cables and all conduits for cables shall also be connected to the earthing mains. A continuous earth strip shall be run in each side of cable tunnel and in cable ducts and trenches.

The power supply cables (LT) from the sub-station and the distribution cables to individual motors shall have 4/3.5 cores.

LT power supply cables shall have four cores and the fourth core shall have cross-sectional area of 50% of the other cores generally. The fourth core of the main supply lines shall be connected to the solidly earthed neutral bar in the substation switchgear as well as at the earth bars in MCC/distribution boards.

Separate electronic earthing system shall be provided for all electronic equipment like PLC's, weighing panel, computer etc.
Earthing scheme to be finalized before basic engineering, in consultation with the client and approval of OEM.

02  Conductor sizes for ground connections:

For equipment ground connections, the minimum conductor sizes used should be as follows:

02.1  High voltage systems :-

75 x 5 mm GI flat :

- Main earthing rings
- Main LT switch-boards
- Transformers
- Earthing leads to earth electrodes.

02.2  LT system where the voltage does not exceed 650V normally :

6 Sq.mm Stranded GI wire :

- Motors and starters upto and including 2.2kW, Light fitting, JBs, etc.
- Instruments and miscellaneous small items protected by fuses of ratings not exceeding 15A.

16 Sq. mm Stranded wire :

- Motors and starters above 3.7 kW and upto and including 15 kW.

25 x 3 mm GI flat :

- Motors and starters above 15 kW, and upto and including 45 kW
- Control desks, cabinets, LCB, Welding socket outlet, Isolators, LDBs.

50 x 6 mm GI flat :

- Motors and starters over 45 kW and HT motors
- MCC, PDB, MLDB.
- Main earthing ring for MCC room, in shop units/plant buildings
- Bonds to crane gantries
- Cable trays all around
- LT Switchboards and other equipment protected by circuit breakers.

03  Earthing electrodes:

The earthing electrodes shall be of GI pipes 50 mm dia and about 4 mm thickness in one piece provided with water holes and other filling devices. Earthing system for
computers and microprocessor based equipment/ PCs shall be distinct and separate from the power and lighting equipment earthing system.

**Earthing of electrical equipment on cranes and travelling machines:**

Every electrical equipment shall have double earthing.  
A ring earthing system shall be provided within the crane/machine to which every electrical equipment shall be connected at least at two places.  
The earth ring on the crane/machine shall be connected to the plant earthing system through the gantry rails. Two sets of earth collector brushes shall be provided on each side of crane/machine to connect its earth ring to the gantry rails.  
Each end of each gantry rail shall be bonded to the plant earthing system.  
In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks.  
Flexible copper bonds shall be provided across any gap in the running gantry rails.  
For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

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**Lightning protection**

All buildings and plant structures vulnerable to lightning strokes owing to their height or exposed situation shall be protected against atmospheric flash-overs and lightning strokes in such a manner as to eliminate any danger to the personnel employed therein. Stipulations of IS : 2309 - 1969 shall be followed.  
A *Faraday Cage*, made of hot galvanised strip steel connected to all buried pipes and steel structures crossing this cage ring shall be laid around each main building or plant unit as earthing device. This shall be separate from the electrical equipment earthing ring main.  
All lightning arrester earth leads of the buildings and plant units shall be connected to this cage ring.  
Air termination network should cover all salient points of the structure. All metallic chimneys, ducts and the like above the roof of the structure shall be bonded to and form part of the air termination network. Vertical air termination points shall project at least 30 cm above the object on which it is fixed.  
Down conductors shall follow the most direct path possible between air termination and earth termination avoiding sharp bends. Down conductor shall have a testing point adjacent to the earth electrode. Each conductor shall have an independent earth termination. All earth terminations shall be interconnected.  
Earthing electrodes and grid for lightning protection will be distinct separate from the earthing system for earthing of electrical equipment and at no place will be connected to other earthing system.  
Earthing connection to equipment subject to movement, vibration and shocks, shall be through flexible stranded conductors.
The termination of strips to the equipment shall be done by bolting and the wires shall be terminated by compression lugs. Jointing of strips shall be done by welding for proper continuity. All contact surfaces shall be thoroughly cleaned of dust and oil and after jointing, the joints shall be given bitumen paint.

Earthing conductors laid directly in ground, shall be coated with one coat of bituminised paints, be wrapped with one layer of bitumaetic tape laid on half lapped and shall have a final coat of bituminised paint to prevent corrosion. Earthing conductors run on walls/floors/cable and equipment structures etc. shall be supported at suitable intervals and painted with black oxide paint.

All joints in the branch connections except at earthing electrode shall be welded and painted black. At road/rail crossings earthing strips shall be laid through conduits/concrete ducts. Special earthing shall be provided for all electronic equipment as per manufacturer’s recommendations/practice.

1.02.23 Repair network

01 General

A repair network shall be laid to cover all the units/buildings of main technological plant for providing power to maintenance tools, tackles and telpthers.

Welding switch socket outlets shall be provided at every 60m distance in conveyer galleries and at least one at every working platform of junction houses. The number of welding socket outlets for main technological plant units shall be decided based on requirement, approach etc. Generally the socket outlets shall be provided in such a manner so that using 30m flexible cable with welding set, total plant area can be covered. Upto three switch socket outlets can be looped per feeder circuit. Sheet metal clad switch units shall be provided for feeding power to telpthers.

02 Switch socket outlets

- 415V, 100 A, 3 pole load break switch
- 3 phase and one earth pin socket
- Switch socket interlocked so as to prevent insertion or withdrawal of plug when switch is “ON”.
- Facilities for terminating two cables of 3.5 x 70 sq. mm aluminium cables.
- All the switch socket outlet shall be fed from PDB directly.

03 Cables

- Outgoing feeders to switch sockets 3.5 x 70 sq. -mm for 100A sockets,
1.02.24  Ventilation and Air-Conditioning of Electrical Premises/Control Rooms

01  General

The control rooms shall be provided with air conditioning system. For central control rooms of standby air conditioners shall also be provided. Rooms for shift in-charge and office in-charges shall be provided with package AC units.

Separate room, as part of control room shall be provided to house AC units. The ventilation and air-conditioning system supplied shall be complete with all necessary central air-conditioning plants (modern microcomputer based), packaged air-conditioners (micro-computer based), fresh air filters, fan units, supply and return air ducts, monitoring and regulating equipment and electrical power supply equipment to complete the job complete in all respects.

Necessary safety interlocks shall be provided to stop the fans/AC system in case of fire and to prevent spread of fire.

Window / package Air conditioners: Energy savers with temperature sensors / Time switches for switching ON/OFF of compressor motors.

The equipment shall meet the requirement listed in equipment specification under part-I.

02  Switchgear rooms, MCC rooms, Cable cellar

All HT/LT substations, switchgear rooms and MCC rooms, cable basement/cellars which do not house any electronic equipment but contain only electrical equipment, shall be pressurised with cooled washed air to maintain the room temperature within 45 deg.C irrespective of outer temperature. This shall match with the duty conditions of electrical equipment in the rooms. Where a large number of electrical equipment are involved, adiabatically cooled air washer system shall be provided to maintain room temperature at 40deg.C. Suitable capacity fan and pumps (1W+1S) shall be provided for each unit. Necessary ducts shall be supplied by tenderer.

03  Electrical rooms with electronic equipment

The electrical rooms housing electronic equipment, Remote I/Os, electronic weighing panels including telephone exchange equipment shall be air-conditioned with pressurisation to maintain the following conditions:
- Room temperature : 30 Deg.C
- Relative humidity : Not more than 50 %
- Pressurisation : 2-3 mm WC

04 Central Control rooms, Rooms for PLC, Servers, Computers and Level-1/2 automation system equipment.

These rooms shall be air-conditioned with pressurisation to maintain the following conditions:

- Room temperature : 21 to 24 Deg. C
- Relative humidity : 50 to 60%
- Pressurisation : 2-3 mm WC
- Temperature gradient: 2 Deg. C/h

05 Small local Control Rooms/pulpits

The control rooms/pulpits shall be air-conditioned to maintain the following conditions:

- Room temperature : 24 Deg. C
- Relative humidity : 50-60%
- Pressurisation : 2-3 mm WC

06 Cable tunnels and basements

These shall be ventilated with fresh filtered air to maintain temperature of air at exit so as not to exceed 45 deg.C and pressurised - ventilation of cable basements and tunnels shall not be combined with other premises. Cable tunnel ventilation shall be sectionalled to maximum length of 150m. Temperature rise shall be limited to 3-5 deg. C above atmospheric dry bulb temperature subject to a maximum of 45 deg.C at the exit of air from these premises. Ventilation and air conditioning system shall be interlocked with fire detection system for safety.

1.02.25 Testing

Test of all equipment shall be conducted as per latest ISS/IPSS applicable. Tests shall also confirm to International Standards IEC/VDE/DIN/BS (in case corresponding test are not mentioned in ISS/IPSS).
All routine test shall be carried out at manufacturer’s works in the presence of purchaser or his representative.

The tenderer shall submit type test certificates for similar equipment supplied by him elsewhere. In case type test certificates for similar equipment are not available, the same shall be conducted in the presence of purchaser or his representative if purchaser so desires, without any financial implications to the purchaser.

All the equipment shall be tested at site to know its condition and to prove suitability for required performance. The site tests and acceptance tests to be performed by Contractor are detailed below.

The Contractor shall be responsible for satisfactory working of the complete system in an integrated manner and its guaranteed performance.

1.02.25.01 Type & Routine

.01 Transformers

A. Routine Tests

viii) Assembly inspection/ Painting check
ix) Measurement of winding resistance
x) Measurement of voltage ratio and check of voltage vector relationship
xi) Measurement of impedance voltage (Principal tapping), short circuit impedance and load loss.

xii) Measurement of no-load and current.
vi) Measurement of insulation resistance/ polarizatation index.

xiii) Dielectric test:

  a) Induced over voltage withstand test
  b) Applied voltage withstand test
      (H.V. power frequency test)

xiv) Certification for off-load tap changer

 xv) Final documentation check

B. Type Tests

i) Temperature rise test

  ii) Measurement of acoustic sound level

  iii) Lightning impulse withstand test (if test certificates are not available)

  iv) Short circuit test

  v) Measurement of commutating reactance and determination of inductive voltage drops (for thyristor converter transformer only).

.02 Busduct

A. Routine Tests

i) One min. power freq. withstand voltage
ii) Measurement of insulation resistance
iii) Measurement of resistance and reactance of busbars

B. Type Tests
i) Heat run test
ii) Short time rating test (thermal & dynamic)
iii) Impulse withstand test
iv) Tests for degree of protection for enclosures

.03 Power Control Centre and LT switchgear

A. Routine Tests
i) Assembly inspection/ Painting check
ii) Measurement of insulation resistance
iii) Dielectric test for assembled unit
iv) Functional test including automatic bus transfer scheme
v) Tests of ACBs including operation test, calibration of releases, measurements of contact resistances.
vi) Polarity tests for CTs.
vii) Final documentation check

B. Type Tests
i) Temperature rise test for main and vertical bus-bars.
ii) Short-circuit test for main and vertical bus-bars.
iii) Enclosure class, degree of protection
iv) Dielectric test including protective circuit.

.04 Load Break Isolator

A. Routine Tests
i) Assembly inspection/ surface treatment check
ii) Power frequency voltage withstand dry test on the main circuit.
iii) Voltage withstand test on auxiliary and control circuits.
iv) Check of the main circuit
v) Mechanical operating test
vi) Insulation resistance measurement
vii) Contact resistance
viii) High voltage test
ix) Final documentation check

B. Type Tests
i) Type test for typical isolator and/ or earthing switches
.05 Current Transformer and voltage transformer

A. Routine Tests
   i) Assembly inspection
   ii) Power-frequency tests on primary windings
   iii) Power-frequency tests on secondary windings
   iv) Over-voltage inter-turn tests
   v) Dielectric test
   vi) Ratio & polarity test
   vii) Measurement of ratio error & phase angle error
   viii) VI characteristics
   ix) PT winding resistance
   x) Final documentation check

B. Type Tests
   i) Short-time current test
   ii) Temperature rise test

.06 Final Test of Materials of Grounding and lightning system
   i) Visual check
   ii) Dimensional check
   iii) Accessories fitting check
   iv) Mechanical and electrical test (where applicable)
   v) Final documentation check

07 CABLES

1. Shop Tests
   a) The cables shall be subject to shop tests in accordance with relevant standards to prove the design and general qualities of the cables as below:-
      i) Routine test on each drum of cables

2. Acceptance tests on drum chosen at random for acceptance of the lot
   a) High Voltage withstand test for HT cable (Hi Pot test)
   b) Type tests certificates on each type of cable, inclusive of measurement of armour D.C. resistance of power cables will be furnished by Contractor

B. PACKING

1. Cables will suit barrel diameter and securely clamped/fixed. The barrels must be sufficiently strong to withstand mechanical shocks and shall effectively protect against transit.
2. Both ends of cable will be metal capped to prevent moisture ingestion. Ends shall be kept inside the cable drum in a manner so that these are accessible for testing.

3. Cable drum identification/marking will be as follows:
   a) Makers name
   b) Consignee's full address
   c) Type size and length of cables
   d) Net and gross weights
   e) Any other marking for shipping
   f) Drum Markings

C. Drum Lengths

1. LT Cables will be delivered at site preferably on standard drums each containing 500 m or 1000 m cables. Where total quantity of a particular cable is less than 500 m, the entire length will be supplied in one drum.

2. For 90% cable drum of each item of cable permissible tolerance is in length + 5% For 10% balance cable drums, Contractor shall ensure that each 500 m capacity drum contains at least 250m and each 1000m capacity drum contains at least 500m cable lengths. Overall tolerance for each item of cable is + 1% of total length.

08. Motors :-

A. Routine Tests
   The following are the routine tests carried out on each and every motor:
   1.0 Measurement of resistance.
   2.0 Insulation resistance test.
   3.0 Motors are tested at 1/3 times the rated voltage for checking the ability of the motor to run upto full speed, when switched in either direction.
   4.0 No load test.
   5.0 High voltage test.

B. Type Tests
   1. Measurement of rotor resistance.
   2. No load test
   3. Locked rotor test.
   4. Full load reading of voltage, current, power input and slip.
   5. Temperature rise test.
   7. Insulation resistance test.
   8. High voltage test.
   9. Polarisation index test (for HT motors)
09 SITE TESTS AND CHECKS

001 General
All the equipment will be tested at site to know their condition and to prove suitability for required performance. The test indicated in following pages will be conducted after installation. All tools, accessories and required instruments will have to be arranged by contractor. Any other test that is considered necessary by the manufacturer of the equipment, Contractor or mentioned in commissioning manual has to be conducted at site. In addition to tests on individual equipment some tests / checks are to be conducted / observed from overall system point of view. Such checks are highlighted under miscellaneous tests but these will not be limited to as indicated and will be finalised with consultation of client before charging of the system. The Contractor will be responsible for satisfactory working of complete integrated system and guaranteed performance. All checks and tests will be conducted in the presence of Client’s representative and test results will be submitted in six copies to Client and one copy to Electrical Inspector. Test results will be filled in proper proforma. After clearance from Electrical Inspector, system / equipment will be charged in step by step method. Based on the test results clear cut observation will be indicated by testing engineer with regard to suitability for charging of the equipment or reasons for not charging are to be brought by the Contractor.

002 Trial Run Test
After the successful test of each equipment as per standard test procedure, the entire control system will be put on trial run test on actual site conditions and operation of the system.

003 Acceptance Test
The acceptance test on the system will be carried out by the contractor as per mutually agreed test procedures to establish satisfactorily functioning of the system as a whole and each equipment as part of the system.

004 Site Tests
The tests to be carried out on the equipment at pre-commissioning stage will include following but not limited to the following:

**Transformer**

1. IR test on each winding to ground and between winding and check for polarization index.
2. Turns ratio test on each tap
3. Polarity and vector group test
5. Heating and drying and checking with heating and cooling curve.
6. Checking of earthing wrt transformer tank (flexible from top cover to tank) other parts, neutrals and tank to electrodes of LAs (for LAs located near transformer).
7. Testing of Buchholtz relay for alarm and trip conditions
8. For bushing CTs, tests applicable will be as for current transformers.
9. Calibration and setting of oil/winding temperature indicators, level gauge
10. Check insulators for cracks.
11. Checking for oil leakage and arresting of leakages (if required)
12. Checking of operation of all valves.
13. Checking of open operation of all valves (except drain and filter set)
14. Filtration of oil by using line filter and heater set
15. BDV test on Oil samples from top & bottom
16. Checking of Oil for acidity, water content and tan delta as per IS 335.
17. Measurement of magnetising current and no load loss.
18. Checking of silica gel breather.
19. Checking of noise level at no load and at full load.
20. Checking of air circulation conditions for indoor transformers.
22. Checking of other points given in manufacturer’s commissioning manuals.
23. IR, wiring and operational tests on all control devices in control cabinet, oil level indicator winding and oil temp. indicators, oil pump, cooling fan etc.

**HT ISOLATOR**

1. IR test before & after HV test
2. HV test
3. Operational test
4. Checking of interlocking with earth switch
5. Checking of operation of earth switch
6. Checking of tightness of earth connection
7. Check for continuity of aux contacts
8. Check working of shunt trip (if applicable)
9. Checking of CTs, PTs (if applicable) as per the details given in HT board.
10. Contact resistance/ millivolt drop test

**LT SWITCHBOARD**
1. IR test
2. HV test with 2.5 kV megger
3. Functional test for all feeders
4. Testing and calibration of all meters
5. Checking and calibration of overload relays and protective relays by primary injection method.
6. Check operation of contactors from local and remote points.
7. Checking of interlocking between incomers/ bus couplers and other feeders
8. Test of prove interchangeability of similar parts.
9. Test to prove correct operation of breakers at minimum and maximum specified control voltages.
10. Checking operation of RC circuit (if there) for tripping of circuit breaker after disappearance of control voltage.
11. Checking of earthing connection for neutral-earth bus, cable armour, location of E/F CT etc. as per the scheme.
12. Checking of tests, service and drawout position of all the breakers and operations of mechanical flag indicator and electrical indication lamps.
13. Checking the functioning of various electrical schemes like auto change over, signaling etc.
14. Contact pressure test

**BUS DUCTS**
1. IR measurement before and after HV test.
2. HV test.
3. Checking tightness of bolts with torque wrench.
4. Checking for phase sequence marking.
5. Check for clearances between phase to phase and phase to earth.
6. Check for minor damages and cracks in supporting insulators and bushings after cleaning.
7. Checking of busbar cracks and rectification of same.
8. Checking for inspection openings and accessibility for replacement of insulator etc.
9. Check tightness of earthing connections on enclosure.
10. Checking of silicagel breather (if there).
11. Checking of working of space heater.
12. Hot air blowing to remove moisture if required.

**Cables**

1. Visual check
2. Checking of continuity and IR values for all the cables before and after HV test.
3. HV test and measurement of leakage current after termination of cable kits (for HT cables).
4. Checking of earth continuity for armour and fourth core (if applicable)
5. Check for mechanical protection of cables.
6. Check for identification (tag number system) distance placement of cable marker, cable joint etc. as per the cable layout drawing.
7. Check earthing of cable structures.
8. Check safe head room in tunnel and basement area.
9. Check clearance from ventilation duct and light fittings for cable structures.
10. Check proper fixing of cable structures.
11. Check for proper drainage and removal of water (if any).

**Lightning Protection**

1. Check continuity of all the earth strips / shield wire.
2. Check tightness of all connections.
3. Measure earth resistance of each electrode and combined system.

**Earthing**

1. Check tightness of all earth connections.
2. Check earthing of all metallic equipments, cable trays, busbar supporting structures, building column (if steel) all elect equipments, pipe lines etc. as per the drawing / specification
3. Measurement of earth resistance for each electrode.
Measurement of earth loop resistance for E/F path of biggest LT drive.

**Miscellaneous**

1. Checking of continuity of the system.
2. Checking of phase sequence from overhead line consumer end.
3. Checking safe accessibility of all operating points
4. Check availability of emergency lighting
5. Check availability of control aux. supply.
6. Ensure availability of first aid box, fire fighting equipments, earth discharge rods, rubber mats, rubber glove.
7. Check oil drainage system for transformer oil
8. Check filling of gravels in transformer pits.
9. Check for safe movement of operators control room / switchgear etc., wrt proper illumination, escape light uncovered openings provision of hand railings in stairs etc.
10. Check proper covering of cable channels.
11. Placement of shock treatment chart, danger boards provision of boards indicating ‘Man on work’ Do not switch ON ‘Do not switch OFF’, ‘EARTHED’ etc.
12. Provision of route map at gallery entry points for indication of escape.
13. Check proper dressing of cables, mechanical protection of cables, placement of cable markers.
14. Check sealing of all cable openings including conduits opening with fire resistance material.
15. Check sealing of all openings at bottom of electrical panels.

**APPENDIX**

**TABLE - I**

**SELECTION OF POWER COMPONENTS & WIRING FOR CONTINUOUS DUTY CAGE MOTOR DRIVES**

Rating of MCCB / MPCB as required shall be selected based on type-2 protection.

| Motor rating at S1 duty (kW) | Minimum rating of MCCB in Amps (AC23) | Minimum rating of Power contactor in Amps (AC3) | Minimum size of Cu wire / flat in sq. mm for internal power connection | Minimum size of Power cable (Al.) termination in sq.mm. |
1.02.27 ILLUMINATION

1.0 General

The lighting system inside and outside plant units are designed based on the desired illumination levels recommended by IS and the practices followed in industries, architectural arrangement, building dimensions including mounting height, environmental considerations, ease of maintenance and reliability of the lighting distribution network.

2.0 The illumination system shall be designed as per IS:3646-1992. The level of illumination, type of fittings, maintenance factor to be considered is as given below:

<table>
<thead>
<tr>
<th>Area</th>
<th>Type of Light Fittings</th>
<th>Lux level</th>
<th>MF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control rooms</td>
<td>Louvered recessed type 2x40W &amp; 4x20W fluorescent fittings</td>
<td>300</td>
<td>0.75</td>
</tr>
<tr>
<td>Electrical rooms having PDB, MCC, VFD panels, PLC</td>
<td>Industrial corrosion proof fluorescent lamp fittings for 2x36W fluorescent lamps Philips type TKC 22/236 or equivalent</td>
<td>200</td>
<td>0.7</td>
</tr>
<tr>
<td>Staircases of plant buildings - do -</td>
<td>Industrial well-glass integral type luminaire</td>
<td>70</td>
<td>0.6</td>
</tr>
<tr>
<td>Staircases (steel) of plant</td>
<td></td>
<td>70</td>
<td>0.6</td>
</tr>
</tbody>
</table>
complex and cable tunnels / cellars | suitable for 70W HPSV lamps, similar to Philips type SDL-23/70 or equivalent | 
---|---
Pump house | - do - | 200
Flood lighting | Weather proof flood light fittings for 1x400W HPSV lamps Philips type H/SVF12 or equivalent | 70
Pipeline tunnel | Industrial fittings for 24V, 2x50W halogen lamps “Sigma” make deck lights or eqvt. | 
Casting Bay | High bay HPSV industrial incandescent (1000 W) equivalent to HDK /SDK of PHILLIPS make | 200
Conveyor Houses / conveyor gantries / junction houses | Fluorescent / incandescent industrial type fitting equivalent to TPW / NXC of PHILLIPS make | 70 to 100
Aviation obstruction | Aviation obstruction light fittings, flame retardant type consisting of multi ultra high intensity 60 mscp LED module, without flashing module, steady in red colour, having omni directional capability and shall be suitable to deliver maximum light output in the zone between 70° above and 10° below the horizontal with a maximum of condition at 20° above the module. | 

a) Standard wattage of lamps shall be

1. FTL
   - 36 W high luminous lamps.
2. HPMV
   - 250 and 400 W
3. HPSV
   - 70, 150, 250 and 400 W
4. Incandescent
   - 60, 100 W (Use of Incandescent lamps shall be avoided)

b) Compact fluorescent lamps are to be used for offices and corridors.

c) All switches and sockets used in office buildings shall be of flush type

d) For street lighting, necessary control gear shall be provided for reduced voltage running during off peak traffic for energy conservation.

Illumination: Electronic ballast having third harmonic distortion less than 6 % and total harmonic distortion less than 12 % with high luminous tube lights are to used. Time switches, reduced voltage controllers, group solar lighting sections for remote areas shall be provide wherever feasible. Lighting Fixtures and Accessories shall be energy efficient

### 3.0 Area Lighting :-

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type of road</th>
<th>Av. Lux level</th>
<th>Type of illumination</th>
<th>MF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group - A1</td>
<td>Important traffic road carrying fast traffic</td>
<td>30</td>
<td>Cut off / semi cut off</td>
<td>0.6</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------</td>
<td>----</td>
<td>------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>Group - A2</td>
<td>Main road carrying mixed traffic</td>
<td>15</td>
<td>Cut off / semi cut off</td>
<td>0.6</td>
</tr>
<tr>
<td>Group - B1</td>
<td>Secondary road with considerable traffic</td>
<td>8</td>
<td>Cut off / semi cut off or non cut off</td>
<td>0.6</td>
</tr>
<tr>
<td>Group - B2</td>
<td>Secondary road with light traffic</td>
<td>4</td>
<td>Cut off / semi cut off or non cut off</td>
<td>0.6</td>
</tr>
</tbody>
</table>

MF : Maintenance factor

The light fittings shall be complete with all accessories like electronic ballast, reflector etc. External area lighting including street/road lighting / tower lights shall be fed from MLDB through separate SLDB located at suitable places. Automatic switching ON/OFF of these circuits shall be done through timers. Flood light towers shall be fed through 415/240V, 3 phase, 4 wire circuit with individual fittings distributed at 240V, single phase, with control and protection located at bottom of each tower. Rewirable fuse in a sheet steel box shall be provided near each fitting to facilitate removal of lamp in off position.

In high bays walkway shall be provided for maintaining light fittings. At other places suitable ladder/platform/approach shall be provided for maintaining/replacement of light fittings.

B. Power distribution

1.0 The distribution of lighting power supply for the individual areas shall be done at 415V, 3 phase, 4 wire bus system through Main Lighting Distribution Boards (MLDB) for the area. The MLDB shall be fed through a lighting transformer. The outgoing feeders of the MLDB shall feed the required numbers of Sub Lighting Distribution Boards (SLDB) for lighting. Each SLDB shall receive power at 415V AC, 3 phase, 4 wire and distribute it into 240V, 1 phase circuits for connection to the lighting fixtures and 240V receptacles. The SLDB shall be located in the rooms, bays etc. covering the respective zone. The SLDB shall be located in the electrical rooms in the respective area.

2.0 Emergency lighting

In case of indoor illumination, separate lighting circuit shall be provided as emergency lighting circuit. Emergency lighting circuit shall be through emergency MCC/PDBs so that in case of failure of power in lighting DBs circuit, these lights can continue to glow. 20% lights shall be connected to this circuit. Balance lights shall be connected through lighting circuit.

Portable Emergency lighting including built-in battery, battery charger & lamps shall be provided in strategic areas like control rooms, staircases, entry of cable tunnels/basements, escape routes, etc. for safety.

3.0 Maintenance lighting

For maintenance lighting, power supply shall be fed from 240/26.5V small capacity step-down transformers to the 24V socket outlets.

4.0 Outdoor lighting
Flood lights for area lighting shall be mounted on towers/poles or building structures. Tower height shall be kept to an average of 22m.

Street/road lighting and boundary wall lighting shall be provided with HPSV/fluorescent lamp fittings mounted on poles of 9m to 11m height.

Neon aviation obstruction lights shall be provided on chimneys and other such tall installations as per regulation. M/S Binay or equivalent make aviation obstruction lights (LED type) shall be provided. For street lighting necessary control gear shall be provided for reduced voltage running during off peak traffic for energy conservation.

5.0 Power factor improvement

Power factor of all the light fittings shall be improved so that it is not less than 0.90. Power factor shall be improved by providing capacitor banks with discharge resistor in the light distribution or by providing capacitors with individual fittings.

C. SPECIFICATIONS :-

A. EQUIPMENTS AND COMPONENTS

1. Lighting Transformer

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Type</td>
<td>Dry Type</td>
</tr>
<tr>
<td>2.0</td>
<td>Power Rating</td>
<td>As per load calculation</td>
</tr>
<tr>
<td>3.0</td>
<td>Primary Voltage</td>
<td>415 V</td>
</tr>
<tr>
<td>4.0</td>
<td>Secondary Voltage</td>
<td>415 V</td>
</tr>
<tr>
<td>5.0</td>
<td>Connection</td>
<td>Star - Star</td>
</tr>
</tbody>
</table>

2.0 Main Lighting Distribution Board (MLDB)

A. General

| 1.0 | Type                  | - Metal clad.                     |
|     |                       | - Non drawout type.               |
| 2.0 | Construction          | - Modular construction.           |
|     |                       | - Fully compartmentalized with metal / insulating material partition. |
| 3.0 | Enclosure class       | IP52                              |
| 4.0 | Type of execution     | Single front.                     |
| 5.0 | Mounting              | - Floor mounting.                 |
|     |                       | - Free standing with ISMC 75.     |
| 6.0 | Installation          | Indoor.                           |

B. Constructional Features :-

<p>| 1.0    | Sheet steel          |
|        | Thickness            | - 2 mm for load bearing members. |
|        |                       | - 1.6 mm for non load bearing members. |
|        | Material             | CRCA                              |
| 2.0    | Cable entry          |
|        | Incomer              | Bottom cable entry.               |
|        | Outgoing             | Bottom cable entry.               |
| 3.0    | Design               | Separate bus alley and cable alley on opposite side of the outgoing modules. |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All the components shall be accessable from front.</td>
<td>Each module to have covering at the bottom.</td>
</tr>
<tr>
<td>4.0</td>
<td>Interlocking &amp; protection</td>
</tr>
<tr>
<td>- Module door interlocked with main power isolating devices.</td>
<td>- Power circuit isolation device to have pad locking in the OFF position with door closed.</td>
</tr>
<tr>
<td>5.0</td>
<td>Operating height</td>
</tr>
<tr>
<td>- Minimum:- 300mm</td>
<td>- Maximum:- 1800 mm.</td>
</tr>
<tr>
<td>6.0</td>
<td>Gland plate</td>
</tr>
<tr>
<td>Undrilled removable bottom gland plates (3 mm thick)</td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>- Neoprene rubber gasket shall be provided for all the doors, removable covers &amp; between adjacent covers.</td>
<td>- Lifting hooks for the panel.</td>
</tr>
<tr>
<td>- Doors shall have concealed hinges.</td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td>Labelling</td>
</tr>
<tr>
<td>Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of:-</td>
<td></td>
</tr>
<tr>
<td>- 25-50 mm for MLDB panel</td>
<td></td>
</tr>
<tr>
<td>- 5 mm for components and module name plates.</td>
<td></td>
</tr>
<tr>
<td>- Danger board on front and rear sides in English, Hindi and local language.</td>
<td></td>
</tr>
<tr>
<td>9.0</td>
<td>Earthing</td>
</tr>
<tr>
<td>- Two separate earthing terminals will be provided.</td>
<td></td>
</tr>
<tr>
<td>- Bolted joints with tooth spring washers for good earth continuity.</td>
<td></td>
</tr>
<tr>
<td>- Earth bus to run in all cable alley of the panel.</td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td>Shipping length</td>
</tr>
<tr>
<td>To be limited to 2.4 M.</td>
<td></td>
</tr>
<tr>
<td>11.0</td>
<td>Limiting dimensions</td>
</tr>
<tr>
<td>- Width of MLDB:- 2400 mm</td>
<td></td>
</tr>
<tr>
<td>- Depth of MLDB:- 500 mm</td>
<td></td>
</tr>
<tr>
<td>- Width of Cable alley:- 300 mm</td>
<td></td>
</tr>
<tr>
<td>- Width of Bus alley:- 300 mm</td>
<td></td>
</tr>
<tr>
<td>- Height of module:- 400 mm (min)</td>
<td></td>
</tr>
<tr>
<td>12.0</td>
<td>Paint shade</td>
</tr>
<tr>
<td>C.</td>
<td>Busbars</td>
</tr>
<tr>
<td>(i)</td>
<td>Main horizontal &amp; vertical busbars</td>
</tr>
<tr>
<td>1.0</td>
<td>Arrangement</td>
</tr>
<tr>
<td>Three phase &amp; neutral.</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>Material</td>
</tr>
<tr>
<td>High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 –1981.</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>Phase Busbar Rating</td>
</tr>
<tr>
<td>- Shall be able to carry continuously the connected load (considering all derating factors) plus a 25% margin.</td>
<td></td>
</tr>
<tr>
<td>- Max. current density shall be</td>
<td></td>
</tr>
<tr>
<td>- 1.0 A/sq.mm for Aluminium</td>
<td></td>
</tr>
<tr>
<td>- 1.5 A/sq.mm for Copper.</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>Neutral Busbar Rating</td>
</tr>
<tr>
<td>50 % of phase busbar rating</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>Short circuit rating</td>
</tr>
<tr>
<td>50 KA for 1 sec.</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>Busbar configuration</td>
</tr>
<tr>
<td>Red-yellow-blue from front to back or top to bottom or left to right as viewed from front.</td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td>Busbar insulation</td>
</tr>
<tr>
<td>Heat shrinkable PVC</td>
<td></td>
</tr>
<tr>
<td>- R,Y,B coloured sleeves for phases</td>
<td></td>
</tr>
<tr>
<td>- Black for neutral.</td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td>Busbar supporting insulators</td>
</tr>
<tr>
<td>Non-hygroscopic</td>
<td></td>
</tr>
<tr>
<td>- Flame retarded</td>
<td></td>
</tr>
<tr>
<td>Requirement</td>
<td>Specification</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>9.0 Max. temp. rise of bus</td>
<td>Not to exceed 35 deg. C. above ambient of 50 deg.C.</td>
</tr>
</tbody>
</table>
| 10.0 Air clearance for bare busbar | Phase to phase: 25.4 mm (minimum)  
Phase to earth: 19.0 mm (minimum) |
| 11.0 Joints and tap off points | Busbar joints and tap off points shall be shrouded and bolted (with cadmium coated bolts with plain and spring washers and locknuts).  
Bimetallic connectors for connection between dissimilar metals.  
Antioxide grease for all bus connections. |
| 12.0 Neutral bus isolation | Through disconnecting link. |
| 13.0 Vertical busbar | Rear side |

(ii) Earth bus
- Material: GI.
- Size: Minimum 50 x 6 mm with extension at both ends.

(iii) Control bus
- Material: Copper.
- Size: Minimum 25 x 3 mm.

D. Insulation level
- Rated insulation voltage: 1100 V
- Impulse withstand voltage: 4 KV as per IS-13947 (Part I) 1993
- One minute power frequency withstand voltage: 2.5 KV for power circuit & 500 V for control circuit

E. Pollution Degree
- Pollution Degree: Pollution Degree 3 as per IS-13947 (Part-1) : 1993; unless otherwise stated

F. Feeder arrangement

Incomers
- Isolating Equipment: 3 pole MCCB (for rating upto 630 A) (with E/F protection).
- Quantity: Two incomer
- Autochangeover: Through contactor logic with suitable timer.  
Normally only one Incomer shall be ON.
- Indication Lamps: LED type indicating lamps for:  
MCCB ON/OFF/TRIP.  
Power ON R / Y / B.
- Meters and selector switches:  
144 sq.mm size voltmeter with 7 position selector switches  
144 sq.mm size ammeter with 4 position selector switches
- Current transformer: 3 numbers for metering.

Outgoing feeder arrangements
- Circuit breaker: Three pole MCCB
- Indications: ON/OFF/TRIP indication lamp.
- Protection: All the equipment inside the boards shall be covered in front with a 3 mm thick bakelite sheet. Only the operating knobs of the equipment shall be projected outside the bakelite sheet for safe operation.
### G. Panel wiring

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0</strong></td>
<td><strong>Power / current transformer circuit</strong></td>
</tr>
<tr>
<td></td>
<td>1.1Kv grade single core, black colour PVC insulated, stranded copper conductor of minimum size 2.5 sq.mm.</td>
</tr>
<tr>
<td><strong>2.0</strong></td>
<td><strong>Ferrules</strong></td>
</tr>
<tr>
<td></td>
<td>- Numbered plastic/ceramic ferrules.</td>
</tr>
<tr>
<td></td>
<td>- Self locking type.</td>
</tr>
<tr>
<td><strong>3.0</strong></td>
<td><strong>Marking</strong></td>
</tr>
<tr>
<td></td>
<td>- Wiring will be properly marked as per relevant IS.</td>
</tr>
<tr>
<td><strong>4.0</strong></td>
<td><strong>Terminals</strong></td>
</tr>
<tr>
<td></td>
<td>- Power &amp; control terminals shall be segregated by insulating material like hylam / bakelite sheet.</td>
</tr>
<tr>
<td></td>
<td>- Power terminals will be stud type.</td>
</tr>
<tr>
<td></td>
<td>- Control terminals will be ELMEX type suitable for connecting two cores of 2.5 sq.mm wires.</td>
</tr>
<tr>
<td></td>
<td>- Minimum 20% spare terminals will be provided.</td>
</tr>
<tr>
<td></td>
<td>- The minimum rating of control terminal shall be 10 Amps.</td>
</tr>
<tr>
<td><strong>5.0</strong></td>
<td><strong>Cable glands</strong></td>
</tr>
<tr>
<td></td>
<td>Double compression cable glands for receiving external power and control cables</td>
</tr>
</tbody>
</table>

### 3.0 SUB LIGHTING DISTRIBUTION BOARD (SLDB)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0</strong></td>
<td><strong>Type</strong></td>
</tr>
<tr>
<td></td>
<td>- Metal clad</td>
</tr>
<tr>
<td></td>
<td>- Shall be suitable for 415/240V, 3 phase and neutral.</td>
</tr>
<tr>
<td><strong>2.0</strong></td>
<td><strong>Construction</strong></td>
</tr>
<tr>
<td></td>
<td>- Totally enclosed.</td>
</tr>
<tr>
<td></td>
<td>- Dust &amp; vermin proof.</td>
</tr>
<tr>
<td></td>
<td>- Welded back and sides.</td>
</tr>
<tr>
<td><strong>3.0</strong></td>
<td><strong>Enclosure class</strong></td>
</tr>
<tr>
<td></td>
<td>IP54.</td>
</tr>
<tr>
<td></td>
<td>IP 55 (with canopy) for outdoor installation.</td>
</tr>
<tr>
<td><strong>4.0</strong></td>
<td><strong>Type of execution</strong></td>
</tr>
<tr>
<td></td>
<td>Single front.</td>
</tr>
<tr>
<td><strong>5.0</strong></td>
<td><strong>Mounting</strong></td>
</tr>
<tr>
<td></td>
<td>Wall mounting.</td>
</tr>
<tr>
<td><strong>6.0</strong></td>
<td><strong>Installation</strong></td>
</tr>
<tr>
<td></td>
<td>Indoor / Outdoor (with canopy).</td>
</tr>
</tbody>
</table>

### B. Constructional Features :-

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0</strong></td>
<td><strong>Sheet steel CRCA</strong></td>
</tr>
<tr>
<td>Thickness</td>
<td>2 mm.</td>
</tr>
<tr>
<td><strong>2.0</strong></td>
<td><strong>Cable entry</strong></td>
</tr>
<tr>
<td></td>
<td>- Incomer :- Bottom cable entry.</td>
</tr>
<tr>
<td></td>
<td>- Outgoing :- Top / Bottom cable entry.</td>
</tr>
<tr>
<td><strong>3.0</strong></td>
<td><strong>Design</strong></td>
</tr>
<tr>
<td></td>
<td>- One Incomer and outgoings.</td>
</tr>
<tr>
<td></td>
<td>- All the components shall be accessible from front.</td>
</tr>
<tr>
<td></td>
<td>- Access to the operating handle of the incoming isolating switch shall be from the front of the cubicle without opening the front door.</td>
</tr>
<tr>
<td></td>
<td>- Operating knobs of outgoing MCBs shall be accessible only after opening the front door of the cubicle.</td>
</tr>
<tr>
<td></td>
<td>- Protective insulated cover plate (3 mm thick bakelite sheet) shall be provided inside the cubicle to shroud all the live parts.</td>
</tr>
<tr>
<td><strong>4.0</strong></td>
<td><strong>Gland plate</strong></td>
</tr>
<tr>
<td></td>
<td>Undrilled detachable gland plates (3 mm thick) shall be provided at the top and bottom with suitable gaskets for cable entry.</td>
</tr>
<tr>
<td><strong>5.0</strong></td>
<td><strong>Miscellaneous</strong></td>
</tr>
<tr>
<td></td>
<td>- Neoprene rubber gasket shall be provided for all the doors, removable covers &amp; between adjacent covers.</td>
</tr>
<tr>
<td></td>
<td>- Suitable locking devices.</td>
</tr>
</tbody>
</table>
### 6.0 Labelling

Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of:
- 5 mm for components and module name plates.
- Danger board on front and rear sides in English, Hindi and local language.

### 7.0 Earthing

Two separate earthing terminals will be provided.

### 8.0 Limiting dimensions

- Width of SLDB: 800 mm
- Depth of SLDB: 300 mm
- Height of SLDB: 400 mm (min)

### 9.0 Paint shade


### C. Busbars

#### 1.0 Arrangement

Three phase & neutral.

#### 2.0 Material

High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 – 1981.

#### 3.0 Phase Busbar Rating

- Shall be able to carry continuously the connected load (considering all derating factors) plus a 25% margin.
- Max. current density shall be
  - 1.0 A/sq.mm for Aluminium
  - 1.5 A/sq.mm for Copper

#### 4.0 Neutral Busbar Rating

50% of phase busbar rating

#### 5.0 Short circuit rating

50 KA for 1 sec.

#### 6.0 Busbar configuration

Red-yellow-blue, black for neutral.

#### 7.0 Busbar insulation

Heat shrinkable PVC
- R,Y,B coloured sleeves for phases
- Black for neutral.

#### 8.0 Busbar supporting insulators

- Non-hygroscopic
- Flame retarded
- Track resistant
- High strength
- Sheet moulded compound or equivalent polyester fibre glass moulded type.

#### 9.0 Air clearance for bare busbar

- Phase to phase: 25.4 mm (minimum)
- Phase to earth: 19.0 mm (minimum)

### F. Feeder arrangement

#### Incomers

| 1.0 Isolating Equipment | 3 pole ELCB
| ELCB shall be of AC 23 duty category conforming to IS: 13947-1993 having fully shrouded contacts. |

| 2.0 Quantity | One |

| 3.0 Indication Lamps | LED type indicating lamps for:
| - Power ON R / Y / B |

#### Outgoing feeder arrangements

| 1.0 Circuit breaker | DP MCB |

### G. Panel wiring

#### 1.0 Power / current transformer circuit

1.1Kv grade single core, black colour PVC insulated, stranded copper conductor of minimum size 2.5 sq.mm.

#### 2.0 Ferrules

- Numbered plastic/ceramic ferrules.
- Self locking type.

#### 3.0 Marking

- Wiring will be properly marked as per relevant IS.
4.0 Terminals
- Power & control terminals shall be segregated by insulating material like hylam / bakelite sheet.
- Terminals shall be ELMEX type suitable for connecting two cores of 2.5 sq.mm wires.
- Minimum 20 % spare terminals will be provided.
- The minimum rating of control terminal shall be 10 Amps.

5.0 Cable glands
Double compression cable glands for receiving cables.

4.0 Control Room Switchboard

<table>
<thead>
<tr>
<th>1.0</th>
<th>Location</th>
<th>Control room for controlling the lighting fixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Type</td>
<td>Flush mounted type</td>
</tr>
</tbody>
</table>
| 3.0 | Construction      | Fabricated from 14 SWG MS sheet with 6mm thick bakelite cover
Shall have conduct knockouts on the sides. |
| 4.0 | Switch mechanism  | Quick make and quick break mechanism                 |
| 5.0 | Power source      | The switchboards shall be fed from SLDB of respective area. |

5.0 Transformer for 24V AC Sockets

| 1.0 | Type          | Dry type
Step-down transformer
Air-cooled |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Rating</td>
<td>Minimum 2500VA</td>
</tr>
<tr>
<td>3.0</td>
<td>Primary / secondary voltage</td>
<td>240V /26.5 V AC , single-phase</td>
</tr>
<tr>
<td>4.0</td>
<td>Construction</td>
<td>The transformer shall be enclosed in industrial wall mounting stainless steel (2 mm thick) box having separate chambers for the transformer, incoming and outgoing MCB's.</td>
</tr>
<tr>
<td>5.0</td>
<td>Cable entry</td>
<td>Suitable knock-outs shall be provided at the top and bottom for cable entry through GI pipes.</td>
</tr>
<tr>
<td>6.0</td>
<td>No. of winding</td>
<td>Two winding</td>
</tr>
<tr>
<td>7.0</td>
<td>Protection</td>
<td>SPN MCB's on primary and secondary side incorporating overload and short circuit releases.</td>
</tr>
<tr>
<td>8.0</td>
<td>Utility</td>
<td>Power supply to 24V repair network</td>
</tr>
<tr>
<td>9.0</td>
<td>Location</td>
<td>On structural platforms</td>
</tr>
</tbody>
</table>

6.0 24 V AC SWITCH SOCKET OUTLET

<table>
<thead>
<tr>
<th>1.0</th>
<th>Type</th>
<th>2 pole, 3 pin with third pin earthed industrial type receptacles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Rating</td>
<td>24 V AC , 5A</td>
</tr>
<tr>
<td>3.0</td>
<td>Construction</td>
<td>Metal clad gasketted construction, weatherproof.</td>
</tr>
<tr>
<td>4.0</td>
<td>Cable entry</td>
<td>Suitable for cable entry through 20mm dia. conduit.</td>
</tr>
<tr>
<td>5.0</td>
<td>Mounting</td>
<td>Wall / column mounting</td>
</tr>
</tbody>
</table>

7.0 240V SWITCH SOCKET OUTLET

| 1.0 | Type          | 1 pole, 3 pin with third pin earthed industrial type receptacles
non-reversible, metal-clad, dust proof, industrial type suitable for horizontal insertion. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Rating</td>
<td>240 V AC , 15A</td>
</tr>
<tr>
<td>3.0</td>
<td>Construction</td>
<td>Metal clad gasketted construction, weatherproof</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>All socket outlets will be supplied with heavy-duty type plug and cap with chain.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>Isolation Switch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rotary type switch mounted flush in the socket outlet box. The isolating switches will be manually operated industrial type of category AC 22.</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>Protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating handle of the rotary switch will be fixed in such a manner that it will not be possible either to insert or withdraw the plug without switching off the supply.</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>Cable entry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suitable for cable entry through 20mm dia. conduit.</td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td>Mounting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wall / column mounting</td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td>Inscription</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inscription plate will be provided indicating the voltage and current rating of the switch socket outlet.</td>
<td></td>
</tr>
<tr>
<td>9.0</td>
<td>Miscellaneous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In hazardous area, flame proof switch socket outlet will be provided.</td>
<td></td>
</tr>
</tbody>
</table>

### 8.0 Miniature Circuit Breakers

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td>Heat resistant plastic moulded type</td>
</tr>
<tr>
<td>2.0</td>
<td>Ref. Standard</td>
</tr>
<tr>
<td></td>
<td>IS: 8828 – 1978</td>
</tr>
<tr>
<td>3.0</td>
<td>Protections</td>
</tr>
<tr>
<td></td>
<td>MCBs shall be provided with quick break trip-free mechanism and direct acting thermal overload and short circuit trip elements.</td>
</tr>
<tr>
<td>4.0</td>
<td>Short circuit capacity</td>
</tr>
<tr>
<td></td>
<td>Not less than 9000A at 0.8pf</td>
</tr>
<tr>
<td>5.0</td>
<td>Mounting</td>
</tr>
<tr>
<td></td>
<td>DIN Channel mounting . Single phase MCBs mounted adjacent to each other and connected to different phases will be provided with adequate insulated phase barriers.</td>
</tr>
<tr>
<td>6.0</td>
<td>Current Rating</td>
</tr>
<tr>
<td></td>
<td>The MCBs shall be selected from standard current ratings.(Asper SLD) MCB shall confirm to curve C . Motor duty MCBs will be provided, if specified.</td>
</tr>
</tbody>
</table>

### 9.0 240 V SINGLE/ DOUBLE POLE SWITCHES

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Application</td>
</tr>
<tr>
<td></td>
<td>The switches are intended for controlling lighting circuits</td>
</tr>
<tr>
<td>2.0</td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td>Weather and dustproof and industrial type</td>
</tr>
<tr>
<td>3.0</td>
<td>Design</td>
</tr>
<tr>
<td></td>
<td>The rotary or toggle switches provided will be of sturdy design</td>
</tr>
<tr>
<td>4.0</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>As per IS : 6875 (Part-3) - 1980</td>
</tr>
<tr>
<td>5.0</td>
<td>Housing</td>
</tr>
<tr>
<td></td>
<td>The unit will be housed in cast iron or cast aluminium box having gasketted, screwed front cover plate, fixing lugs and suitable provision for terminating conduit/cable at the top, bottom or sides as specified.</td>
</tr>
<tr>
<td>6.0</td>
<td>Mounting</td>
</tr>
<tr>
<td></td>
<td>DIN Channel mounting . Single phase MCBs mounted adjacent to each other and connected to different phases will be provided with adequate insulated phase barriers.</td>
</tr>
<tr>
<td>7.0</td>
<td>Terminal suitability</td>
</tr>
<tr>
<td></td>
<td>Terminals suitable for aluminium conductor cables.</td>
</tr>
</tbody>
</table>

### B. Cabling and Wiring

01 All wiring from SLDB to lighting fixtures and receptacles shall be carried out with 1100V / 650V grade PVC insulated and PVC sheathed unarmoured cable in MS / GI pipes. For each outgoing phase conductor from the MCB of SLDB, one no. neutral conductor shall be taken.
from the same SLDB and shall run along with the phase conductor throughout the length of the cable run upto the luminaires.

02 All lighting cables for the entire complex shall be PVC insulated with copper conductors.

C. Lighting Fixtures and Accessories

01 All the luminaires will be designed, manufactured and tested in accordance with the Indian Standards in so far as they are applicable. Lighting Fixtures and Accessories shall be energy efficient.

02 All the luminaires will be industrial type. Specification for the various types of sodium vapour and fluorescent fittings mentioned in the schedule of quantities will be followed. All the lighting fixtures will be complete with all parts along with lamps/tubes, control gears and accessories for installation and efficient performance whether specifically mentioned in the specification or in the schedule of items or not.

03 Individual light fittings will be provided with suitable gland arrangements for 3x2.5 sq.mm armoured copper cable entry unless otherwise specified. Terminals of all fittings will be suitable for taking 3x2.5 sq.mm, copper conductor PVC insulated and PVC sheathed cable.

04 All fittings will be supplied with all interconnections made and fully wired upto the terminal block.

05 All live parts will be provided with suitable sleeves to prevent accidental contacts. The earthing terminal in the fitting will effectively earth the body of the entire luminaire.

06 Dust and vapour tight fittings will have the enclosures suitably designed to withstand the heating effect.

07 The fixing arrangement of various components and lamps will be in such a way that the maintenance and replacement jobs can be easily carried out.

08 All flameproof equipment will be provided with flameproof plugs.

09 Flame proof fittings and control gearboxes will be provided as per relevant IS in hazardous area.

D. ILLUMINATION FITTINGS

1.0 OUTDOOR LIGHTING FITTINGS.

All road lighting fittings will be mounted on steel tubular poles with single/ double or triple outreach brackets having sodium vapour lamps. The fittings will be cut-off / semi cut-off distribution and integral type.

For lighting of open areas self-supporting steel towers shall be provided with flood light fittings and sodium vapour lamps.

2.0 FLUORESCENT FITTINGS

2.01 DECORATIVE FLUORESCENT LIGHT FITTING

Decorative type fluorescent tube light fitting complete with stove enameled mounting rail, polyester filled ballast, spring loaded rotor lamp holders, starter holder and starter, power factor correction condenser to improve the power factor to 0.95 and acrylic diffuser. Provision will be made for mounting the fitting end to end in continuous row and/or for mounting individually using high impact black polystyrene end plate. All the fluorescent tube lights fixtures shall have electronic ballast having third harmonic distortion less than 6% and total harmonic distortion less than 12%.

2.02 INDUSTRIAL TYPE FLUORESCENT LIGHT FITTING
The fitting will have channel and reflector made of CRCA sheet steel with white cover plate. Channel and reflector will be finished with light Grey stove enamelled outside and white stove enamelled inside. The fitting will be complete with all electrical accessories like polyester filled ballast, starter, spring loaded rotor lamp holders, starter holder, power factor improvement capacitor to improve the power factor upto 0.95 etc. All the fluorescent tube lights fixtures shall have electronic ballast having third harmonic distortion less than 6% and total harmonic distortion less than 12 %.

All types of fluorescent fittings will be suitable for mounting on wall/ceiling/conduit suspension.

2.02.1 WELL GLASS FITTINGS
Well glass lighting fitting will be fitted with sodium vapour or mercury vapour lamps. These fittings will be suitable for hanging by means of hangers, brackets, hooks etc. as required. All fittings will be integral type.

2.02.2 FLOOD LIGHT FITTING
- Sodium vapour flood light fittings are required for area lighting as specified in schedule of quantities.
- The flood light fitting will be weatherproof and suitable for outdoor duty. The housing/enclosure will be of die cast Aluminium alloy and finished with hammertone Grey. The enclosure of the luminaries will be provided with a flat toughened glass in the front. Adequate gasketting will be provided with synthetic rubber for making the luminaries completely weatherproof. The fitting will be provided with facility to position the luminaries for effective lighting at the target area. The fitting will also be provided with graduated protractor to aid accurate aim and ensure a con-trolled light distribution.
- High quality polished Aluminium will be used in the reflector to ensure powerful light beams. The reflector will be anodised to enhance the longevity and contoured in multiple segments for optimum optical performance. The fitting will be provided with GES porcelain lamp holder. The control gear housing (separate control gear-non-integral type) will be housed with copper wound ballast, perfected improvement capacitor and terminal block. An electronic igniter will be provided in the luminaries.
- All the control gear components will be pre-wired in all respects and terminated to the terminal block for incoming cables. The fitting will be provided with earthing terminal and wiring will be done by multi-strand copper conductor. All the fasteners will be electroplated and passivated. The fitting will be suitable for twin/Single 400 watts HPSV lamps.

2.02.3 STREET LIGHT FITTING
- Street light fittings will be suitable for outdoor duty in weatherproof, single piece die cast Aluminium enclosure, finished with epoxy paint outside and stove enamelled inside. The fitting will be provided with GES porcelain lamp holder, and anodised Aluminium reflector with facility for obtaining cut off as well as semi-cut off light distribution. These will also be provided with high transparency clear acrylic cover with neoprene rubber gasket to make them absolutely dust and weather proof. Control gear compartment will be provided with detachable CRCA steel, pre-wired with ballast, capacitor, igniter and terminal blocks for incoming supply. Fittings will be provided with earthing terminals and wiring will be done with multi-strand copper conductor.
- All the fasteners will be electroplated/passivated and mounting arrangement will be suitable for direct mounting on poles having maximum 65 mm. OD with provision for holding the pipe in extended portion of control gear by means of clamps

2.02.4 FLAME PROOF FITTINGS
Flame proof type fittings will be well glass type luminaries suitable for use with HPLN 250W (High pressure Mercury Vapour) lamp with separate control gear complete with copper ballast, power factor improvement capacitor, terminal block enabling loop-in-loop out connection. Both fittings & control gear will be of cast Aluminium alloy LM6 or cast iron stove enamel, Grey hammertone finish outside and white inside.

The control gear box and enclosure for fittings will have certification from CMRS, Dhanbad and will be suitable for gas groups IIA & IIB as per IS 2148-1981. The fittings will be designed as per IS 2206 (Part-I) -1987. The material for cable gland will be brass/stainless steel/aluminium alloy LM6 and will be double compression type suitable for indoor/outdoor use. These are must for every flameproof fittings and accessories.

2.02.5 CONTROL GEAR, LAMP & ACCESSORIES

- **Lamps**

  Sodium vapour lamps will be suitable for universal burning position. The characteristics of the lamps will be in line with the relevant Indian Standards. The outer bulbs will be elliptical heat resistant type, evacuated to minimise heat losses and coated with light diffusion film for pleasing colour discharge. The lamp will be provided with corrosion resistant, nickel-plated screw base.

- **Ballast’s**

  All ballast's will be of proven design and capable of delivering long trouble free service. The ballast's will be made up of low loss silicon with steel lamination and will be wound with polyester-based super enamelled copper wire. The ballast will be polyester filled and able to dissipate the heat efficiently so as to keep the temperature rise well within the limits specified in the IS.6616-1972. The ballast will be provided with tapping at 200,220 and 240 volts and will be suitable for HPSV lamps.

- **Capacitors**

  Capacitors will have element wound from layers of high purity Aluminium foils laid over the two faces of capacitor paper. The Aluminium cylindrical case containing the elements will be dried under high vacuum and impregnated before being sealed. The solder type lug terminals will be mounted over porcelain insulators at the sealed end and the capacitor will conform to IS: 1569. The value of capacitance will be chosen as to raise the power factor of burning lamps to above 90%.

- **Igniters and Starters.**

  Igniters for HPSV lamps will be of proven design and capable of delivering long trouble free operations. The igniter and starters will be suitable for tropical condition and conform to IS: 2215-1968.

- **Lamp and Starter Holders**

  Lamp and starter holders will have good spring contacts and of well tried out design. The spring contact will be such as to prevent disconnection due to vibration during cleaning. They will also have facility for easy removal.

3.0 Street Lighting Poles

Lighting poles will be fabricated from GI of specified section with joints swaged together when hot and bevelled on outside edges. A weatherproof sheet steel junction box will be provided at the bottom of the pole and contain fuse, neutral link, bolted type terminals, grounding stud etc. The bolted type terminals will be suitable for receiving 4 x 16 mm2 AYFY cables with loop-in-loop out arrangement GI conduits will be embedded in the muff for incoming and outgoing cables.
The street light poles of 9M height will be conforming to: 410-SP-29
The street light poles of 7M height will be conforming to : 410-SP-3
All erection consumables like bricks, sand, cement stone chips etc. for foundation of poles will be supplied & erected

4.0 High Mast Lighting Tower

4.01 Mast Proper
The mast will be 30 meter’s high and designed in such a manner that it is capable of withstanding external forces exerted by wind pressure as per IS: 875 (Part 3)-1992 along with load of the lantern carriage assembly.

4.02 Mast Construction
The mast will be fabricated from special steel plates conforming to BS 4360 cut and folded to form number of polygonal sections, giving a continuous tapered profile for stability and aesthetics. Silicon content in steel should not exceed 03% for good quality galvanisation. Bottom section will be provided with plate welded to it for anchoring the mast to a reinforced concrete foundation block. To increase the strength, gussets will be provided.

The bottom section will be accommodate winch, electric drive etc. and for the safety of the same a vandal resistant and weather proof door will be provided with locking arrangement.

The fabricated and welded mast sections as detailed above will be hot dip galvanised with a minimum thickness of coating 90 microns conforming to IS 4759-1996, IS: 2629-1990 & IS: 2633-1992, both internally and externally.

After the delivery of the mast at site, these will be jointed by slip stressed fit method with necessary stressing equipment. No site welding or bolted joints will be accepted. Earthing terminal will be provided on the mast base and feeder pillar-box as per relevant ISS.

The mast will be provided with suitable aviation obstruction lamp.

4.03 Head Frame
The head frame designed to be a capping unit of the mast will be of welded steel construction, galvanized internally and externally after assembly.

The head frame assembly will accommodate specially designed LM 6 die-cast pulleys to accommodate the wire ropes and cable. Pulley construction will ensure that wire rope does not jump out of the grooves.

The suspension arrangement for lantern carriage will be with three ropes of stainless steel running on three on three pulleys for superior stability. There will be a separate pulley for running the electric supply cable.

The pulleys will run on stainless steel shaft/spindles and will be self lubricating type.

The whole head frame assembly will be covered and protected by steel canopy, hot dip galvanized internally and externally and secured to frame by stainless steel hardware.

4.04 Lantern Carriage
It will be of mild steel construction and hot dip galvanized internally and externally. The lantern carriage will be so designed and fabricated to hold designed number of flood light fittings and their control gearboxes, radically symmetrical. All junction boxes, Controlgear, fittings etc. mounted on the lantern carriage will be on non-corrodable material with class of protection IP 55.
At the top docking position, combined guides and stops will ensure concentricity between the lantern carriage and the masthead. The stops will also help to ensure proper levelling and positioning of the lantern carriage at its top position. All the lower docking position, the lantern carriage will rest firmly at a maintainable height from the ground level with the help of stoppers for ease of maintenance.

During lowering/raising operation the design will ensure that there is no damage caused to the mast surface and any other parts installed.

4.05 Winch Assembly

The winch will be self sustaining and self lubricating type specially designed without the need of breaks, springs or clutches, and will consist of two drums fabricated from steel with machined grooves and mounted inside the mast at a convenient height from the base.

The wire rope will be wound on the drum with one end attached to the lantern carriage while the other end is clamped to the winch drum. The design will ensure no inter winding of the fitting ropes.

At least four turns of rope will remain on the drums when the lantern carriage is fully lowered.

4.06 Support Ropes

The support ropes will be of stainless steel and will be capable of safely handling the lantern carriage load.

4.07 Supply cables.

Power supply cables will be class B insulated with required number of cores provided with multi-pin heavy duty locking type male/female connectors at the end. Pulley assembly will accommodate extra cable for emergency supply.

Test load will be of 5-meter length 5-core 2.5-mm2 copper conductor cable with multi-pin heavy duty locking type male/female connectors at the ends. Under no circumstances the test lead will travel through the mast.

4.08 Foundation

The design and construction of foundation for high mast lighting tower will be included in the scope of the contractor. The contractor will consider the following indicative data as design parameter for high mast. However the actual data will be indicated during tender scrutiny.

   a) Soil bearing capacity at 1-Metre depth  :- As per data supplied by Purchaser (BSP)
   b) Wind speed                               :- As per data supplied by Purchaser (BSP)
   c) The Contractor will submit the design drawings for approval of MECON for high mast based on soil bearing capacity and wind speed. The Contractor will be responsible for safe & efficient erection of the mast.

4.09 Electric Drive & Fittings

The drive will be 3 phase, 415 volt, 50 Hz, class B insulated, flameproof type induction motor/geared motor with suitable torque limiter.

The motor will be mounted on MS hot dip galvanised plate inside the mast with a possibility of adjusting its position. The drive will be capable of taking the load of whole lantern carriage with luminaries, control gearboxes, aviation obstruction light mounted on it.

Manual handle will be supplied along with power tool for operating the winch manually in case of power failure. Reversible type starters for motor, contactors for lighting circuit, MCB isolator switch etc. will be provided in a flame proof & weatherproof enclosure.
4.10 Light Fittings

The light fittings will be of flood light type with twin 400-watt HPSV lamps. The quantity, mounting position/angle and optical characteristics will be decided on the basis of the following illumination requirement.

Minimum 30 lux illumination will be achieved at a horizontal distance of 30 meters from the bottom of the mast all around. Illumination level of 10 lux will be sufficient at plant boundary wall, parking area, Administrative Building, etc. Minimum of 3-5 lux is required to be achieved at a horizontal distance of 125 Metre from the bottom of the mast towards all area. Minimum 20 lux will be achieved in the areas adjoining at the perimeter of 40 meter (approx.) radius considering the mast base at the centre.

All lighting performances will be checked holding the lux meter in horizontal plane at ground level.
GENERAL TECHNICAL SPECIFICATION

NO. GS-O3

FOR

TELECOM. & FIRE DETECTION AND ALARM SYSTEM

MECON LIMITED, RANCHI

No. MEC/S/1901/11/38/00/00/F1889/R2

JULY, 2007
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Intelligent Fire Detection & Alarm (FDA) System

1.00 GENERAL

This General Technical Specification (G.T.S) covers the technical requirement for MICROPROCESSOR BASED ANALOGUE ADDRESSABLE TYPE INTELLIGENT FIRE DETECTION AND ALARM SYSTEM (FDAS) for BSP 7.0 Mt. expansion.

1.01 The FDA system shall cover design, engineering, manufacture, packing & supply, erection, installation, testing & commissioning of the FDA system..

2.0 The FDA system shall consist of minimum following equipment:

- Smoke detectors, Heat detectors, Multi criteria detectors combination of rate of rise heat detector & photo electric smoke detector, other types of detectors as per the design criteria. All addressable electronic equipments should be UL / FM approved.

- MAIN FIRE ALARM CONTROL PANEL (FACP) along with accessories to integrate with the fire fighting system for automatic actuation.

- Break glass type microprocessor based addressable manual call points with chain & hammer.

- Hooters.

- Transponders/ Interface Modules.

- Response indicators where required for above false ceiling detectors & normally closed rooms.

- Power supply equipment.

- Battery back - up for 24 hours, in case of power failure, shall be provided.

- U.P.S system.

- Siren and Accessories.
- All types of cables (FRLS) and cabling accessories.
- Erection materials
- Earthing Materials & Earthing.
- Minor civil works required for installing FDA System equipment as required.
- GI pipes /GI conduits /PVC rigid conduits and other accessories wherever required for laying of cables.
- Trench work, if required, for cabling.
- Furniture, Racks etc.
- All erection accessories, consumables and miscellaneous material not indicated in specification but required for completing the job in all respects.
- Preparation of Design and detailed engineering drawings and documentation, bill of materials with specification.
- Submission of operational and maintenance manuals.
- Submission of as-built drawings.
- Commissioning spares till handing over of the system.
- Two years maintenance spares.
- Special tools & tackles for testing & maintenance of the system

2.1. AREAS TO BE COVERED BY FIRE DETECTION & ALARM SYSTEM are as follows.

- Control rooms, HT / LT Substation, MCC rooms, HT/LT Transformers, UPS room, PLC room, computer room, Battery room, Corridor, Cable basement, Cable gallery, Conveyors, Telephone exchange room, computer room, offices, hydraulic rooms or other rooms as required, False ceiling / flooring etc.
- Control rooms, UPS room, PLC room, computer room shall be provided with VESDA/VIEW(very intelligent early warning).
2.2 Training of Purchaser's personnel.

The tenderer shall arrange for training of purchaser’s personnel for operation & maintenance of the Analogue addressable type Fire Detection & Alarm system. It is under the tenderer’s scope of supply.

The tenderer shall give detailed training program mutually agreed as per requirement well in advance prior to the commencement of training. The tenderer shall supply all training materials, instructions & other connected literature in six copies to the purchaser in English language. In addition each trainee shall also receive a copy of the same.

2.3 INFORMATION TO BE FURNISHED BY TENDERER ALONG WITH OFFER

- BILL OF MATERIALS with make and model no. of equipment.
- Fire Alarm System schematic.
- Layout scheme of detectors with Fire Alarm Panels & cables in complete.
- List of deviations.
- Power requirement.
- General View of panels.
- Manufacturer's product catalogues.

2.4 DRAWINGS TO BE PREPARED BY SUCCESSFUL TENDERER

A: FOR APPROVAL

- Final Bill of Materials.
- Schematic of Fire alarm system.
- Location scheme of detectors.
- External connection diagrams.
- Equipment layout drawings with mounting arrangement, termination details etc.
- Cable routing.
- Specification data sheets for equipment and cables.
- Panel general view.
- Cable and pipe schedule.
- Quality Assurance Plan for equipment & cables as per format enclosed.

B: FOR INFORMATION AND REFERENCE
2.5. TESTS AND INSPECTION

All equipment shall undergo type and routine tests at manufacturer’s works. All tests shall conform to UL / FM / N.F.P.A / IS 2189 approvals & standards. Factory Test certificates shall be submitted when requesting for inspection. The material shall be dispatched only after issue of inspection or waiver certificate and after getting dispatch clearance.

2.6. GUARANTEE AND WARRANTY.

The tenderer shall study the specification & satisfy himself thoroughly regarding the workability of the plant, equipment & system offered & also take full responsibility for the guaranteed operation & performance of the same as well as for their smooth, safe & reliable working. The tenderer shall guarantee the integrated operation of the system & equipment covered in his scope as a whole including interfaces required to be established with other related system.

Should the tests specified show that the equipment has failed to achieve the guaranteed parameters, the supplier shall carry out necessary modification or part replacements to achieve the guaranteed parameters & successful demonstration, the tests shall be repeated without any extra cost to the purchaser.

The tenderer shall submit quality assurance program (QAP) in the format enclosed for individual equipment, panels, cables and overall system. This shall be followed for inspection / waive.

Tenderer shall give guarantee to maintain the system for ten years & shall ensure the availability of spares for ten years.

2.7. RESPONSIBILITY.

The tenderer is fully and solely responsible for timely completion and guaranteed performance of the equipment and system despite any approval / concurrence given by purchaser / consultant.
3.00 ENCLOSURE CLASSIFICATION

For purpose of quotation, Tenderer is required to consider the total plant area as “SAFE AREA” as per NEC. However, any change in the classification shall be indicated to the tenderer during tender discussions.

Degree of protection of equipment shall be as per IEC 947.1.1988 and IS 13947 (part I) 1933.

Panels, Boxes and Centers in electrical rooms IP 42
Panels and Boxes in heavy environment condition IP 54
Field devices IP 65
Air conditioned control rooms. IP 4X

4.00. APPLICABLE CODES AND STANDARDS

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<th>SL. NO:</th>
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<th>DESCRIPTION</th>
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<td>1</td>
<td>IS-2189-1988</td>
<td>Code of practice for selection, installation and maintenance of automatic fire</td>
</tr>
<tr>
<td></td>
<td>Reaffirmed in -1998</td>
<td>detection and alarm system (second revision –Amendment-II for IS 2189)</td>
</tr>
<tr>
<td></td>
<td>NFPA</td>
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<tr>
<td>2</td>
<td>NFPA – 72 &amp; UL – 268,</td>
<td>For selection of Fire Alarm Panel, all detectors &amp; modules.</td>
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<tr>
<td>3</td>
<td>UL – 864,</td>
<td>For Fire Alarm Panel.</td>
</tr>
<tr>
<td>4</td>
<td>IS-5-1994</td>
<td>Color for ready mixed paints and enamels (Fourth Division)</td>
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<tr>
<td>6</td>
<td>IS-694-1990</td>
<td>PVC insulated cables for working voltages upto and including 1100V (Third</td>
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<tr>
<td></td>
<td></td>
<td>revision-Amendment-I)</td>
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<tr>
<td>7</td>
<td>IS-1554 PART-I-1998</td>
<td>PVC insulated (heavy duty electric cables part-I for working voltages upto</td>
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<td>&amp; including 1100V (Third Edition-Amendment-I)</td>
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<td>8</td>
<td>IS-10810 PART-53-1984</td>
<td>Method of test for cables part-53-flammability test</td>
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<td>Reaffirmed in 1991</td>
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5.0. SYSTEM SPECIFICATION

MICRO PROCESSOR BASED, ANALOG ADDRESSABLE TYPE INTELLIGENT FIRE DETECTION & ALARM SYSTEM.

DESIGN REQUIREMENTS.

All equipment & component shall be new & MANUFACTURER’S current model.
The computer aided microprocessor based addressable analog type Fire Detection and Alarm system shall be a software controlled automatic system and shall provide necessary programmed functions and various controls. The system shall consist of central processing units (CPU), various man machine interface module communication system, microprocessor based fire alarm control panels, printer, video display unit. Addressable analogue automatic sensors and interface unit as applicable.

The system basically comprises of Detectors, Indicators, Manual Call Points, Fire Alarm Control Panels, Power supplies and other accessories required for completing the system.
The system shall use both Automatic fire detectors and addressable manual fire alarm call points.

Microprocessor based Break glass type manual call points with chain & hammer.

An electronic hooter or horn or electric bell, siren associated with fire alarm system. Actuation of any automatic fire detectors / manual fire alarm call points shall cause.

- Annunciation of alarm condition, type and location of acknowledged detector.
- Audible signal with flashing of light, until acknowledged.
- Frequency of audible signal shall be as per IS-2189-1988.
- Indication of Alarm / trouble location on the Main Fire Alarm Panel / on the local Graphics computer in the control room.

- Suitable number of N.O & N.C potential free contacts shall be kept in the Fire Alarm Control Panel. **Interlocking with automatic fire fighting system.**
- Origination of fire alarm shall also be transmitted to the concerned ventilation and A/C equipment, so that the ventilation system and A/C system is switched off.
- A distinctive audible and visible signal indicating the occurrence of a fault within the system (for example break in circuit, short circuit, fault in power supply etc.)

- **Cross zoning should be implemented in the soft ware before raising any alarm from any detector.**

**Features.**

**Diagnostics:** The system shall be self diagnostic type, involving detection and alarm of any fault or open / circuit in the system. On acknowledging audio alarm is silenced while alarm lamp persists, till rectification of fault.

The system shall have test mode facility to check the healthiness of the system.
Audio alarm for fault shall be different from fire signal alarm in tone and intensity.

Isolation of line in case of line faults and give alarm.

Audio visual alarm for fuse blown out.

Release of loud alarm /siren under the control of operator.

Resetting of the system.

5.1. Detectors

A. Heat Detectors

**Fixed temperature (static) elements**: These shall be designed to operate when they reach a pre-selected threshold temperature.

**Fixed temperature cum Rate Of Rise temperature elements**: These shall be designed to operate when their temperature rises beyond the fixed temperature and allowing the increase in temperature above fixed temperature for a specified period.

The detectors shall be plug in type and shall have common base.

The visual alarm LED shall be clearly visible from outside by a flashing light.

The detectors shall have provision for connecting repeat response indicator.

The detector shall be suitable for 24V D.C operation.

B. Smoke Detectors

**Analog addressable photo electric smoke detectors**: These shall be operated by detecting the scattering or absorption of light by smoke particles.

The detectors shall be plug in type and shall have common base.

The visual alarm LED shall be clearly visible from outside by a flashing light.

The detectors shall have provision for connecting repeat response indicator.

The detector shall be suitable for 24V D.C operation.
Any other type detector the, Tenderer feel necessary.

The detectors shall be plug in type and shall have common base.

The visual alarm LED shall be clearly visible from outside by a flashing light.

The detectors shall have provision for connecting repeat response indicator.

The detector shall be suitable for 24V D.C operation.

C. Multi Detector:
Detector shall be multi criteria combination of rate of rise heat detector & photo electric smoke detector.

D. Flame detector
**Ember detectors:** These detectors operating in the infra red region shall be used to detect moving fires on coal conveyors.

**Spark detectors:** These detectors operating in the infra red region shall be useful in ducts and similar concealed area application. The detector shall be suitable for 24VDC operation.

Life of Detectors & FDA Panel, shall be spelt out in the offer.

6.0. **MANUAL FIRE ALARM CALL POINTS (MCP), Addressable type.**

MCP’s shall be Manually operated device used to initiate an alarm signal.

Usage of all types of MCP shall be as per IS-2189-1988. All devices such as automatic pull switch, circuitry etc, shall be totally enclosed in the box.

The manual call point stations are break glass type general alarm station.

The manual call point shall consists of a MS enclosure with a glass front. One NO contact is built into the enclosure. The front glass keeps the switch in pressed condition.

The contact changes and this change over is sensed by the monitor module and alarm generated at the control panel.

The manual call points are available in whether proof / flame-proof enclosures also.
The operation of manual call point in the event of emergency, shall be by breaking the shutter proof glass with the help of hammer provided along with call point.

Manual call points are installed near exit / entrance doors, stair cases or outdoor locations where automatic fire detectors cannot be installed.

7.1 ADDRESSABLE INTERFACE UNIT:-

The interface unit shall be suitable for connecting normally open type alarm initiating devices such as pressure switch, flow switches, level switches, potential free contacts etc. in the addressable loop, if required.

The interface unit shall be a sealed electronic unit with an address switch for individual address. It shall be housed in a metallic / high impact plastic enclosure and suitable for indoor / outdoor installation. The operation voltage shall be 24 V D.C.

7.2 Monitor Module.

Monitor Module monitors are dry contact type fire or security initiating devices. It reports its unique address to the panel to pin point the exact alarm location.

Features:
Provides individual addressable input for fire alarm or security devices

Monitors either two or four wire (fault-tolerant) initiating device circuits. The monitor modules shall provides a two or four wire fault tolerant initiating circuit for normal open contact fire alarm devices and supervisory devices.
Provides full analog supervision of circuits.

The monitor module shall be assigned a point address via two direct dial decade switches. It's address and circuit status i.e normal, open, short are communicated to the control panel. An integral LED blinks each time the controller scans the module and LED latches in alarm condition by command from the controller.

7.3 Address Control Module:

The control devices shall form part of loop devices. Control module shall supervises and controls indicating devices and their associated wiring. The module shall also provide SPDT switching action for other locally powered equipment.
Features:
Provides addressable control to indicating devices
Controls and supervises two or four-wire (fault tolerant) indicating device circuits. Provides full analog supervision of circuits.

The module provides a supervised 2 wire or 4 wire fault tolerant output indicating circuits for audible devices, strobes and response to normal open circuit or short circuit condition of the circuit.

The module shall be assigned an address using direct dial decade switches. When the controller commands the modules the internal relay energizes and switches externally supplied power to activate connected polarized indicating and other control devices. An integral LED shall blinks each time the controller scans the module and the LED latches in alarm condition by command from the controller.

Application:
For Controlling hooters, strobes, dampers or any other switching device

7.4 Fault Isolation Module:

Fault Isolator Module shall be used on panel intelligent loop communication circuits along with other modules and sensors. It detect a wire-to-wire short and electrically isolates that condition from the circuit so that communication is maintained with unaffected devices on the same circuit.

Application:
The module enables part of an intelligent interface board communication circuit to continue operating when a short occurs on the circuit. If used in a two wire loop configuration, one module isolates a short to the part of the loop between the module and the intelligent interface board, allowing the rest of the loop to continue operating normally, the modules isolate a short or open to the part of the loop between them. In a star configuration a module can be used in each leg so a short on one leg does not affect communication on any other leg. An integral LED blinks to indicate normal status and is on to indicate a short in the loop.

7.5 Fire Exit Board:

Self illuminous “FIRE EXIT” sign boards shall be provided indicating escape routes to escape under fire condition. The type of sign board shall be as per site condition.
8.0. MICROPROCESSOR BASED FIRE ALARM CONTROL PANEL (FACP): -

Fire Alarm Control Panel shall be intelligent, with its own Microprocessor and memory in each every card.

The control panel as a built in feature shall have one / two modules & each module without adding any card shall be able to create additional loop ie. 2 loop/module. Each loop shall be able to take 60 to 90 detectors. Control panel shall have facility to expand up to 7 / 10 modules.

The control panel shall have necessary loop modules, alarm o/p modules and control output for various control functions. 100% hot redundancy shall be provided in the FACP control unit & other critical component like CPU, memory, memory control, power supply cards, RAM etc. to ensure uninterrupted operation of the FDA system. The standby cards shall perform the entire functions of the system when the main CPU & other control cards fail without affecting the functioning of FDA system. Any failure of cards shall be brought to the notice by audio – visual alarm.

The control panel shall have facility to process the input signals and also have facility to control all the input data received from addressable analogue type detectors /addressable interface unit.

Fire alarm control panel shall have number of electronic filters to ignore false alarm and increase sensitivity to real fires from sensors. The electronic filters shall recognize the unwanted alarm from detectors due to electrical spikes.

The fire alarm control panel shall have separate 400 character LCD display area to indicate the address of each device and clear text about the location of alarm / trouble. The panel should have complete QUERTY key pad for easy monitoring & maintenance.

The Fire Alarm panel shall have facility to connect to a local graphics work station comprising of PC, Printer, Keypad, Mouse, peripherals etc., The graphic work station shall form part of mimic. Also the Fire alarm panel shall be connected to the facility LAN point for feeding data to the Central Graphics Work station at the Central Fire Station (CFS). The necessary TCP/IP hard ware & software shall be built- in the panel. The Central Graphics Station shall be in the scope of a different package. The Fire Alarm panel shall be compatible to the Central Graphics station software.
The control panel shall have optional printer facility to print out the alarm / trouble occurrences with suitable fire fighting measures.

Control panel shall have the following features:-

Logging an alarm, time and action text on printers.

Status check of disabled alarm addresses before they are restored.

Storing of alarm and the possibility of internal organization of alarms.

The fire control panels offered shall have high degree of flexibility with:

The possibility of expanding to a bigger system with several control panels and control and information units.

Programmable activation of control output relays for tripping ventilation system, AC system and closing of fire doors in the event of fire.

Individually controlled, monitored alarm outputs for external hooters, lamps etc.

Fire control panel shall have facility for test features.

The status check of each detector, interface units for alarm, prior warning, trouble, disabling shall be possible from control panel.

The control panel shall have memory storage for last events and an alarm counter for number of alarms occurred after the control panel is installed.

Individual LEDs & manual actuation button for Deluge valves shall be part of the Fire Alarm panel in the form of integrated annunciator modules. This is required in addition to automatic actuation by the panel.

Fire alarm control panel shall have the sounder silence, reset, more alarm push buttons and also push buttons for user menu structures.

The Power Supply to the control panel shall be 240 V, 50 Hz. Single phase, AC supply.

8.1 The fire alarm control panel shall be able to provide the following features:

<table>
<thead>
<tr>
<th>Acknowledge</th>
<th>To acknowledge the alarm</th>
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<table>
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<tr>
<th>Feature</th>
<th>Description</th>
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<tr>
<td>Control-By-Time</td>
<td>To program the outputs to turn on at specific time</td>
</tr>
<tr>
<td>Automatic day / Night sensitivity</td>
<td>To have higher sensitivity during unoccupied period.</td>
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<tr>
<td>Adjust</td>
<td></td>
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<tr>
<td>Device Blink Control</td>
<td>For flashing LED’s on the detector.</td>
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<td>Drift Compensation</td>
<td>For compensating the detector response due to environmental changes.</td>
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<tr>
<td>Pre-alarm control panel Indication</td>
<td>For early indication of fire in the incipient stage</td>
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<tr>
<td>NFPA 72 Smoke Detector sensitivity</td>
<td>For routine check-up of the sensors from the panel</td>
</tr>
<tr>
<td>test</td>
<td></td>
</tr>
<tr>
<td>System Status Report</td>
<td>Documentation of various system parameter</td>
</tr>
<tr>
<td>Alarm Verification, by device with</td>
<td>To eliminate generation of false alarm due to dust cigarette smoke</td>
</tr>
<tr>
<td>tally or</td>
<td></td>
</tr>
<tr>
<td>Printer Interface</td>
<td>For printer interface which is used for system documentation</td>
</tr>
<tr>
<td>Non –Alarm Module Reporting</td>
<td>For some module which are used only for supervision of third party systems</td>
</tr>
<tr>
<td></td>
<td>and which are used as Fire alarm points.</td>
</tr>
<tr>
<td>Periodic Detector Test</td>
<td>For detector testing from the panel. Which eliminates the need for testing</td>
</tr>
<tr>
<td></td>
<td>the detectors in the field every now and then</td>
</tr>
<tr>
<td>Trouble Remainder</td>
<td>To remind the operator of the maintenance required at the individual detectors.</td>
</tr>
<tr>
<td>Upload /download to PC computer</td>
<td>For programming the panel in the first power up</td>
</tr>
<tr>
<td>Alarm Verification with Tally</td>
<td>To verify any alarm received by the fire alarm panel before the hooters are</td>
</tr>
<tr>
<td></td>
<td>sounded.</td>
</tr>
<tr>
<td>Walk Test</td>
<td>The entire loop can be tested by a single person with the print out at the printer.</td>
</tr>
<tr>
<td>Smoke Detector maintenance Alert</td>
<td>Give an indication to the operator that the detector requires cleaning.</td>
</tr>
</tbody>
</table>

The system shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.

The display assembly shall contain, and display as required, custom alphanumeric labels for all analogue addressable modules, and software zone for easy identification of fire location.
The system display shall provide a 400 character back-lit alphanumeric Liquid Crystal Display (LCD). It shall also provide six Light Emitting-Diodes (LED’s) that shall indicate the status of the following system parameters: AC POWER, SYSTEM ALARM, DISPLAY TROUBLE and SIGNAL SILENCE & CPU failure.

The system display shall provide a 25 key touch key – pad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different pass word levels shall be accessible through the display interface assembly to prevent unauthorised system control or programming.

The system display shall include the following operator control switches: SIGNAL SILENCE, LAMP TEST, RESET, SYSTEM and ACKNOWLEDGE.

**System expansion:** Design the main FACP and transponders so that the system can be expanded in the future (to include the addition of twenty percent more circuits or zones) without disruption or replacement of the existing control panel. This shall include hardware capacity, software capacity and cabinet space.

**8.2 Field programming:**

The system shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.

The field programmability is essentially required so as to make the necessary modifications in the system parameters as per the site conditions.

The field programmability shall allow the client make changes in various system parameters as per their operation philosophy.

All programming shall be accomplished through the standard FACP key board or through the video terminal.

All field defined programs shall be stored in non–volatile memory to ensure no data is lost during the power loss.

**8.3. Specific system operations:**

Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog addressable smoke detectors in the system from the system key pad or from the key board of the video terminal. Sensitivity range shall be within the allowed UL window. This allows for higher sensitivity at high fire risk area.
Alarm Verification: Each of the Analogue Addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or any time after system turn – on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands. To eliminate generation of false alarms due to dust or cigarette smoke.

**Point read:** The system shall be able to display the following points status diagnostic functions without the need of peripheral equipment. Each point shall be annunciated for the parameters listed.

A: Device status  
B: Device type  
C: Custom Device Label  
D: Software Zone Label  
E: Device Zone Assignments  
F: Analog Detector Sensitivity  
G: All Program Parameters.

**System history Recording and reporting:** The fire alarm panel shall contain a history buffer that shall be capable of storing minimum 800 system output/input/control activations. Each of these activations, shall be stored and time and date stamped with the actual time of the activation, until an operator requests that the contents be wither displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may be displayed and or printed.

The history of buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.

**Automatic Detector Maintenance Alert:** The fire alarm control panel shall automatically interrogate each Analogue addressable system detector and shall analyze the detector responses over a period of time.

**8.4 Response Indicator.**

The response indicator shall comprise of indicator lamp with flashing enclosed in a red plastic cover and fitted inside the M.S. BOX AND ENGRAVED “FIRE” on the plastic cover.
8.5 Alarm Sirens, Hooters

The siren shall be of rugged construction, have weather proof protection and suitable for outdoor mounting. It shall have adequate range to cover a radius upto 3 K.M and shall be dual tone. The operator at the fire station / security control room shall have facility to energizes the siren.

The siren shall be suitable for 240 V +/-10%, 50 Hz +/-2Hz single phase A.C. Frequency shall be as per standards. The siren shall have rain canopy. The siren shall have IP-65 enclosure.

Hooters
The electronic sounder / loud speaker being located at vital places shall have minimum audible level of 65 dB OR 5 dB above noise level of the working area.

8.6 Power Supply, Cabling and Wiring and Control Centre:

Power Supply:
The power to the Graphics computer shall be derived from a suitable UPS with 50% loading. The power to the Deluge valve actuation system shall be derived either from fire alarm panel (24VDC) or shall be locally generated in the field from supervised Battery and Charger system.

Wiring type for fire alarm device loop: Style -6 – 4WIRE – FAULT TOLERANT or Style - 4 – 2 WIRE for loops greater than 3km.

9.0 CENTRAL PROCESSING UNIT (CPU) of FIRE ALARM PANEL.

CPU shall communicate with various microprocessor based fire alarm control panel /peripherals of the system and execute /receive FIRE & FAULT alarms, control the activation of o/p’s etc. CPU failure should be indicated by an LED on the front facia

CPU shall also communication with printer and video display unit through RS-232C or current loop.
Indications / information received from detectors /field devices, switches etc to CPU shall be repeated to other panels if specified.

The CPU shall serve as an interface between controller for operator peripherals and remote fire alarm control panels.

The CPU serves as central processor, system software shall be designed specifically to monitor status; processing alarms according to priorities, controlling / processing communications with operator peripherals; and synchronizing all system activity.

For reason of reliability and preventing inadvertent changes, system shall be maintained in non-volatile memory. System shall permit reprogramming by authorised personnel only.

The CPU shall indicate post dates for carrying out periodical system maintenance for each detector without interrupting other detectors. The same shall have printing facility. The CPU shall derive power from panel Power supply

The looping scheme, scheme of detector connection shall be software programmable.

9.1. LOCAL VIDEO DISPLAY UNIT: (GRAPHIC WORK STATION)

The VDU shall be for data retrieval, alarm annunciation, commands and programming functions.

The VDU shall have for the following functions,
Alarm and returns to normal
Commands, reports and programming
Time, day and date
Mimic diagram display with alarm points using AUTO CAD drawings.

Alarms and all other change of status shall be displayed in the screen area reserved for the information. Upon receipt of alarm, an audible shall sound and the condition and point type shall flash until acknowledged by the operator.

Multiple levels of access to the system shall be provided for operators and supervisors via user defined passwords.

Monitor used for display shall be 21 inch color monitor.
9.2. **PRINTER:-**

Printer used in the system shall be hard copy output device and shall provide real time records of the system events and provide system reports on demand.

The printer shall automatically record all alarms, troubles, acknowledgements, return to normal and commands selected by the user.

Alarm shall be highlighted differently than other messages and shall be recorded, including type, location, time, date and numerical address of alarm point. If an alarm is received during the preparation of reports, the printer shall interrupt the report to record the alarm and afterwards resume the report automatically.

All changes to system programming shall be recorded automatically.

Power supply to the unit shall be 240V, 1 phase. 50Hz AC.

9.3. **CABLES:**

The cables required for detectors connection shall be multi core, (2 core, 3 core, 4 core), stranded as per IS-1554, IS – 8130 & IS - 5831 as in BOQ. The cable shall be Fire Resistant Low Smoke (FRLS), screened type.

The power supply cables shall be as per IS-1554 part-I –1988, Twisted pair, 1100 Volt grade.

However if any special cables are required for detector cabling etc, the tenderer shall specify clearly briefing the specification.

For detector wiring - Annealed tinned solid copper conductor of 1.5 /2.5 /4.0 sq. mm, as required (IS – 1554) PVC insulated & PVC sheathed, Armoured cable.

Cables connected to detectors shall be given ‘S’ loop on both sides of the detectors which shall be properly clamped to the ceiling.

‘S’ loop shall also be left where cables connect sounders, panels, dampers, etc.

Appropriate glands shall be provided for the armoured cable near terminals of junction box.

Unused cable holes if any should be plugged.
For all types of cables 20% spare core (or minimum one core additionally) to be kept.

All the cables and wires shall be tagged for proper identification. Wires shall be identified by ferrules at junction and cables by colour bands at every 3 M distance.

Over-head lines for fire alarm system shall not be used when connecting different building. They shall be laid under ground according to IS: 1255-1983.

The cables and wiring for fire Alarm circuit shall not be clubbed with other cables and wiring which must be laid well away from them.

The panel should have additional capacity to operate auxiliary equipment like fire dampers, ventilation and / or pressurizing fans, emergency light, smoke vents etc. if required.

10.00 SPACING AND SITING OF DETECTORS AND MANUAL CALL POINTS:

10.01 General:

A well laid out detection system can perhaps do nothing to reduce the incidence of fire but can certainly help to lessen the resultant loss by reducing the delay between ignition and the start of effective fire fighting.

Heat and Smoke sensitive detectors depend on the convective movement of the combustion products from the fire to the detector.

The spacing and siting requirements for these detectors are based on the needs to restrict the time taken for movement of combustion products to ensure that these combustion products reach the detectors fitted in the ceiling in adequate concentration within a reasonable time lag.

10.02 Spacing of Detectors:

(A) For the open areas under flat horizontal ceilings, the horizontal distance from any point in the area to the detector (point type) shall not exceed 5.3 M for heat detectors or 7.5 M for smoke detectors.

In case of line type detectors, spacing of not more than 18 M between two projected beams and not more than half that spacing from an external wall parallel to the beam may be used.
Beam length shall not exceed maximum permitted by approving authority. In case of air sampling detectors, distance between detector and farthest fan shall not exceed 10 Mts.

(B) The maximum allowable height of the compartment is 7M for the purpose of rule (A) above.

In case the height of the compartment exceeds 7M, the following restrictions shall apply.

Smoke Detectors:

a) Upto 7M height :-

either multisensor or optical detector or a combination of both depending on occupancy.

b) Above 7M but less than 10M height :-

Combination of multisensor and optical detectors in a ratio of 1:1 with spacing reduced to 5M.

c) Above 10M upto 25M height :-

Optical beam detectors or air sampling detectors.

Heat Detectors:

a) Upto 5M height :-

Fixed temperature (static) element type detectors or combination detector having fixed and ROR elements, Grade 2 or 3; preferably in the ratio 1:1.

b) Above 7M upto 9M height :-

Rate of rise cum fixed temperature (static) element type detectors with spacing reduced to 3.5M (Grade 1 only).

c) More than 9M height :-

Heat detectors at these height are not acceptable.
Where high air movement prevails in the protected blocks, the following additional provisions shall apply (excluding those for protection of false ceiling, false floor plenums and shafts) over the restriction stated in rulers (A) and (B) above.

The following tables should be used to calculate smoke & heat detector spacing in general.

REF: IS-2189-1988 REAFFIRMED IN 1998

TABLE-1 AND TABLE-2
(CLASSES 5.3, 5.32, 5.5 & 5.17)

<table>
<thead>
<tr>
<th>CEILING HT IN MTS.</th>
<th>UP TO 3.3 MTS.</th>
<th>3.3 UP TO 4.5 MTS.</th>
<th>4.5 UP TO 5.5 MTS.</th>
<th>5.5 UP TO 6.5 MTS.</th>
<th>6.5 UP TO 7.5 MTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTUAL SPACING OF DETECTORS SMOKE (I+P.E) IN MTS. WITHOUT A/C</td>
<td>8 MTS.</td>
<td>7 MTS.</td>
<td>6 MTS.</td>
<td>4.5 MTS.</td>
<td>3 MTS.</td>
</tr>
<tr>
<td>WITH A/C TRUE SPACING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIR CHANG. PER HR</td>
<td>MULTIPLYING FACTOR</td>
<td>(MTS.)</td>
<td>(MTS.)</td>
<td>(MTS.)</td>
<td>(MTS.)</td>
</tr>
<tr>
<td>7.5 OR LESS</td>
<td>1</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>8.6</td>
<td>0.95</td>
<td>7.6</td>
<td>6.65</td>
<td>5.7</td>
<td>4.275</td>
</tr>
<tr>
<td>10</td>
<td>0.91</td>
<td>7.28</td>
<td>6.37</td>
<td>5.46</td>
<td>4.095</td>
</tr>
<tr>
<td>12</td>
<td>0.83</td>
<td>6.64</td>
<td>5.81</td>
<td>4.98</td>
<td>3.735</td>
</tr>
<tr>
<td>15</td>
<td>0.74</td>
<td>5.92</td>
<td>5.18</td>
<td>4.44</td>
<td>3.33</td>
</tr>
<tr>
<td>20</td>
<td>0.64</td>
<td>5.12</td>
<td>4.48</td>
<td>3.84</td>
<td>2.88</td>
</tr>
<tr>
<td>30</td>
<td>0.5</td>
<td>4.0</td>
<td>3.5</td>
<td>3.0</td>
<td>2.25</td>
</tr>
<tr>
<td>60</td>
<td>0.38</td>
<td>3.04</td>
<td>2.66</td>
<td>2.28</td>
<td>1.71</td>
</tr>
</tbody>
</table>

REF: IS-2189-1988 REAFFIRMED IN 1998

TABLE-1
(CLASSES 5.3, 5.32, 5.5 & 5.17)

<table>
<thead>
<tr>
<th>FIXED TEMPERATURE</th>
<th>CEILING HT IN MTS.</th>
<th>UP TO 3.3 MTS.</th>
<th>3.3 UPTO 4.5 MTS.</th>
<th>4.5 UPTO 5.5 MTS.</th>
<th>5.5 UPTO 6.5 MTS.</th>
<th>6.5 UPTO 7.5 MTS.</th>
</tr>
</thead>
</table>

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<table>
<thead>
<tr>
<th>GR-1</th>
<th>TIME</th>
<th>INSTANT</th>
<th>20 SEC.</th>
<th>4 MTS</th>
<th>3.5 MTS</th>
<th>2.5 MTS</th>
<th>1.5 MTS</th>
<th>1 MTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR-2</td>
<td>TIME</td>
<td>INSTANT</td>
<td>40 SEC.</td>
<td>3.5 MTS</td>
<td>3.0 MTS</td>
<td>2.0 MTS</td>
<td>1.5 MTS</td>
<td>--</td>
</tr>
<tr>
<td>GR-3</td>
<td>TIME</td>
<td>INSTANT</td>
<td>60 SEC.</td>
<td>3 MTS</td>
<td>2.0 MTS</td>
<td>1.5 MTS</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

**Note:**

**Air changes per hour is defined as:**

\[
60 \times \text{volume per minute of air supply to the protected space} / \text{volume of protected space}
\]

Detectors shall not be located in the vicinity of supply air diffusers. Minimum distance between the detector and the air inlets /diffusers shall be at least 1.5 M.

Detectors shall be so mounted as to favour the air flow towards return air openings.

The above provisions shall not disturb the normal population (count) of detectors which is provided assuming that air handling systems are off.

After designing the detector spacing, it shall be cross-checked to ensure that there is at least one smoke detector for every 100 M Sq. or one heat detector for every 50M Sq. of the compartment area.

**10.3 Special Consideration:**

**A. Ceiling and Roofs:**

Protection of ceiling and roofs shall conform to BS: 5839, Part-I.

**B. Corridors**

If the corridors are less than 5M wide, the distance between the detectors may be increased by half the difference between the actual width and 5M. If the
corridor is more than 5M in width, the same shall be treated as a normal compartment.

10.4 **Walls and Partitions:**

a) Detectors shall not be mounted within 500 mm of any walls or partitions.

b) If a compartment is divided into sections by walls, partitions or storage racks, their height shall be such that the distance between the top of the latter and the ceiling shall be greater than 450mm.

If the height difference is less than 300mm, each section shall be deemed as separate room for provision of detectors.

10.5 **Obstructions:**

Any ceiling obstruction (such as beam, duct etc.,) the depth of which is more than 150 mm the distance between the detector in the vicinity of such obstruction shall be decreased by twice the depth of obstruction.

However if the depth of obstruction is more than 10% of the ceiling height, such obstruction shall be treated as a wall and provision of detectors shall be governed by the rule above.

10.6 **Voids and False-Floors:**

All voids and false-floors having height of more than 800 mm shall be provided with detectors and such detectors shall be installed within 150 mm of the ceiling of such voids of false floors.

10.7. **Enclosed Staircases, Vertical Shafts and Ceiling Penetrations:**

Where stairways, enclosed chutes or shafts or lifts, hoists or escalators penetrate ceiling/floors, detectors shall be sited at each level within 1.5M of the penetrations. In case of stairways not penetrating through the ceiling, detectors shall be provided at each of the landings.

Where there are more enclosures or cabins per floors, false ceilings, plenums and shafts, response indicators should be provided at permanent places.

10.8 **Special Requirements:**

Where the atmosphere inside a block is subject to sudden or rapid changes in temperature e.g. kitchens, boiler house etc., ROR type of heat detectors should be avoided to minimise false alarms.
Where ambient temperature are likely to be high, the operating temperature of the heat detector should be at least 30 degrees C above the maximum anticipated ambient temperature.

A detector shall be placed within 1.5M from any door, window or other openings in the wall partitions between protected and non-protected premises.

Every enclosure like a cabin, however small it is, within the protected compartment shall be provided with detector(s).

Reference shall be made to the committee in advance with full particulars in following cases:

I. Installation of smoke detectors within ventilation ducts,

II. Siting of optical beam type smoke detectors having transmitter and receiver components

III. Layout of detectors in compartments where heating arrangements are provided (stratification of smoke)

iv. For areas which are subject to adverse environmental conditions like vibration, pollution, shock etc.

10.9 Sitting of Manual Call Points:

In high bay areas (where the ceiling height is more than 9 mts. and where no detectors can be provided) manual call points shall be located at each entry and at every 30 mts. interval on all sides if, required. All stair cases shall be provided with manual call points at every alternate landing and near to door entry.

Where necessary, the travel distance may require to be reduced to less than 30M e.g. where there is difficulty in free access within the risk or in potentially dangerous risk.

Call points shall be fixed at a height of 1.4M above the surrounding floor level, at easily accessible, well illuminated and conspicuous positions which are free of obstructions.

Where the call points shall be housed in dust proof and moisture proof enclosure shall be properly sealed with rubber lining.
The glass surface should be minimum 30 cm.sq. in area and glass thickness should not exceed 12mm.

Manual call point shall be located preferably near entry / exit to building / staircases at various levels.

10.10 **Spacing Guide-Line:**

(a) Sufficient no. of detectors shall be used and they shall be positioned such that no point requiring detection in the area to be protected, is obstructed or outside the field of view of atleast one detector.

(b) In applications where, the fire to be detected could occur in an area not on the optical axis of the detector, the distance shall be reduced or alternatively more detectors added to compensate for the angular placement of the fire.

(c) The spacing of the detectors shall vary from fuel to fuel. It is therefore necessary to fix the distances as per the recommendations of the manufacturers.

(d) The location of the detectors shall also be such that their line of sight is not impeded by structural members or any other opaque objects or materials.

(e) When installed outdoors, detectors shall be shielded to prevent diminishing sensitivity due to rain, snow, ice etc., and allow a clear vision of the hazard area.

(f) Approval of the committee must be obtained before commencing the installation for their specific requirement.

10.11 **B. Belt Conveyors:**

Every fire detector should be allotted an identification no. preceded by alphabetical initials showing the type of detector from the time of inspection prior to commissioning.
LOUDSPEAKER INTERCOMMUNICATION (LSIS) SYSTEM

01. General
This General Technical Specification (G.T.S) covers the technical requirement of LOUDSPEAKER INTERCOMMUNICATION (LSIS) System for expansion to 7.0Mt. of BSP.

The systems are intended to provide instantaneous, reliable and effective communication as per the technological requirements between various process control points, control rooms, shift in charges, senior operation & maintenance personnel of the Plant complex in high noise level conditions (in the range of 90 to 110 db).

Loudspeaker intercommunication system subscriber stations shall be provided at the locations as per the list given below.

02. List of Subscriber Station for LSI System

<table>
<thead>
<tr>
<th>Station No.</th>
<th>Location of Subscriber Station</th>
<th>Type of stations</th>
</tr>
</thead>
</table>

03. System Features

The system shall be microprocessor based, distributed amplifier type.

The system shall consist of a central exchange, master control station, number of subscriber stations, paging loudspeakers, power supply equipment and interconnecting cable network.

The equipment shall be designed for reproducing high level perfectly intelligible speech and shall have high operational reliability under adverse environmental conditions such as corrosive and dusty atmosphere high temperature, humidity, vibrations and high noise level (in the range of 90 - 110 db) of the Steel plant Complex.

The system shall be designed in modular form so as to enable modification / expansion of the system easily as and when required without affecting the installed equipment.

The system shall have sufficient capacity to expand suitable number of subscribers to the tune of 20% of the indicated system capacity. The system with it’s present configuration shall have the sufficient capacity to connect a subscriber stations.
The system shall have the provision for automatic muting of the associated loudspeaker while making announcement to avoid acoustic feedback.

In principle all subscriber stations shall be connected to the central exchange by standard twisted, multi pair PVC insulated, PVC sheathed armoured communication cable.

The interconnecting cable network shall be designed using armoured cables laid on Cable trays. Wherever necessary un-armoured cables shall be laid through GI conduits keeping in view the shop layout & site condition.

The Loudspeaker intercommunication system subscriber stations shall be provided at the locations as per the subscriber list to be prepared by the package contractor.

The communication requirements of various subscribers shall be as per the technological chart (communication matrix) enclosed with this technical specification.

The various equipment and component of the system shall conform to the relevant IS / IEC for safety standard, climatic & environmental condition, electrical measurement standard and degree of mechanical protection.

04. The system shall provide the following modes of communication amongst it's various subscribers:

No limitation on number of simultaneous communication channels.

Master to Subscriber call.

Subscriber to Master call.

Subscriber to Subscriber call through master.

Subscriber to Subscriber call through direct dialing.

In Subscriber - to - Subscriber call mode (through direct dialing), a subscriber can call the chosen subscriber by dialing the number allotted for the called subscriber.

In case the called station is busy the calling station shall get a flash of the BUSY LED indicating that the called station is busy. If the called station is free the Green LED shall glow and the subscriber is connected to the called party and communicate with him.
The calling subscriber talks into the microphone and the message shall be heard at called subscriber station through his loudspeaker.

The called party can straight away speak into the microphone in his station. Both the parties can talk and hear at the same time.

Any other subscriber if wants to talk to either of them at that instant of time shall get busy indication for them. On completion of his message, calling subscriber shall normalise his switch board by reset switch.

Group call from a subscriber with a pre-determined number of subscribers. Facility for more than six simultaneous group call shall exist in the system. Group calls can be arranged in priority order.

Group paging shall be possible through master control station.

All party conference shall be possible through the master control station.

In case of emergency all the subscribers of the system can be paged simultaneously.

Priority call for a subscriber by pressing the priority break in. It shall be possible to provide priorities amongst the subscribers / group of a system at any time through the central exchange by suitable change in the software.

Reset facility on auto / manual mode.

Status monitoring indication on each subscriber.

Diagnostic features in built in the system.

Programmable communication chart. The system shall have facility to establish or change interconnection between any one or more subscribers and their facilities as and when required at site through a PC.

05. **Equipment details**

05.01 The loudspeaker intercommunication system shall be microprocessor based, distributed amplifier type and broadly consist of (but not limited to) the following

- Central exchange
- Control desk with master control station
- System main junction box
- Nos. subscriber station of outdoor wall / column mounted type complete with amplifiers, microphones and re-entrant horn type loudspeakers & associated accessories. All outdoor stations shall be provided with weather proof housing and associated erection accessories.
- Nos. desk top type subscriber station complete with handset station, extension amplifiers, box type loudspeaker & associated erection accessories.
- Centralized power supply unit complete with mains power distribution board for the system and back up UPS of suitable capacity.
- Interconnecting cable network
- Junction boxes, mounting accessories & all other erection accessories required for the system and it's cable network.

05.02 Central exchange

The Central exchange shall be microprocessor based & frequency bandwidth 200 – 15000Hz. intended for automatic speech path switching and blocking between various subscriber stations connected to the system. The Central exchange shall be provided with all the hardware including system control panel, relay sub-racks, main switch panel, CPU, interface cards, relay control cards, diagnostics modules required for connecting required subscriber stations (inclusive 20% spares). However, the system shall be suitable for expansion to connect additional subscriber station in future.

All switching elements shall be of modular design.

The Central exchange shall be provided with diagnostic features, ie; facility for monitoring and checking the functions of subscriber stations.

The Central exchange shall be of modular design and all the necessary communication and functional modules as well as power supply modules with protective devices.

The Central exchange shall be housed in dust proof, self supporting free floor standing type or wall mounting cabinet with a lockable rear door.
Cabinet shall have facility for terminating cables and carry all other devices necessary for switching the desired communication links between the subscribers of the system. All devices assembled and wiring shall be such as to provide easy access for operation and maintenance.

For cable entry the panels / equipment shall be provided with steel gland plates at the bottom with cable glands for fixing armoured / un armoured cables.

The Main system junction box shall have the facility to terminate the signal cable coming from at least 64 subscriber stations in the field side.

05.03 Subscriber Station

Each subscriber's station shall consist of a pre-amplifier, an amplifier, a loudspeaker, a noise compensated microphone, power supply equipment and a switchboard (carrying number of push buttons / switches for station selection & group calls) and junction boxes.

All the subscriber stations shall be suitably interconnected to meet the technological requirement as per technological chart (communication matrix).

The subscriber station shall be either indoor desk mounted type or outdoor wall / column mounted type depending upon the location where it shall be used.

The subscriber stations shall be made of fibre glass reinforced polystyrene or Aluminum die cast to withstand the trying environment of the plant complex.

Each Subscriber station have it's junction box for termination of incoming and outgoing cables (both signal cable / power supply cable).

All the outdoor wall mounted / column mounted stations shall be dust proof, weather proof / pilfer proof type.

Desk mounted type subscriber station conforming to IP52 shall be used in the Control rooms.

Outdoor stations conforming to IP 55 shall be used in the Shop floors and Junction house areas.

All the junction boxes used for the systems shall conform to IP55.

Amplifier:
The **Power amplifier** shall be made up of solid state devices with power output to give through associated loudspeaker sound intensity level of at least +3 db above the ambient noise level.

Connections to the loudspeakers, microphone and power supply source shall be in a way to match the requirement of the other control devices of the process station.

Facility to adjust the volume shall be provided.

Facilities to monitor the proper functioning of the amplifier shall be provided.

Out put Power : 15 watts r.m.s.  
Frequency Response : 200 Hz - 15000 Hz (+/-3db)

**Microphone :**

The microphone shall be of robust construction matching with the amplifier input and shall be immune to the stray magnetic fields and mechanical vibration.

It shall be of uni-directional response pattern with noise canceling characteristics.

It shall be provided with a goose neck or a suitable mounting matching the arrangement at the control station/indoor stations and shall be in built in the station / hand held receiver type for out door stations.

Frequency Range: 200 Hz - 15000 Hz (+/- 3 db)

**Microphone amplifier** shall be fully solid state and shall have frequency response of 200 Hz to 5000 Hz and the response shall drop off sharply beyond the speech frequency zone to achieve maximum intelligibility under high noise level condition. The amplifier for transmission shall be so designed as to provide uniform sound level at one or more called subscribers.

Loudspeaker :

The loudspeaker shall be of all weather proof sturdy design suitable for operation under rough industrial conditions.
The loudspeaker shall have uniform sensitivity and low frequency cut off having suitable directional response pattern for efficient and high quality speech reproduction.

It shall match the output of the amplifier.

The loud speaker shall be either industrial re-entrant horn type or box type depending upon the location where the station shall be used. Each loudspeaker shall have a junction box for termination of cables from the station junction box.

The indoor box type loudspeaker shall be housed in sheet steel enclosure suitable for wall mounting and shall have built in volume control facility. It shall have uniform sensitivity with low frequency cut off at 250 Hz.

The industrial horn type loudspeaker shall be weather proof version of die cast Aluminum body with sturdy mounting bracket suitable for mounting on wall/column. The driver unit shall be concealed in the horn to prevent damage due to environmental condition and pilferage.

**Peak output power**
- 6 watts for indoor box loudspeakers
- 15 watts for outdoor industrial horn type loudspeakers.

**Switch board :**

The switch board shall be either integrated with the subscriber amplifier or separate unit to be mounted along-with the subscriber’s other accessories. The switch board shall have push button / switches for station selection, channel selection & group call selection. In addition there shall be display / indication about Power supply ON, channel busy, the number of the called station, calling station & number of incoming priority call pending etc.

**05.04 Power supply**

All the equipment shall be suitable for operation from a centralized 240V ± 10%, 50Hz ± 5%, Single phase, AC mains power supply. On failure of AC supply the system shall automatically switch over to inverter supply derived from a set of back up battery having suitable AH capacity to meet the power supply requirement of the system for 1 hour. The power supply equipment including the battery bank and main power distribution box shall be installed in a separate room near the Central exchange.
The power supply equipment shall be provided with protections against short circuit, over voltage, under voltage and transients.

05.05 **Cable Network**

The Loudspeaker intercommunication system shall have a separate cable network for facilitating the provision of subscriber stations as required for the plant.

The **signal cables** shall be completely separated from wiring of any other circuit of high voltage. When the cables are to be laid in the electrical cable trays of the conveyor galleries, sufficient space shall be maintained (as per the Indian electricity rules) from the cables of the high voltage circuits.

Each subscriber station shall be connected to the power supply unit through a separate cable network using **power supply cables** of required size.

Each Subscriber station shall be connected to the Central exchange by using multi-pair signal cables through the Main system junction box. The system junction box shall have termination facility for all incoming (cables from the Central exchange) as well as all outgoing cables (cables from the subscriber stations).

Loudspeaker shall be connected to subscriber station by loudspeaker cable.

**The size of the cables are as given below.**

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>3 core, 2..5 sq.mm, ATC, Armoured PVC</td>
</tr>
<tr>
<td>Signal cable</td>
<td>5 pair, 0.5 sq. mm, ATC, Armoured PVC</td>
</tr>
<tr>
<td>Loudspeaker</td>
<td>1 pair, 24/0.2 mm, ATC, Armoured PVC</td>
</tr>
</tbody>
</table>

All telecommunication cables shall be made up of annealed high conductivity solid / stranded copper conductor.

Armoured PVC cable shall be used when the cable is to be laid on trays in cable tunnels / cable galleries or on cable trays. All the cables shall conform to IS : 694 & IS : 1554 (Part I), 1988 or latest version.

05.06 **Ambient conditions**
All the equipment shall be designed to work reliably and effectively under the following ambient conditions:

- **Temperature**: 0 to 55 degree Celsius
- **Relative humidity**: Upto 90% at 35 degree Celsius
- **Environment**: Dusty and corrosive
- **Vibrations**: 25 Hz (+/-) 2 Hz
- **Ambient noise level**: 90 to 110 db.
LOUDSPEAKER TALK BACK (LSTB) SYSTEM

01. General
This General Technical Specification (G.T.S) covers the technical requirement of Loudspeaker talk back system for expansion to 7.0Mt. of BSP.

Loudspeaker talk back system shall be provided for facilitating reliable two-way intercommunication between various strategic points of the plant complex. The subscriber stations shall be provided at locations having very high ambient noise level.

The system having the requisite number of subscribers shall be provided in various units of the plant complex for smooth flow of information between process points.

02. System features

02.01 The system shall be of distributed amplifier type using latest state-of-art technology.

02.02 The system shall be designed for perfectly clear and intelligible speech communication and shall have high operational reliability under adverse environmental conditions including high noise levels (90 to 110 db).

02.03 The system shall be designed for two channels of communication ie; in paging and private modes. In paging mode the announcement from any station shall be heard at all other stations through respective loudspeakers while in private mode close-talk communication shall be possible between two or more stations.

02.04 The proposed systems shall be configured as an open line system.

02.05 The system shall be provided with call attention tone facility preceeding all paging / announcement calls.

02.06 Each communication station shall be provided with indication such as power ON, channel busy, volume control etc..

02.07 The system shall have provision for automatic muting of the associated loudspeaker in the paging / announcement mode to avoid acoustic feed back.
02.08 The system shall have the facility to have interconnection with the telephone exchange for speech communication in private mode and paging mode.

02.09 The system shall be of modular construction for easy expansion of subscriber stations as and when required without affecting the installed equipment.

02.10 The system shall be designed for continuous reliable operation and of rugged construction to withstand shock and vibration.

02.11 The system shall be suitable for operation from a centralised 240 V +/- 10%, 50Hz +/- 5%, single phase AC mains power supply. Power supply cable shall be drawn to each subscriber location from this centralised source.

02.12 The communication equipment shall be designed to work effectively to provide clear speech communication between the subscribers under the following ambient condition:

- Temperature: 0 deg.C to 55 deg.C
- Relative humidity: Upto 90% at 35 deg. C
- Surrounding: Dusty and Corrosive
- Vibrations: 25 Hz (+/-) 2 Hz
- Ambient noise: 90 to 110 db

03. **Establishment of a call**

Any person willing to communicate with another person has to go to the nearest subscriber station, lift the handset, press the "PRESS TO PAGE" switch and call for the desired person.

A call attention gong automatically proceeds the paging announcement. The paging announcement is heard on all the loudspeakers of the system except that of the calling station. After the announcement the calling person releases the "PRESS TO PAGE" switch and waits for the response of the called person.

The called person can go to the nearest station and communicate with the calling person directly in private mode by simply lifting the handset.
A third person can join the conversation in conference mode. During the private mode the associated loudspeakers are free to receive paging announcement generated by other stations.

04. Equipment details

04.01 Each system shall be distributed amplifier type and broadly consist of (but not limited to) the following:

- Subscriber station of both desk and outdoor (pole/wall/structure mounted) type complete with built-in amplifiers, additional extension amplifiers (if required), microphones etc. as per the requirements.

- Industrial horn type/box type loudspeakers.

- Power supply unit.

- Interconnecting cable networks comprising power supply cable, signal cable, loudspeaker cables, Junction boxes, cable termination devices, mounting accessories & other erection accessories for the system.

04.02 Subscriber stations

The subscriber stations shall be indoor desk or outdoor wall/pole mounted type as per the requirement.

Desk mounted subscriber stations conforming to IP 52 shall be used in control rooms, offices, etc. while outdoor stations conforming to IP 55 shall be used for shop floor areas and outdoor applications.

The desk mounted subscriber station shall broadly comprise a desk top hand set station, an extension amplifier and box type loudspeaker. The desk top hand set station shall consist of line amplifier, signal processing unit, function switches, indication lamps, etc. all housed in moulded fibre glass reinforced polystyrene case. The wall mounting type extension amplifier shall consist of a power supply unit and a plug in type power amplifier electronic module.

The pole/wall/column mounting subscriber station shall have die cast aluminum alloy (LM6) housing/fibre glass housing. The station shall broadly comprise of line amplifier, power amplifier, control signal lamps, switches for page/private channels and other functions, noise canceling microphone and receiver hand set, etc. all housed in the above mentioned housing. The subscriber station shall be provided with dust, weatherproof
protection cover suitable for outdoor installation. The re-entrant horn type loud speaker shall be used in conjunction with these stations.

Pilfer proof subscriber stations shall be considered for outdoor locations where there is scope of pilferage.

The subscriber station shall also have provision for direct plugging in additional higher wattage amplifier to raise the power output wherever required.

The press to talk micro switch shall be provided in the handset itself. It shall be designed in such a manner that only when this micro switch is pressed the microphone shall be ON.

**04.02.01 Amplifiers**

The amplifiers shall be fully solid state using integrated circuits/semiconductor devices and shall generally have a frequency response characteristics of +/- 3 db between 60 Hz to 10 KHz and the response shall drop off sharply beyond the speech frequency zone to achieve maximum intelligibility under higher noise level conditions.

The design of the amplifiers shall be such as to limit the effects of external interference. It shall essentially be free from hum and have a total harmonic distortion of not more than 5% at full output.

The amplifier dynamic characteristic shall accommodate the entire dynamic range of sound signal and shall provide optimum fidelity ensuring faithful sound reproduction.

The amplifiers shall be of suitable wattage and impedance to match with the speakers connected to it.

The amplifiers shall be designed to operate from power supply with voltage variation of +/- 10% without much variation in output or gain.

**04.02.02 Microphones**

Microphones shall be of robust construction matching with amplifier input.

It shall be of noise canceling type with proper directional response pattern to suppress ambient noise.

It shall be designed to limit the non-linear effects caused by external interference due to magnetic fields, mechanical vibration and wind. The
microphone shall be immune to the stray magnetic fields and mechanical vibration.

It shall be provided with a gooseneck / suitable mounting / fist type for the indoor stations and shall be in built in the handset for out door stations.

04.02.03 Loudspeakers

The loudspeaker shall have uniform sensitivity and low frequency cut off having suitable directional response pattern for efficient and high quality speech reproduction.

It shall match the output of the amplifier. Necessary line matching transformer shall be provided for each loudspeaker.

The loudspeaker shall be either industrial re-entrant horn type (conforming to IP 55) or box type (conforming to IP 52) depending upon the location where the station shall be used.

The indoor box type loudspeaker shall be housed in sheet steel enclosure suitable for wall mounting and shall have built in volume control facility.

The industrial horn type loudspeaker shall be weather proof version of die cast Aluminum body with sturdy mounting bracket suitable for mounting on pole / wall / column. The driver unit shall be concealed in the horn to prevent damage due to environmental conditions and pilferage.

Peak output power

- 6 watts indoor box loudspeakers
- 15 watts outdoor industrial re-entrant horn loudspeaker

04.03 Power supply.

The equipment will be suitable for operation from a centralized uninterrupted power supply. This power supply source shall be made available to the tenderer for use in the respective control rooms of the units.

The power supply equipment shall be provided with protections against short circuit, over voltage, under voltage and transients.

04.04 Cable network
Each of the loudspeaker talk back system shall have a separate cable network for facilitating the provision of subscriber stations as required for the plant.

List of subscribers for the system.

| Station No. | Location of Subscriber Station | Type of stations |

04.05 **Cables for the LSTB Systems:**

The signal cables shall be completely separated from wiring of any other circuit of high voltage. When the cables are to be laid in the electrical cable trays of the conveyor galleries, sufficient space shall be maintained (as per the Indian electricity rules) from the cables of the high voltage circuits.

Each subscriber station shall be connected to the power supply unit through a separate cable network using 3 core power supply cables.

Armoured PVC cable shall be used when the cable is to be laid on trays in cable tunnels / overhead cable galleries / overhead cable trays.

The tenderer shall furnish the specification of the signal cable, power supply cable and loudspeaker cable proposed to be used in the system.

All cables used shall be made up of annealed high conductivity solid / annealed copper conductor.

All PVC armoured and un armoured telephone cables shall be Fire retardant low smoke type (FRLS Type) having protective system of inner and outer sheath specially designed with thermoplastic or thermosetting materials having superior resistance to ignition and flame propagation with smoke emission and toxicity or corrosive characteristics. The cable will conform to the following standards -

* IEC - 332 (Part 1)
* IEC - 332 (Part 3)
* IEEE - 383
* BS - 4066
* Swedish Chimney test as per 4241475
GENERAL ANNOUNCEMENT SYSTEM

01. General
This General Technical Specification (G.T.S) covers the technical requirement of GENERAL ANNOUNCEMENT SYSTEM for expansion to 7.0Mt. of BSP.
The general announcement system shall facilitate announcement / paging over a number of loudspeakers distributed judiciously all over the plant complex.

02. Design feature

02.01 The system shall be central amplifier type. The amplifiers shall be located in the the CONTROL ROOM premises and the announcement points shall also be installed in the in plant control room.

02.02 The amplifier shall have the capacity of suitable output power inclusive of 50% stand-by capacity.

02.03 The announcement / paging shall normally be made from the main plant control rooms with provision of a second announcement point in the Shop in charge's office.

02.04 The loudspeakers shall be operated group wise or all at a time depending upon the requirement.

02.05 The system having the requisite number of loudspeakers shall be provided for the plant complex for announcement of instructions and smooth flow of information between process points.

03. System feature

03.01 The general announcement system shall ensure quality performance using the latest technology in design and manufacture of audio equipment.

03.02 The system shall facilitate near total reproduction of original speech or music and shall guarantee trouble free operation.
03.03 The system shall adopt modular construction. The amplifier rack shall be provided with input and output terminals, plated and tinned for good contacts.

03.04 The system shall be switched on through press – to - talk switch.

03.05 Suitable protection of the system against accidental wrong connection, over loading, short circuit etc. shall be provided.

03.06 The equipment shall be of rugged construction to withstand shock and vibration.

03.07 The system shall be capable of withstanding extreme conditions of temperature and humidity.

03.08 The equipment shall be suitable for operation from 240V +/- 10%, 50Hz +/- 5%, Single phase, AC mains power supply. The power supply equipment shall be provided with protections against short circuit, over voltage, under voltage & transients.

03.09 The communication equipment shall be designed to work effectively to provide clear speech communication in the plant under the following ambient condition:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>0 deg.C to 55 deg.C</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>Upto 90% at 35 deg. C</td>
</tr>
<tr>
<td>Surrounding</td>
<td>Dusty and Corrosive</td>
</tr>
<tr>
<td>Vibrations</td>
<td>25 Hz (+/-) 2 Hz</td>
</tr>
<tr>
<td>Ambient Noise</td>
<td>90 to 110 db</td>
</tr>
</tbody>
</table>

04. Equipment details

04.01 Each of the system shall broadly consist of but not limited to the following:

- Amplifier rack housing preamplifier, power amplifier including working and stand-by capacity with changeover facility, monitoring facilities etc.
- Microphone assembly
- Loudspeakers (re entrant horn type / indoor box type) complete with mounting accessories such as poles, mounting brackets.
• Cable network comprising cables, wires, junction boxes, cable termination devices, GI pipes/conduits, and all other cable laying accessories.

04.02 **Power amplifier**

The amplifier shall be fully solid state electronics.

The amplifier dynamic characteristics shall accommodate the entire dynamic range of the sound signal and shall provide optimum fidelity ensuring faithful reproduction of speech and music.

The stability of gain shall be fairly high. Reliable and quality components shall be used in its construction to prevent drift in their characteristics.

The amplifier shall be provided with easy to operate filter type volume and tone controls and potentiometer adjustment facility to regulate its input sensitivity.

The amplifier shall be provided with variable high frequency boost for increased clarity of speech and music.

04.03 **Microphone**

The microphone shall be of gooseneck desk mounted type offering high sensitivity and reliability and shall facilitate optimum reproduction of speech and music.

It shall be of noise canceling type having unidirectional pick-up pattern and shall prevent acoustic feed back due to reverberation from within the announcement / paging room.

The microphone shall be provided with in-built screen to prevent explosive wind and breathing sound.

It shall be capable of withstanding vibrations and shocks. Adequate protection against penetration of dust and foreign particles into the microphone shall be provided.

04.04 **Loudspeaker**

The loudspeaker shall have uniform sensitivity and low frequency cut off having suitable directional response pattern for efficient and high quality speech reproduction.
It shall be of sturdy construction capable of withstanding extreme conditions of temperature and humidity.

The loudspeaker assembly shall be capable of being swiveled in any desired direction, thus allowing flexible beaming of sound.

The driver unit shall incorporate built-in line matching transformer.

The loud speaker shall be either industrial re-entrant horn type (conforming to IP 55) for use on shop floors or box type (conforming to IP 52) for use in control rooms and other such rooms.

The indoor box type loudspeaker shall be housed in sheet steel enclosure suitable for wall mounting and shall have built in volume control facility.

The industrial horn type loudspeaker shall be weather proof version of die cast Aluminium body with sturdy mounting bracket suitable for mounting on wall/column. The driver unit shall be concealed in the horn to prevent damage due to environmental condition and pilferage.

Peak out put power : 6 watts for indoor box loudspeakers
15 watts for outdoor industrial re-entrant horn type loudspeaker

04.05 Power supply

The equipment will be suitable for operation from a centralised uninterrupted power supply source.

Uninterrupted power supply for the system shall be made available to the tenderer at a central location (preferably at the telephone exchange). The Amplifier racks for the system shall be installed in the telephone exchange premises and the announcement points shall be from the respective control rooms of the premises where the system is to be installed.

The power supply equipment shall be provided with protections against short circuit, over voltage, under voltage and transients.

04.06 List of location for loudspeakers for System
To be prepared by the respective supplier.

04.07 Cables

The loudspeaker cable shall be 2 core, 24/0.2mm twisted annealed tinned high conductivity copper conductor, PVC insulated and overall PVC
sheathed, generally as per IS-694. The cable shall be GI wire armoured or unarmoured as per the requirement.

All PVC armoured and unarmoured telephone cables shall be Fire retardant low smoke type (FRLS Type) having protective system of inner and outer sheath specially designed with thermoplastic or thermosetting materials having superior resistance to ignition and flame propagation with smoke emission and toxicity or corrosive characteristics. The cable will conform to the following standards -

* IEC - 332 (Part 1)  
* IEC - 332 (Part 3)  
* IEEE - 383  
* BS - 4066  
* Swedish Chimney test as per 4241475

05. Technical parameters

05.01 Amplifier:

- Input sensitivity: 100 mv
- Bandwidth: 100 Hz to 10 KHz
- Signal to noise ratio: Better than 60 db
- Hum and noise level: Better than 65 db below rated output power
- Distortion: Less than 3% at 1 KHz and at full output power
- Floating outputs: 100v/70V
- Protection: Against open and short circuits and spurious oscillation
- Safety requirement: As per IEC-65/268

05.02 Microphone:

- Type: Unidirectional, dynamic (moving coil)
- Frequency response: 100 Hz to 10 KHz
- Impedence: 230 - 270 Ohms

05.03 Loudspeaker:

- Type: Horn/Box enclosure
- Bandwidth: 100 Hz to 10 KHz
- Input voltage: 100V/70V
- Voice coil impedance: 8 Ohms, 16 Ohms
- Sensitivity at 1KHz: 111 dB +/- 3db per watt at distance of 1 metre.
CLOSED CIRCUIT VIDEO MONITORING (C.C.V.M) SYSTEM
GENERAL TECHNICAL SPECIFICATION

01.00 General

The Closed Circuit Video Monitoring (C.C.V.M) System will be provided for comprehensive round the clock surveillance for control and supervision of technological processes at points which are difficult to be observed directly or which require monitoring from a remote control center by operational people.

The system consists of colour cameras (CCD type) with fixed/zoom lens, 21” TFT color monitor, monitor console, water cooling jacket, blower unit, wiper & washer unit of the weather proof housing, remote controlled Pan & Tilt unit, Receiver Driver unit, matrix switcher, Digital Video recorder, camera mounting platforms/structures, control console with control units for complete control of the cameras. Inter connecting video and control cables, Video distribution amplifiers / Video cable equalizers (if required), & all other auxiliary equipment, connectors & erection accessories etc. as required for completeness of the system.

02.00 System requirements.

The cameras will be of Charge Coupled Device (CCD) type and these will be mounted in such a manner as to provide continuous monitoring of the critical processes / operation of the shop floor as required.

The system will provide clear and sharp picture on monitors in industrial lighting conditions at any time of the day or night.

The complete CCVM Systems will work on 240 V ± 10%, 50Hz ± 2 Hz, single phase AC supply. In case any other power source is required, the same will be arranged from the above available source. The CCVM system will be provided with an uninterrupted power supply system for feeding stabilized and continuous power supply to all equipment.

All equipment for C.C.V.M systems covered in this specification will comply with the CCIR standards.
All control functions related to the CCVM Systems comprising Cameras, Monitors, Water cooling jacket, blower unit and wiper & washer unit of the weatherproof housing will be effected from the control units, which are to be installed in the control rooms of the shop.

All the CCTV Cameras shall be multiplexed to suitable number of monitors. The CCTV Cameras along with multiplexing & control shall be interfaced to the operator stations.

### 03.00 Equipment details

The C.C.V.M. system will comprise of the following.

- Colored cameras with vari focal length/motorized zoom lenses.
- Camera mounting platforms / structures.
- Water cooling jackets, complete with wiper and washer units, compressed air arrangement
- Remote controlled Pan & Tilt units.
- Receiver Driver unit
- Matrix switcher
- Key board unit
- Digital video recorder
- Control console
- Color video monitors
- Interconnecting power, video and control cables
- Video distribution amplifiers/ Video cable equalizers, as per requirement.
- Alarm annunciator
- All other auxiliary equipment, connectors, erection accessories etc. as required.
03.01 Camera

The cameras will be compact, of rugged design and suitable for industrial continuous monitoring applications.

These will be specially designed and tested to provide continuous good quality video output throughout wide variations in environment conditions like temperature, humidity, shock and vibrations and varying light condition prevalent in the industrial steel plant.

The cameras will use 1/3” format interline transfer CCD imager and have virtually zero lag, no image burns and no geometric distortion. These will be of latest state of art technology ensuring high operational reliability.

The cameras shall deliver well defined, clear, high resolution colored picture, with sufficient contrast to allow for good object recognition even in poor light conditions. A highly sensitive automatic light compensation circuit will ensure constant video signal independent of wide variations in light levels.

The cameras will have long life and require virtually zero maintenance in adverse environmental conditions prevalent in the steel plant.

The Cameras will also possess the following features:

- High resolution.
- Low power consumption.
- Phase adjustable line lock facility.
- All controls like back focus, lens select, phase adjustment, power ON/OFF etc.
- The camera unit will be complete with all electronic circuitry, devices, components, control switches, standard mount for lenses, mounting assemblies etc. The mounting assemblies of the cameras will be individually selected depending upon the special requirements as per actual site conditions.

Color cameras of 1/3” format with Auto iris remote zoom focal lenses are envisaged to suit different requirements of site. The camera shall be color CCD type, high resolution of minimum 450 TV lines. All outdoor cameras shall be provided with sun shield.

Pick-up device -- 1/3-inch format, interline transfer, CCD image sensor
Minimum illumination – 0.01 lux at f 1.2
Signal to noise ratio -- 46dB minimum
Electronic Shutter -- Automatic, On/off selectable.
Video outputs -- Composite video - 1.0 V p-p, 75 ohm
AGC -- On/Off selectable
Aperture Correction -- Horizontal & Vertical
Synchronization --- Line lock - for roll-free vertical interval Switching
- Crystal lock
Connectors -- Video out: BNC
- Video/DC-Iris connector: 4-pinEIAJ
Operating Temperature -- as per location indicated
EMC -- CE/UL certification

03.02 Camera lens

The camera lens will be suitable for the camera on which it is to be mounted. The lenses chosen will be Auto iris remote zoom controlled so as to meet the operational requirements. The choice of lenses, their focal length and viewing angle will be judiciously done for effective monitoring suited to the specific application requirements.

Technical Parameter of Motorised zoom lens

<table>
<thead>
<tr>
<th>SL.</th>
<th>DESCRIPTION</th>
<th>Motorized Zoom</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Make</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Model no.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type of lens -</td>
<td>Motorized Zoom</td>
</tr>
<tr>
<td></td>
<td>Lens format</td>
<td>1/3&quot;, 1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>Focal length and aperture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iris type</td>
<td>Auto IRIS</td>
</tr>
<tr>
<td></td>
<td>Type of mount</td>
<td>C / CS</td>
</tr>
</tbody>
</table>

03.03 Camera mounting platform:

The camera mounting platform will be suitable for mounting the camera assembly on walls / column / structures as per the actual requirements at site and keeping in view the area to be covered by the individual camera. The mounting will be with adjustable support so as to have flexibility to move the camera assembly as and when required. Wherever necessary, structures / vertical poles to mount the cameras shall be fabricated.
03.04 Water cooling jacket for the camera.

At the locations where the ambient temperature is high, the protective camera housings will be provided with water cooling jacket to protect the camera against high temperature. Cooling water will be supplied to the jacket continuously to cool the camera and keep it fully efficient & operational.

Double walled stainless steel housing will be provided for protection of cameras from high temperature. Back cover of the water cooled housing will be detachable so that the camera can be taken out/installed from the rear for service and inspection. Piping for cooling water and purging air must be suitably protected against high ambient temperature/radiation heat. The glass panes of the housing will be resistant to influences like quick changes in radiation temperatures.

The cooling jacket will have temperature sensor to monitor the temperature of the camera, a toughened glass front, filter & an annunciator. Whenever the camera temperature crosses the upper threshold limit of the desired temperature there will be audio visual indication in the control room for the attention of operator.

Compressed air and a wiper & washer unit will be installed with the water cooling jacket to keep the front glass of the cooling jacket clean from dust & dirt.

**The housing will have enclosure as per IP 65.**

**Technical Parameter**

<table>
<thead>
<tr>
<th>SL.</th>
<th>DESCRIPTION</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material of housing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of camera mounting</td>
<td>C / CS</td>
<td></td>
</tr>
<tr>
<td>Temperature range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressed Air</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.05 Receiver Driver Unit

The receiver shall be able to receive pan & tilt, camera and lens positioning and adjust command signals from the operators keyboard through the CPU/Matrix and execute them. The unit shall generate the power for the enclosure, camera, zoom lens etc. Receiver driver unit shall comply min IP 65 for outdoor. The equipment shall be CE/UL certified.

The receiver driver unit shall withstand the temperature indicated for the corresponding area.

03.06 Pan and Tilt unit

The pan and tilt unit will comprise of pan & tilt head and control unit. The pan and tilt head will be remotely controlled from the control unit.

The pan & tilt head will be heavy/ medium duty type/light duty type, rugged in construction and smooth in operation. The unit shall be able to cater the load of weather proof housing with water cooling jacket, wiper & washer unit and compressed air pipe line arrangement. The unit will be used to cover large area of interest for surveillance in different directions, as required by the operator.

The unit will be suitable for mounting on walls / column / structures / hanging from ceiling as per the site requirements. The unit will have complete freedom of movement throughout the entire pan & tilt scan. The unit will be completely sealed for all weather proof use.

The pan and tilt units will be designed so as to ensure long operational life. The units will employ electric motors with quick reversibility and dynamic braking characteristics, have rugged worm gears assembly to minimize backlash and ensure drift free operation. It will be possible with ease to reposition the cameras field of view at any time. The unit will have manual over ride on the auto mode to enable the operator to choose the area of scan as and when required.

The Pan & Tilt unit shall withstand the temperature indicated for the corresponding area.
A) Technical Parameter of Pan and Tilt unit

<table>
<thead>
<tr>
<th>SL.</th>
<th>DESCRIPTION</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Make</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Model no.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Angular travel in horizontal plane</td>
<td>0-355 deg.</td>
</tr>
<tr>
<td></td>
<td>Angular travel in vertical plane</td>
<td>+/-90 deg.</td>
</tr>
<tr>
<td></td>
<td>Operating speed – Panning</td>
<td>6 deg./sec</td>
</tr>
<tr>
<td></td>
<td>Operating speed – Tilting</td>
<td>3 deg./sec</td>
</tr>
<tr>
<td></td>
<td>Maximum load (Load rating to be compatible for camera, lens and housing fitted)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Braking</td>
<td>Mechanical friction type</td>
</tr>
<tr>
<td></td>
<td>Construction material</td>
<td>Main body – Aluminium casting</td>
</tr>
<tr>
<td></td>
<td>Whether heavy-duty/medium duty/light duty</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whether suitable for indoor/outdoor use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rated temperature range</td>
<td></td>
</tr>
</tbody>
</table>

03.07. MICROPROCESSOR BASED MATRIX SWITCHER:

To control the C.C.V.M system microprocessor based matrix switchers are envisaged. The system shall have matrix switchers at control rooms.

At control rooms matrix switchers of suitable inputs and outputs and alarm interface units are provided for switcher to handle the alarm events.

The switcher system shall provide minimum the following basic features

- Full matrix switching.
- Synchronized video switching
- A logging printer port which provides a hardcopy printout of either the system status changes or system Tables and Sequences.
- Keyboard log-on/log-off with password protection.
- 16 character camera titling.
- Accommodation of alarm points.
- CE/UL certification
The matrix switcher must be modular in construction i.e. should have Main base having CPU, power supply and main bay, and required number of input and output cards must be put in the bay for configuring a solution. The system should allow multiple number of keyboards to be directly connected to it in star configuration. It should allow prioritizing the keyboards as per the requirement.

Video Inputs -- as per bill of quantities
Video outputs -- as per bill of quantities
RS-232 Ports -- 1 each for PC, printer and alarm signals
Input voltage level -- 0.5 V p-p to 2.0 V p-p, Composite Negative Sync
Gain -- Unity (75 ohm terminated)
Switching -- Cross point Matrix
Features -- Full matrix switching, any camera to any monitor - Programmable switching sequences.
- Salvo switching capability
- P/T/Z control outputs in the form of Biphase/RS-485/RS-422 etc.
- min 40 character on screen display for time-date, camera number, camera ID, monitor or status information & 16 character alarm titling
- With the keyboard, following P/T/Z controls shall be available:
  a) Pan, tilt, auto pan and random pan
  b) Zoom, focus and iris control

Operating Temperature -- as per locations indicated
Humidity -- 0 to 95 % relative, non-condensing.
EMC -- CE / UL certified

**Alarm Interface units**

An additional alarm interface unit shall be also supplied along with the above switcher. The unit shall have the ability to automatically display video under alarm conditions. It shall accept upto 64 contact closures or logic level inputs from remote sensing devices. The unit shall also provide 8 relay closure outputs upon alarm conditions.

**03.08 Key Board for matrix switcher**

Keyboard is envisaged for full function, for system control and programming at control rooms. The keyboard includes integral pan/tilt/zoom joystick for controlling cameras features.
Features
- Control of Matrix switcher
- Soft backlit keys with user friendly menu and easy to read display
- Joystick for P/T/Z control of camera
- Shall be interfaced to Matrix switcher for control of Camera selection and P/T/Z control.
- LCD display of complete menu for selection of various functions
- CE/UL certification

Connectors
- RJ11 connector for matrix switcher (power/data)
- Aux. power, for extended distances.
- RS-232 port for remote programming
- Other standard connectors.

03.09. DIGITAL COLOR MULTIPLEXER CUM RECORDER

This multiplexer and integrated digital recorder provides multi-camera recording and playback with the added capability of multi screen viewing. Programming is easily accomplished via front panel control keys and on-screen display menus.

The duplex multiplexer/recorder can encode up to 8/16 color video inputs on its internal hard drive while simultaneously displaying video in the full screen or any of the multi-screen modes.

GENERAL REQUIREMENTS

The multiplexer specified shall be designed to record (encode) and playback (decode) up to 8/16 color cameras. The unit shall also have the added capability of multi screen viewing.

In playback (DECODE mode), the multiplexer shall provide a full screen display of any of the sixteen previously recorded cameras or it can display a selection of any of the cameras in various multi-screen modes.

The multiplexer/recording shall allow instant access to critical recordings by alarm, time, date, and camera searches.

The multiplexer/recorder, in addition to camera video, shall provide the time & date, camera number, and a user programmable 16 character camera title, which is recorded.
The multiplexer/recorder shall provide, but not be limited to, the following features:

- On-screen menu programming,
- Sequencing of cameras,
- Video loss with on-screen indication,
- Freeze function,
- Action/Alarm output relay contacts,
- Password access protection.

The multiplexer/recorder shall use good compression technology for high quality video, and shall include a minimum hard drive capacity for storing data for 24hrs X 15 days.

The multiplexer/recorder shall include a SCSI-2 / USB port for archiving video to external media.

A 21” color monitor shall also be supplied along with above for viewing multiplexed / recorded video.

The multiplexer / recorder shall be designed for use as a desk top unit or may be rack mounted using an optional rack mount kit.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video Standard</td>
<td>PAL, 625 line, 50 Hz</td>
</tr>
<tr>
<td>Digital Memory</td>
<td>720H x 576 V</td>
</tr>
<tr>
<td>AGC</td>
<td>Automatic or manually adjust for each video input</td>
</tr>
<tr>
<td>Inputs</td>
<td>Camera: 8/16 inputs; 16/32 BNC connectors.</td>
</tr>
<tr>
<td>Outputs</td>
<td>min 2 composite monitor outputs</td>
</tr>
<tr>
<td>Recording</td>
<td>extremely high quality video recording for</td>
</tr>
<tr>
<td></td>
<td>15 days storing capacity</td>
</tr>
<tr>
<td>Recording modes</td>
<td>Selectable from 0.1 IPS to real time recording,</td>
</tr>
<tr>
<td></td>
<td>max recording speed 50 IPS for 16 cameras (max)</td>
</tr>
<tr>
<td>Resolution of recording</td>
<td>High, medium and low quality.</td>
</tr>
<tr>
<td>Input voltage level</td>
<td>0.5 V p-p to 2.0 V p-p, Composite Video signal</td>
</tr>
<tr>
<td>Display Modes</td>
<td>On monitor A - Full, quad and various combinations of multi-screen viewing</td>
</tr>
<tr>
<td>Features</td>
<td>P/T/Z controls with keyboard</td>
</tr>
<tr>
<td></td>
<td>Motion detection with direction sensing.</td>
</tr>
<tr>
<td></td>
<td>Programming via included software</td>
</tr>
<tr>
<td></td>
<td>Sequencing of cameras</td>
</tr>
</tbody>
</table>
- Video loss with on-screen indication
- Instant access to critical recording by alarm, time, date and camera searches.
- Display of time, date, camera number and user programmable 16 character camera title for viewing and recorded information.

Ethernet port (RJ-45) -- For network video access, shall be provided. Remote viewer software to allow simultaneous access shall be also provided.

EMC -- CE / UL certified

03.10. CCVM Monitors

The CCVM monitors will be suitable for industrial applications and compatible for the cameras. These will be of fully solid state type, modular in design, have low radiation and provide a bright, clear, well defined and high resolution picture display on the Screen.

All controls for power supply on/off, brightness, contrast, color, vertical hold, horizontal hold, etc. will be provided on the front panel behind the flip open protective cover for readily adjusting the video signal. The input and output video connectors for coupling the video input/output to other equipment, DC restoration switch and power supply connections will be provided on the rear panel. The monitor will have easy access for servicing and other adjustments.

The video monitor will be housed in a dust-proof metal enclosure with anti-dazzling light shield. It will be suitable for rack mounting / mounting on control console / ceiling hang type as per the site requirement at a convenient viewing angle.

The monitor will be designed to produce high resolution.

The monitor will have the following features:

All controls for power supply on/off, brightness, contrast, color, vertical hold, horizontal hold, etc. Provided behind the flip open protective front cover.

Automatic degaussing at power on.

Desk type/rack mountable with rack mountable kits. Quick start.
Easy access for servicing and adjustments.

Technical Parameter

<table>
<thead>
<tr>
<th>SI</th>
<th>DESCRIPTION</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model no.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picture tube size</td>
<td>21”</td>
<td></td>
</tr>
<tr>
<td>Scanning system</td>
<td>PAL</td>
<td></td>
</tr>
<tr>
<td>Horizontal resolution</td>
<td>460 TV lines (Centre)</td>
<td></td>
</tr>
<tr>
<td>Vertical resolution</td>
<td>420 TV lines</td>
<td></td>
</tr>
<tr>
<td>Video input</td>
<td>1.0 V pp</td>
<td></td>
</tr>
<tr>
<td>Input impedance</td>
<td>75 ohms</td>
<td></td>
</tr>
</tbody>
</table>

Controls
Power on/off, LED pilot light, brightness, color, contrast, V-hold, H-hold, impedance – 75 ohm/ high SW, DC restoration SW etc.

03.11 Control Console

The control console shall house matrix switcher, Keyboard, Multiplexer & recorder and other control equipments, interfacing modules required for control of complete system. The console shall be of industrial usage, dust & vermin proof. It shall be located in control room. The console shall be of pre-wired ready for installation and commissioning. Required protections and cooling arrangements shall be incorporated. The equipment shall meet IP 54.

Control of blower unit, wiper & washer unit of the water cooling jacket, temperature indication of camera and audio visual alarm indication in case the temperature violates the desired limits shall also be housed.

03.12 Video cable equalizers

The video cable equalizers will be used to compensate for high frequency losses due to long runs of coaxial cable used between the camera and video monitor.

03.13 Surge Protection

Surge protection for video, power and control signals shall be given for
cameras and associated equipment at both ends. The equipment shall protect cameras and associated equipment in case of surge. It shall be as per BS6651.

Required junction boxes and associated equipments shall be supplied to complete the installation in all respects.

Surge capability shall be of min 10kA UL /CE listed

03.14. CABLES

For connecting the control room equipment with field equipment following cables are envisaged. Co-axial cable for video signal transmission, twisted pair shielded cable for controlling cameras are envisaged.

a) Co-axial cables are envisaged for video signal transmission for cameras which are upto 500mts distance. Beyond 500 mts post equalizing amplifier shall be used.

a) Independent control and video cables are envisaged for these cameras.

b) Power cable can be looped for maximum 2 cameras only.

d) Booster amplifier shall be used wherever video signal is weak.

e) The following criteria shall be used for selection of cables.

   Power supply cable : min 2.5 sq.mm
   Control cable : min 2.5 sq.mm

While designing cable layout and selection of multi core cable the following criteria must be satisfied.

- Minimum 20% of pairs shall be considered as spare subject to min one pair.

- All cables shall be of FRLS type

03.14.01 Video Cable:

The specifications shall be as under:

Center conductor size -- 7/0.4 mm Annealed Tinned Copper (ATC)

Di-electric material -- Polyethylene (PE), White color.
Shield material -- Copper braided.
Jacket material -- FRLS PVC BLUE.
Armour -- 1.4 mm GI wire round.
Outer jacket thickness -- 1.2 mm FRLS
Outer jacket -- FRLS PVC BLUE
Nominal impedance. -- 75 ohms

03.14.02. POWER SUPPLY CABLE:

The specifications shall be as under:

No of cores -- min 3 (three)
Conductor size -- min 2.5 sq mm, 7/0.68 multi strand with standard annealed electrolytic copper conductor.
Primary insulation -- PVC insulated of 85º C PVC as IS-5831 Type C
Thickness of PVC insulation -- 0.8 mm
Color code -- Red, Black and Green
Inner and Outer Jacket -- Extruded Flame retardant and 90º C PVC to IS 5831- Type ST2
Armoring -- Galvanised Steel Wire / flat as per IS-1554 part-I

The above cables shall also have the following:

1) Fire retardant shall be as per standard IEC 332 part III Cat A.
2) The insulation grade shall be 600 V/1100 V as a minimum and shall meet insulation resistance, voltage and spark test requirement as per BS-5308 Part –III.
3) Armour over inner jacket shall be of galvanized steel wire/ flat as per IS-5544 Part I.

03.14.03. TWISTED PAIR CABLE.

No of pairs -- as required
Conductor size -- 2.5 sq mm standard annealed electrolytic copper conductor.
Primary insulation -- Low density polyethylene (LDPE)/ PE as per IS 6474
Thickness of insulation -- 0.5 mm
Pair shielding -- Aluminium backed by mylar/ polyester
Drain wire -- 0.5 sq mm multistrand bare tinned
Inner and Outer jacket  --  Extruded flame retardant and 90° C
PVC to IS 5831-type ST2

The cable shall be as per IS – 1554. Part – I.
VHF COMMUNICATION SYSTEM
GENERAL TECHNICAL SPECIFICATION

01. General
This General Technical Specification (G.T.S) covers the technical requirement of VHF communication system for expansion to 7.0Mt. of BSP under modernization.
VHF communication system is intended for instantaneous two-way radio communication amongst base station and a number of mobile/ portable hand held trans-receiver sets in the Steel plant complex.
In addition to the above hand held trans-receiver sets shall be provided with DTMF dial pad to interface with telephone exchange of the Steel plant. Telephone interface equipment shall also be provided.

02. Design Basis

02.01 The equipment shall use synthesised frequency control. The frequency channel shall be easily programmed and provide extremely stable frequency operation. It shall be possible to programme the sets upto 12 channels by use of PROM & E-PROM.

02.02 The transreceiver sets shall operate on simplex / semi-duplex mode.

02.03 All controls on the sets shall be positioned in a manner so as to be conveniently operated.

02.04 Protection against misuse and reverse battery polarity to be provided.

02.05 The equipment shall be light in weight and designed for low power consumption.

02.06 The equipment shall be weather proof rugged in construction and designed for continuous and reliable operation under adverse environmental and operating conditions of a power plant complex.

02.07 The mobile stations to be used in the cranes / moving machines shall be able to take the shocks and vibrations of these machineries.

02.08 The equipment shall require minimum of maintenance and be easy to maintain.

02.09 The transreceiver sets shall be designed for having high carrier stability with adequate suppression of spurious emission and a low distortion.
02.10 The units such as transmitter, receiver, power supply unit shall be mounted on separate PCB for ease of maintenance and serviceability.

02.11 The transreceiver sets shall have LCD display for visual indications regarding channels with back lighting for operating in a low light environment.

03. Equipment Details

The VHF radio communication systems shall comprise of the following –

- ------ Nos. fixed transreceiver sets to be used as base stations.
- ------ Nos. portable handset stations
- ------ Nos. of walkie-talkies with DTMF dial pad to interface with telephone exchange.
- Telephone interface equipment shall also be provided.
- Each of the trans-receiver stations complete with connectors, cables, power supply unit, Ni-Cd rechargeable battery, battery charger, suitable antenna units and mast / structure for the base station antennas.

03.01 Portable hand held type sets.

The trans-receiver set shall be compact, lightweight having low power consumption.

The sets shall be fully IC based, modular in nature, synthesized frequency controlled, with multi channel facility.

Each trans-receiver set shall comprise of transmitter section, receiver section, a control unit complete with all controls, microphone, speaker, built-in helical antenna and rechargeable 12V Ni-Cd battery all housed in a splash proof cabinet cast from aluminum alloy.

Each set shall be provided with a rugged leather carrying case.

The set shall have the provision for using earphone.

Technical parameters :

- Frequency range : Frequency synthesised over the range of
03.02 **Base / Mobile transreceiver sets**

The trans-receiver sets shall be fully solid state modular in design, synthesised frequency controlled, multi channel, based on the latest development in VHF communication field.

The set shall be compact, light weight having a splash proof cabinet cast from aluminum alloy. It shall have low power consumption.

Each trans-receiver set shall comprise of transmitter section, receiver section, a control unit complete with all controls, microphone, loudspeaker and antenna unit.

The base station shall be designed to work from a 240V AC mains supply. However a maintenance free battery of suitable capacity along with a charger unit shall also be considered for the base station.

The mobile stations shall be provided with a maintenance free rechargeable 12V Ni-Cd battery for power source.

**The sets shall have** -

- digital channel display.
- provision for connecting external speaker.
- provision for interfacing with telephone exchange.
- provision for selective calling facility.

The transreceiver sets shall be so designed as to be easily configured into fixed base station / mobile stations, as required. The equipment shall be supplied with full range of accessories so that it shall be suitable use as mobile / static applications.
The set shall be supplied with following accessories when used as a Fixed base station.

- Desk top type microphone assembly.
- GP antenna / Yagi antenna with RF cable & connectors.
- Power supply unit complete with battery set, charger unit and DC power cable for fixed stations.
- Mast required for the antenna unit.

The set shall be supplied with following accessories when used as a Mobile station in moving cranes / machineries.

- Fist type microphone assembly.
- Mounting assembly for mounting in vehicles.
- Antenna assembly with RF cable for mobile use.
- Earphone facility / external speaker.

**Technical parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>Frequency synthesised over the range of 134 - 174MHz</td>
</tr>
<tr>
<td>RF power output</td>
<td>25 Watt</td>
</tr>
<tr>
<td>Channel spacing</td>
<td>12.5 / 25 KHz</td>
</tr>
<tr>
<td>No. of channels</td>
<td>12</td>
</tr>
<tr>
<td>AF output</td>
<td>Minimum 1 Watt into 8 ohms load</td>
</tr>
<tr>
<td>AF distortion</td>
<td>Less than 5 % at 1 KHz</td>
</tr>
<tr>
<td>Type of operation</td>
<td>Simplex or semi-duplex</td>
</tr>
<tr>
<td>Type of antenna</td>
<td>GP/YAGI/WHIP antenna as per requirement</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0 - 55 degree Celcius</td>
</tr>
</tbody>
</table>

**03.03 Battery Charger**

Portable single phase battery charger shall be suitable for charging at least 6 nos. 12 Volts Ni-Cd batteries at a time.

The unit shall comprise a transformer provided with mains voltage tapings, full wave bridge silicon rectifiers and controlling choke. The charger shall be provided with mains isolator switch, rotary switch for selecting different charging modes, flush mounted charging current DC ammeter, supply ON/OFF indication lamp and protective fuses.

The entire assembly shall be housed in a sturdy sheet steel box having proper ventilation arrangement, terminals with insulated knurled screwed
knobs for connecting to batteries and provided with mains and battery leads and pair of battery charging clips with marked polarity.

04 Training of Purchaser’s personnel.

The tenderer shall arrange for training of purchaser’s personnel for operation & maintenance of the VHF system. It is under the tenderer’s scope. The tenderer shall give the detailed training program mutually agreed as per requirement well in advance prior to commencement of training.

05 PERFORMANCE GUARANTEE.

05.01 The Tenderer shall study the specification & satisfy himself thoroughly regarding the workability of the plant, equipment & system offered & also take full responsibility for the guaranteed operation & performance of the same as well as for their smooth, safe & reliable working.

All equipment shall be guaranteed for workmanship, materials design and satisfactory performance to the parameters in accordance with the specification document and relevant clauses of the General Condition of Contract. The guarantee for performance shall cover individual items and systems for their ratings/outputs.

05.02 The Tenderer shall guarantee the integrated operation of complete system & equipment covered in his scope as a whole including interfaces required to be established with other related system.

The Tenderer shall conduct performance/ acceptance tests on each of the major items of equipment supplied to demonstrate that the equipment and system supplied are capable of achieving the performance parameters specified and contracted for, in accordance with the General Condition of contract. The total system performance shall also be guaranteed and demonstrated.

Should the tests specified show that the equipment has failed to achieve the guaranteed parameters, the supplier shall carry out necessary modification or part replacements to achieve the guaranteed parameters & successful demonstration the tests shall be repeated without any extra cost to the purchaser.

06 INSTALLATION OF EQUIPMENT, TESTING & COMMISSIONING.
06.01. The Tenderer shall be fully responsible for the satisfactory erection, installation, testing & commissioning, start-up & performance test of the V.H.F equipment and its associated cable network.

06.02. The Tenderer shall furnish with his tender the particulars of the license held by him / the sub vendor he proposes to engage for carrying out the installation work against this specification.

The Tenderer shall furnish to the purchaser / consultant, the names and particulars of the certificate of competence of the supervisors and workmen to be engaged for carrying the installation work against this specification.

06.03 All erection, testing & commissioning work shall be carried out in accordance with the requirement specified in this tender document, the standard recommended practice and best workmanship. All electrical work shall also comply with standard norms and practices adopted by the purchaser and representative state / Central Govt. authorities.

06.04 For complete erection, testing & commissioning, the Tenderer shall bring all insulation aids / materials, consumables, tools, test equipment, qualified & experienced personnel, in order to carry out the job successfully. A list of the same shall be furnished to the purchaser for review.

All technical personnel assigned to the site by the Tenderer must be fully conversant with the system hardware & software.

06.05. The Tenderer shall provide and maintain an office at the site during installation, testing and commissioning stage for his staff. The Tenderer shall make his own arrangement at his own cost for the transport of his staff and labour to and from the site of works. Appropriate storage of the materials to be supplied will be arranged by the Tenderer at the site. The Tenderer’s responsibility shall also include safety and security of the equipment at site.

06.06. On completion of erection & installation of all equipment, & before start up, each item of the system shall be jointly inspected by the purchaser and the Tenderer for correctness and completeness of the installation and accessibility to start up leading to commissioning tests.

The list of commissioning tests to be performed shall be mutually agreed upon and included in the Tenderer’s Quality Assurance Plan (QAP).

The commissioning spares for all items / equipment shall be included along with the commissioning services. The consumables required during the commissioning of the system shall be included as part of the commissioning
spares. Requisite factory & site test reports shall be supplied by the Tenderer.

06.07 The Tenderer's scope for testing and commissioning shall also include

Provision of all necessary measuring instruments / test equipment.

Preparation of final commissioning report.

Conducting Preliminary Acceptance Test (PAT) & Final Acceptance Test (FAT) and attending rectification of all points raised during all above tests.
PLANT TELEPHONE CABLES & ACCESSORIES.
GENERAL TECHNICAL SPECIFICATION

1.0 General.

This General Technical Specification (GTS) covers the technical requirement of Telecommunication cables & accessories for B S P 7.0 Mt. expansion.

1.1 SCOPE OF WORK:-

The scope of work includes complete design, engineering, supply, storage at site, erection, installation, laying of cables, testing, and commissioning of PLANT TELEPHONE CABLES & ACCESSORIES. The system described in this specification & handing over the system in ready to switch on condition to purchaser on TURN KEY basis.

The scope shall broadly cover the following and also shall include such of those items and accessories not mentioned here but required for satisfactory operation of the system.

The scope of work of the bidder shall start from subscribers side of Main Distribution Frame (MDF) of Small Auto Telephone Exchange (SAX) to the telephone hand set in side the shop premises including jumpering of cables.

The integrated cable network for the shop shall be designed by the shop package tenderer keeping 50% spare cable pairs and will terminate all cables in a cabinet / Distribution box (D.B). From this cabinet / D.B the shop package tenderer shall bring the cables to subscriber side of M.D.F of the SAX for the concerned shop including jumpering of cables in the M.D.F.

The shop package tenderer shall work in co-ordination with the centralized package tenderer. However the Telephone exchange (SAX) & telephone hand shall be provided by the inter plant package contractor / purchaser. Telephone connections shall be provided at each room of the office building, shift offices, Control rooms, ECRs, MCC’s, laboratory etc.

1.2 This specification forms part of the tender documents and shall be read in conjunction with the general conditions of contract (GCC) and other documents enclosed with Notice Inviting Tender. Purchaser’s decision shall be final in case of conflict between stipulations under various documents.

1.3 Preparation and submission of drawings like bill of materials, technical data sheets etc. complete in all respects for Purchaser/Consultant’s approval / comments.
Submission of drawings & documents, technical catalogues, test certificates etc.
The components and materials used and the equipment supplied shall conform to high standards of design, engineering and workmanship and shall be suitable for efficient operation and reliable service in steel plant conditions.

2.0. TESTS

All cables shall be fully tested in accordance with the relevant clauses of the applicable standards.

Type test certificates shall be submitted to the Purchaser for all cables as stipulated in the relevant standard. Type tests shall be carried out as per the relevant standards in the presence of Purchaser’s representative for those items stipulated in the Technical Specification/data sheet and agreed with the Purchaser to ascertain compliance.

Routine tests as per relevant standards shall be carried out on all cables in the presence of Purchaser’s representatives at manufacturers works. In all the cases, test certificates shall be submitted. No cables or other materials shall be dispatched unless the test certificates are accepted by the Purchaser.

2.1 GUARANTEE

The tenderer shall stand guarantee for the trouble free operation and satisfactory performance of all the cables supplied by him as per GCC. The material used shall be new and best of its kind available and shall conform to relevant latest Indian standards.

The guarantee shall also cover faulty design or materials or workmanship. The supplier shall do all rectification or replacement under the guarantee free of cost.

The supplier will replace cables without any cost implication to purchaser in case of any failure during testing and commissioning.

The supplier shall replace the wrong/defective cables supplied by them, missing items (observed during inspection at site after receipt of materials) or any damages caused to cables during transportation free of cost after receipt of information from the Purchaser. In case of any dispute, decision of purchaser shall be final. The supplier shall depute his representative to site for replacement/rectification work without any extra cost to purchaser.
2.2 MAKE OF CABLES.

Refer separate document for Vendors./ As per approved vender list of BSP.

2.3 TECHNICAL SPECIFICATION OF CABLES.

Telecommunication cables

All cables shall have copper conductor. Each conductor shall consist of 0.51 m.m dia. & 0.63 m.m dia. solid wire of annealed high conductivity copper, twisted in pairs, fully filled with petroleum jelly. The cables shall conform to the latest edition of the standard specification.


i) Telephone cable of polythene insulated fully filled with petroleum jelly, polythene sheathed Poly-Al. Moisture barrier with another polyethylene sheath, armoured with two numbers of galvanised steel-tape over abedding of water proof cotton tape complying with P&T specification ITD, S/WS-129D, ITD, S/WT-143B.

ii) Telephone cable 0.51m.m dia annealed Copper conductor PVC insulated, screened, PVC sheathed, unarmoured & overall PVC jacked.

iii) Telephone distribution Box of different size.
iv) Erection accessories.
GENERAL SPECIFICATION

2.0 : INSTRUMENTATION AND CONTROL SYSTEM
# General Technical Specification

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01. GENERAL

01.01 This specification broadly covers the basic features & requirements comprising design, engineering, selection criteria, supply, installation guidelines & practices to be followed for all field & control room mounted instrumentation and control devices & systems required for various shop units of the plant. Adequate and latest state-of-art technology based Instrumentation and control system shall be provided for all the shops/units of the plant, with a view to achieve safe, reliable, efficient and trouble-free operation of the plant, as well as safety of the plant equipment and operating personnel.

01.02 Instrumentation & control equipment shall conform to the Bureau of Indian Standards (BIS) / Inter Plant Standardisation in Steel industry (IPSS) / International Electro-Technical Commission (IEC) / Instrument Society of America (ISA)/ DIN / BS / JIS and other reputed internationally accepted standards as applicable, unless otherwise specified in the Technical Specification for Tender.

01.03 This specification, together with all other norms and standards, referred to herein or considered applicable as per good engineering practices, shall cover the principles of design, engineering and implementation of instrumentation & control systems for various shop units of the plants. This specification will be the main guiding and deciding document and can be over ridden only by a Client standards in very specific cases or particular requirements, indicated if any in the main technical specification of the tender document.

01.04 Instrumentation & control equipment shall comply with the Indian Electricity Rules, 1956 along with their latest amendments regarding safety, grounding and other required stipulations specified therein for installation and operation of electrical systems in the plants.

01.05 All the Instrumentation & control equipment shall conform to the safety requirements stipulated in relevant BIS ég, IS: 9858-1981 on Safety requirements of electronic measuring apparatus, IS 516-1981 on Safety requirements of mains operated electronic apparatus, IS 3945-1978 on Specification of electrical instruments for hazardous atmospheres, etc. All the equipment shall be suitably protected from voltage surges, Electro Magnetic Interferences, Radio Frequency Interferences and also from Lightning, in specific cases. Wherever Indian standards are not available, IEEE, ISA, NEMA standards shall be applicable.

01.06 All equipment to be supplied and all work to be performed including system design and engineering, shall comply with the statutory requirements of Government of India and the State Government.
02. ENVIRONMENTAL SPECIFICATION

All instrumentation & control equipment and their accessories, including those to be used in air-conditioned control rooms, shall be rugged, industrial grade and suitable to withstand the operating conditions in the plant and atmospheric conditions.

These equipment shall be suitable for operating continuously under the environmental conditions indicated below:

<table>
<thead>
<tr>
<th>Field instruments</th>
<th>Control room instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>0 – 60°C</td>
</tr>
</tbody>
</table>
| Relative humidity | 0 – 95%                   | 0 – 80 % (non-condensing).

The enclosure protection class for various instrumentation & control equipment shall comply with the guidelines indicated in IEC/EN 60529/IS: 13947, Part-1, 1993. Generally, the following protection classes for panels, consoles, desks etc. shall be followed as a minimum:

i) Air-conditioned control rooms : IP 22

ii) Indoor non-air conditioned areas:

   a) Ventilated areas : IP 42
   b) Non-ventilated areas : IP 54

iii) Outdoor areas : IP 65

All field devices shall be rated for minimum IP 65 protection class.

03 BASIC DESIGN CONSIDERATIONS:

03.01 General

The instrumentation & control system equipment shall be adequately designed to monitor and control all significant variables in accordance with the process & operating requirements along with process/ safety interlocks & alarms for abnormal conditions. The system shall be designed to ensure that the accuracy of instruments and the overall system accuracy meet the process requirements.

Design & selection of instrumentation & control system shall take care of the following features as a minimum:

1. Latest state-of art and proven technology
2. High accuracy, reliable performance, easy expandability, modular design.
3. Standardisation of items & makes for maximizing interchangeability and minimizing inventories.
5. Easy maintainability and diagnostic features.
6. Fail safe features.
7. User friendly testing & calibrating facilities in both local & remote mode.
8. Flexibility for carrying out maintenance work with the process on.
9. Generally Foundation field bus based field instruments shall be considered. Wherever, not applicable, two-wire, true Smart type transmitters, generally
operating on 4-20 mA DC having HART signal super imposed with 24 V DC power supply or field bus based as applicable.

10. For all instrumentation signals, open architecture based Automation system with facility for Foundation field bus/ Profbus interface shall be considered, which shall be interfaced to Level-1 automation network at HMI level.

11. Fail safe features.

12. Safety to plant equipment and operating personnel.

13. Sustained availability of spares & consumables for at least 10 years.


15. Provision for future expansion in design & selection, e.g. sizing of final control elements, flow sensors, space inside the control room, space on the panels/cabinets/desks etc.


17. Final control elements with electric, pneumatic, hydraulic or hybrid actuators depending on application requirement. Final control elements with local valve position indicators and valve position transmission to control room.

18. Steam, nitrogen, water or compressed air lines for purging and cleaning purposes, wherever necessary.

19. Dual redundant devices for measurement & control of critical parameters.

20. Uninterruptible Power Supply (UPS) system.

21. Calibration/ configuration of both HART based & Field bus based transmitters from DCS/PLC & through hand held calibrator.

22. Hand held calibrators shall be provided with adequate memory capacity & device description of all HART certified devices loaded therein. The calibrators shall be supplied with precision 250 ohm resistances.

23. All recorders shall be 12-channel high speed chart-less type with SVGA/TFT screen and multiple display formats. It shall be possible to download into DCS/ PLC from these recorders. Recorder shall be provided with Ethernet connectivity. For this purpose, necessary software shall be provided by the recorder manufacturer. Recorder shall also have USB port for transporting data by pen drive.

24. All instruments shall have standard ranges. Ranges for indicators shall be selected so that normal value shall be indicated in the middle third of the scale.

25. In hazardous area applications, electronic/electrical instrumentation equipment shall be suitable for hazardous area classification as per IEC. These equipment shall be intrinsically safe conforming to CENELEC standard and certified by appropriate statutory bodies (FM, BASEFA etc.). Intrinsically safe systems shall be designed using zener/ IS barriers. Where intrinsically safe design is not feasible, ex-proof equipment/enclosure, certified by statutory bodies like CMRI Dhanbad/ CCOE Nagpur shall be supplied. Other acceptable safety procedures (e.g. increased safety procedure, pressurisation etc.) shall be used, wherever
applicable. Required documentation/certificates shall be submitted in conformance with all such features.

26. All transmitters shall have built-in digital output indicators calibrated in engineering unit of flow, pressure, level, temperature, differential pressure etc.

27. Flow switches shall be electronic type.

28. Isolator cards shall be provided for isolation of instrument signals, wherever necessary.

29. Transmitters in the field shall be housed inside transmitter cabinets.

30. All field-mounted instruments shall be of suitable weatherproof construction, as per details indicated for respective items.

31. Temperature sensors shall be with SS head, covers & SS chain

32. Wetted parts of the instrumentation equipment shall be selected so as to withstand physical and chemical properties of the service fluid coming in direct contact with the instrument.

33. Colour codes for pipelines, cables, lamps, and panels shall be followed for the plant as per industry/plant standard.

34. All the manufactured/fabricated items / impulse pipes & fittings shall be properly painted as per requirement & standard practice, depending upon nature of environment in which these are to be installed. Selection of primer and finish paint shall be done as per relevant IS standard or equivalent international / industry standards.

35. All impulse lines shall be SS pipes/tubes of appropriate ratings as per ASTM A269 standards. Tubes valves, manifolds & fittings shall be of Swagelok/ Parker make.

36. All fittings & accessories shall be new & rust protected. All flanged type instruments shall be supplied with companion flanges, nuts, bolts & gaskets.

37. Instruments used on oxygen lines must be oil and grease free and shall be marked ‘for oxygen use’ and colour coded blue.

38. Whenever corrosive atmosphere is present, all instruments and associated equipment exposed to such a medium shall be designed & protected to withstand the adverse effects.

39. Wherever instrumentation equipment is installed underground, suitable approach, sufficient space for maintenance, drainage, ventilation and illumination shall be provided.

40. All instrument ranges shall be standardized over the whole plant for local and remote instruments by the expression 
\[
(1, 2, 4, 6, 8, 10, 12, 15, 50) \times 10^n
\]
where \( n = 1, 2, 3, \) etc.

41. Necessary certificates from appropriate authorities shall be submitted for all applicable items regarding their suitability & installation.

42. Continued availability & supply of Instrumentation & control equipment including their spares parts & consumables shall be guaranteed for a minimum period of 10 years.
43. In case, Instrumentation & control equipment are supplied from foreign sources / manufacturers, care shall be taken to select only those vendors who have competent associates/ partners / representatives in India with ability to provide required technical support & after sales service.

03.02 Temperature Measurements

1. The following types of primary sensing elements shall be used, depending on temperature of process fluid & application requirements:

   i. Pt-Rh 13% / Pt (ISA Type “R”)
   ii. Pt-Rh 10% / Pt (ISA Type “S”)
   iii. Pt-Rh 30% / Pt-Rh 6% (ISA Type “B”)
   iv. Chromel – Alumel (ISA Type “K”)
   v. Chromel – Constantan (ISA Type “E”)
   vi. Copper – Constantan (ISA Type “T”)
   vii. Iron – Constantan (ISA Type “J”)
   viii. RTD (Pt 100)
   ix. Radiation Pyrometers

2. RTD shall generally be used for measurement in the temperature range of -200°C to 300°C and thermocouples for higher temperatures.

3. For control application or wherever duplication of temperature signals are required, microprocessor based temperature transmitters shall be used.

4. RTDs shall usually be three-wire type. Four-wire type RTDs shall be used, whenever specifically required.

5. For differential temperature measurement by RTDs, Pt-1000 elements shall be used.

6. Temperature transmitters or secondary instruments used with thermocouples, shall have automatic cold junction compensation. All temperature transmitters shall be SMART type. HART/Field bus compatible, as applicable. Enclosure class of temperature transmitter shall be IP 67 for field mounted transmitters.

7. Resistance thermometers (RTD) shall be used for cryogenics and low temperature applications, in general.

8. Thermocouples shall normally be mineral insulated (i.e., extruded MgO) type. However, for applications exceeding 1100°C, lead type ceramic insulation shall be provided. Ceramic insulation shall be of recrystallised alumina (Al₂O₃, 99.7%) as per DIN VDE 0335.

9. Thermocouple assembly shall be spring-loaded to ensure positive contact with thermowell.

10. Measuring junction of thermocouples shall be grounded or insulated depending on the type of electric system or safety protection requirement.

11. Separate conduits or cable entries shall be provided where duplex thermocouples are used.

12. Thermocouple calibration shall be in accordance with IS, DIN, IPTS or equivalent standard:
13. For Pt-Rh / Pt thermocouples, Linearisation shall be done in temperature transmitter or in DCS/PLC, as applicable.

14. Thermowells fabricated out of bar stock having sufficient mechanical strength shall be provided to enable maintenance work of thermocouple / RTD without affecting production.

15. AISI 316 shall be used as thermowell material, unless other special material is required due to process fluid and conditions. For temperature range between 800°C – 1100°C, Inconel 600 shall be used as thermowell material. For temperature more than 1100°C, ceramic thermowell shall be used. Ceramic material shall be selected based on the process environment.

16. Any pipe of less than 4” nominal diameter, shall be expanded to 4” size to install thermowell.

17. Thermocouples shall be complete with compensating leads, installation fittings. The indicators, controllers shall have broken sensor protection.

18. Interconnections to / from thermocouples to temperature transmitter shall be made via compensating cables of thermoelectric characteristics matched with thermocouple.

19. Bimetallic type thermometers having minimum dial size Φ150mm shall be used for local indication of temperature. Temperature gauges with smaller dial sizes may be used for machine mounted applications.

20. For bimetal type thermometers, external dial reset facility shall be provided for zero adjustment.

21. Capillary tubes, wherever used, shall be of stainless steel material with flame-proof PVC, neoprene or steel armour, as suitable for the application.

22. In case, compensating leads are to be laid on the top of the furnace /hot surface, these shall be asbestos covered with mesh shielding or other suitable insulating materials. Mineral insulated cables shall also be used for such applications.

23. Compensating cables connected to transmitters shall not be through terminal blocks but shall be directly connected.

24. Junction boxes for connecting compensating cables shall have terminal blocks suitable for type of thermocouples to be connected.

25. A protection tube consisting of a gas-tight ceramic sheath, preferably reinforced with stainless steel, shall be provided with Pt-Rh/Pt thermocouples, unless some other special construction is specified.

26. Radiation pyrometers shall be used when:

1. Measured temperature is beyond the practical operating range of thermocouples.

2. Environment will contaminate or seriously limit the life of the thermocouples.

3. Target is not easily accessible.

4. Average temperature of a large area is to be measured.
27. Normally, the radiation pyrometer shall respond to 98% of the target temperature.

28. Radiation pyrometers shall be provided with scavenging air or nitrogen to keep their lens clean and shall be water-cooled or air-jacketed when the surrounding temperature exceeds 50°C.

29. Pyrometer for critical application shall be with water cooled facility with sensing of low flow condition by flow switches as well as automatic shut-off of pyrometer in case of failure of cooling water.

30. Isolation valve shall be provided before radiation pyrometer for on-line maintenance of radiation pyrometer.

03.03 Molten Steel Temperature Measurement

1. For molten steel temperature measurement, disposable type immersion thermocouples having response time of less than 3 seconds shall be used. The corresponding temperature measurement system shall be complete with lance assembly, adapter, disposable thermocouple cartridge and two-way connector for the lance.

2. For immersion type hot metal / steel temperature measurement, shielded flame proof and heat resistant compensating cables shall be provided.

3. Temperature measurement system shall be microprocessor based.

4. Linearisation shall be provided for B, R & S type thermocouple shall be done in microprocessor based temperature measurement system.

5. 4–20 mA analog output for the measured temperature shall be provided for hooking up to DCS /PLC.

6. 4-½ digit type digital indication shall be provided in the temperature measurement system panel. This digital indicator shall retain the last value until the next measurement cycle is initiated by inserting the thermocouple probe in the lance.

7. One printer shall be provided in the temperature measurement panel for printing the measured temperature along with the heat no. Heat no. will be down loaded to the measurement system from DCS/PLC through RS 232C/ RS 422/ RS 485 link.

8. Ready, measurement and measurement complete/ probe open signals shall be displayed in the measurement system panel with green, yellow and red LED indication.

9. In the field, one local control box, 200 mm jumbo display for temperature indication and red, yellow and green lights for measurement complete/ probe open signal, measurement and ready status display shall be provided. Measurement complete/ probe open shall also be indicated by blowing horn.

10. Power isolation switch at local control box end shall be provided.

11. 24 V DC signals and 230 V AC signals shall be segregated in the local control box and microprocessor based temperature measurement system panel.

03.04 Flow measurement

03.04.01 For Fluids:
1. Normally orifice plates, magnetic flow meters or vortex flow meters shall be used for flow measurement of industrial service fluids, depending on the merit of the application. Positive displacement, turbine and Coriolis flow meters shall be used in custody transfer measurements and in processes, where high measurement accuracy is required. However, other types of flow meters may also be used when necessitated by particular technical requirements.

2. Vortex flow meters shall be generally be used for steam/gas service, upto 8” line size.

3. Magnetic flow meters shall be generally used for water & fluids having conductivity greater than 5 µS/cm.

4. Coriolis type mass flow meter shall be used for all viscous materials (tar pitch etc.) and for inert gas (argon, nitrogen etc.) applications of line sizes upto 2”.

5. Vortex Flowmeters shall be used for inert gas flow metering for line sizes > 2”

03.04.03

Differential pressure type devices

1. Normally, concentric square-edge type orifice plates shall be used.

2. For better accuracy, the Beta (β) ratio of concentric type orifice plates shall not preferably exceed 0.6. However, in no case, β shall exceed 0.7.

3. Minimum thickness of concentric square-edge type orifice plate shall be as follows:-

<table>
<thead>
<tr>
<th>Line Size</th>
<th>Minimum Thickness</th>
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</thead>
<tbody>
<tr>
<td>2 to 12” (i.e., 50 to 300 mm)</td>
<td>3.18 mm</td>
</tr>
<tr>
<td>14” to 36”</td>
<td>6.35 mm</td>
</tr>
<tr>
<td>Above 36”</td>
<td>10.0 mm</td>
</tr>
<tr>
<td>For temperature &gt;316°C</td>
<td></td>
</tr>
<tr>
<td>2 to 8” (50 to 200 mm)</td>
<td>3.18 mm</td>
</tr>
<tr>
<td>10” &amp; above</td>
<td>6.35 mm</td>
</tr>
</tbody>
</table>

4. Quarter-circle and conical entrance type orifice plates shall be used for viscous fluids.

5. Eccentric or segmental type orifice plates shall be used with dirty fluids.

6. Flow nozzle, venturi or averaging pitot tube may be used in high flow applications or where the allowable pressure-drop is low.

7. All orifice plates shall normally be made of AISI 316 material, unless otherwise called for by process requirement.

8. Generally flange tappings shall be used. However, corner or D & D/2 type tappings can be used as per requirement.

9. For line sizes between 1” to 2”, carrier-ring type orifice plate with corner tapping shall be used.

10. For line sizes less than 1”, integral orifice plate shall be used.

11. For line sizes greater than 2”, orifice plate with flange tapping shall be used.
12. In dirty/ contaminated process lines or process lines where line pressure is low (in mm WC range) & line size is large, D & D/2 tappings shall be used.

13. All orifice plates shall be fabricated with a collar, which shall extend outside the mounting flange.

14. Tag no., orifice plate bore diameter, upstream (+) and downstream (-) side marking, and plate material shall be engraved on the handle of the orifice plate.

15. Flanges shall be in accordance with ANSI B16.36 and of minimum Class 300 rating upto line size of 24". For line sizes above 24", flanges in accordance with IS 6392, and of suitable rating shall be used.

16. Tag no., flange size, flange rating and flange material shall be engraved on all flanges.

17. Gasket material for orifice plates shall be suitable to withstand physical and chemical properties of process fluid and shall be matched with the pipeline standard, as required.

18. Supply of orifice plate assembly shall include the orifice plate, flanges, stud-bolts, nuts, jackscrews, gaskets, pressure tapping nozzles and plugs.

19. Drain / vent hole correction shall be as per ISA RP 3.2.

20. Orifice plate or flow nozzle shall be installed as per standard, but not less than with straight pipe lengths of 10 times pipe internal dia. (10 D) on the up stream and 5 D on the downstream, free from bends, tees, branch pipes and control valves, etc. Upstream and downstream straight pipe lengths shall be as per section 1.1 of BS 1042. 1981 and also on the guidelines of ISO: 5167, 1997.

21. Control valves shall be installed after the orifice plates in the direction of flow.

22. All flow meters shall have drainage valves except for oxygen service.

23. Corrosive media shall be separated from transmitters by separating chambers with valves for isolation.

24. For steam flow and flow of liquid at temperature greater than 120°C condensation chambers of identical dimensions shall be used. Condensation chambers shall be installed as near to flow sensor as possible.

25. Depending on specific requirements/applications, averaging pitot tubes with multiholes (eg. Annubar type) placed in the direction of fluid stream may also be used. The calculations and design shall be as per manufacturer’s standard.

26. IBR certification shall be provided for steam and vapour applications, as per IBR standard.

27. All flow meters on inter plant pipes for gas balance system shall have an accuracy of 0.5% f.s.d. or better.

28. In contaminated water lines / gas / orifice plates shall be installed in bypass line with isolation valves. So that on-line maintenance shall be possible.
29. Generally, metal tube type rotameters shall be used. Glass-tube enclosed type rotameters may be used up to 3 kg/cm² process pressure, if the process fluid is air, inert gas or water.

30. For line size greater than 2”, bypass type rotameters shall be used, instead of on-line mounted type rotameters.

03.04.04 **For solids:**

1. Generally, flow measurement of solids in powdered, amorphous or granular form shall be done using ultrasonic type or load-cell based weigh-hopper type or nucleonic type sensors, depending on the merit of the application.

2. For measurement of mass flow of suspended solids in liquids or slurries, nucleonic type instruments shall be used.

03.04.05 **Vortex flowmeters:**

For selection of vortex flow meters, following to be taken into account:

1. Reynold’s no. shall be at least 20000 and minimum flow velocity shall be as specified by manufacturer.

2. Vortex flow meters shall not be considered in wet gas application.

3. Vortex flow meters shall not be considered for viscous, waxy or erosive services.

4. For gas application, the bluff body shall be in horizontal position to avoid condensate and for liquids in vertical lines the flow shall be upwards to keep the line full.

5. A location with minimum pipe vibration shall be selected. The pipe shall be supported at both ends, as necessary.

6. If pressure and temperature compensation are required for gas flow application, the pressure tapping shall be placed as close as possible to upstream of flow meter. The temperature tapping point shall be located at least 5D on the downstream of flow meter.

7. Straight length requirement shall be as specified by manufacturer. If meter size is smaller than the line size, concentric pipe reducers shall be used. Eccentric reducers shall not be used as they disturb the flow profile.

8. All vortex flowmeter shall be SMART type with HART protocol. Local display of vortex flowmeters shall be calibrated in engineering unit.

9. Accuracy of the vortex flow meter shall be ± 1% or better.

10. Sensing technique of the vortex flow meter shall not be thermistor based.

11. Necessary calibration unit for checking the electronic unit of vortex flow meter shall be provided.

12. Enclosure class of vortex flow meter shall be IP 67.

03.04.05 **Electro - magnetic flow meters:**

1. Selection of Electromagnetic flow meters, shall be decided based on the following:

   All electro-magnetic flow meters shall be SMART type. Electro-magnetic flow meters, which are to be installed in the control, alarm & interlocking circuits, shall have 4-20 mA DC output with HART signal superimposed on it. Electro-magnetic flow meters, which are to be installed in the furnace cooling water monitoring circuits (not in control, alarm or interlocking circuits), shall be Field bus compatible.

   Liner material shall be selected based on service. Generally, for liner material PTFE shall be used.

   If gases are entrained in the liquid, meter shall be installed in vertical process line.
While installation it shall be ensured that flow tube is always completely filled with liquid.

Straight length requirement of minimum 5 D in the upstream and 3 D in the downstream shall be provided for water services. However, for other services it shall be designed as per manufacturer’s recommendation.

Installation of electromagnetic flow meters shall be avoided near large conducting surface e.g. metal surfaces. (Large surface may interfere with magnetic field of instrument thus affecting accuracy).

Pulsed DC excitation shall be provided for field excitation of Electro-magnetic flowmeter. Power & signal circuits of electro-magnetic flowmeter shall be completely isolated from each other.

Minimum one no. of grounding ring for metallic pipelines and minimum two nos. of grounding rings for non-metallic pipelines shall be used for installing the electro-magnetic flow meter.

Selection and sizing of electro-magnetic flow meters flow characteristics published by the manufacturers shall be followed. Allowable flow velocity shall be considered based on the specific merit of the service, allowable pressure drop, cost effectiveness and as per manufacturers recommendation. However, 2 to 3 meter/ sec flow velocity shall be considered for optimum results.

In case tube sizes are lower than the process pipelines reducers and expanders constructed preferably from the same as pipeline material shall be used. Such reducers and expanders shall be designed with 8(eight) degree downward and 5(five) degree upward angle respectively.

Accuracy of electro-magnetic flowmeter shall be ± 0.3% or better. Local display shall be calibrated in engineering unit.

In contaminated water lines, electro-magnetic flowmeter shall be installed in bypass line with Isolation valve.

Sensor & transmitter of the electro-magnetic flowmeters shall separated in all cases.

Electro-magnetic flowmeter shall be provided with built-in auto zero facility for ensuring stable zero point.

Separate earthpin shall be provided exclusively for earthing of electro-magnetic flowmeters. Preparation of such earthpins shall be governed by the general methodology as described in IS: 3043, 1987 or relevant international standards.

Necessary calibration unit for checking the electronic unit of electro-magnetic flowmeter shall be provided.

Enclosure class of electro-magnetic flowmeters shall be IP 67.

03.04.06 Coriolis mass flow meters:

For selection and sizing of coriolis type flow meters, following shall be taken into account:

1. If required flow rate cannot be handled by one meter, two or more meters can be used in parallel.
2. Selection of wetted part materials shall be carefully chosen to suit process fluid.
3. SS shall not be used for liquids containing Halogen. Hastelloy tubes shall be used for all application containing Halogen.
4. Coriolis mass flow meters shall not be used in two-phase fluid application.
5. Pressure drop across flow meter shall be selected, ensuring no cavitation occur under any process condition.
6. Flow meter support shall be as per manufacturer’s recommendation.
03.04.07 Ultrasonic flow meters:

For selection of Ultrasonic flow meters, following to be taken into account:

1. Ultrasonic flow meters shall be used in clean liquids and gases.
2. Ultrasonic flow meters shall be used where pressure drop is not allowed.
3. On critical services Ultrasonic flow meters with insertion probes shall have retraction mechanisms to allow on stream maintenance.
4. Clamp on type shall only be used for liquid metering.

03.04.08 Turbine flow meters.

1. Turbine meters for custody transfer shall have two pick-up coils for use with an electronic pulse integrity input circuit in read out system.
2. Turbine type meters shall have flanged connections
3. Strainers shall be provided immediately upstream of turbine meters
4. In liquid service, adequate filtering and degassing shall be provided.

03.04.09 PD meters :

1. Positive displacement type meters shall have flanged connections.
2. PD meters shall not be selected for use in non-lubricating liquids e.g. LPG.
3. Strainers shall be provided immediately upstream of PD meters.
4. In liquid service, adequate filtering and degassing shall be provided.

03.05 Pressure measurement :

1. Either bourdon tube (spiral or helical), bellows or diaphragm type sensing element shall be used in pressure gauges/ switches, depending on the process service.
2. The pressure gauges shall be designed in accordance with IS: 3624, 1987.
3. Pressure gauge accuracy shall be ±1.0% of span or better. Accuracy shall include the combined effect of linearity, hysteresis and repeatability.
4. The element and other wetted part materials of pressure gauges/ switches shall be of AISI 316, unless process media necessitates use of other materials.
5. Movement material of gauges shall be of AISI 304. Outer casing and bezel material shall be either made of die cast aluminium with epoxy coating.
6. Pressure gauges shall have external zero adjustment facility and minimum IP55 housing.
7. The sensing element of pressure gauges/ switches shall withstand the specified over-pressure (i.e., at least 125% of span) for at least 30 minutes, without affecting their elastic characteristics.
8. Pressure gauges shall have dial size of 150 mm diameter. Gauges of smaller dial size may be used for machine mounted applications.
9. Pressure gauges/ switches used in pulsating pressure applications (e.g. delivery side of pumps, compressors, etc.) shall be provided with externally adjustable pulsation dampener or snubber.
10. Wherever the process temperature exceeds 70°C, pressure gauges/switches shall be equipped with pigtail syphon of the same material and schedule as the process pipeline.

11. Wherever the process pressure exceeds 50 kg/cm², solid front type pressure gauges shall be used (i.e., a metal partition shall be provided between dial and element).

12. Window material of the pressure gauge shall be of shatterproof glass.

13. For pressure measurement in slurries, viscous and corrosive fluids, diaphragm seals of suitable material shall be provided along with pressure sensing devices. Diaphragm seals shall be integral with the gauges/switches, unless otherwise specified.

14. The sealing liquid for diaphragm seal shall be an inert liquid compatible with process fluid and its temperature.

15. Depending on process application, suitable chemical seal along with capillary of required length shall be provided.

16. Diaphragm seal type pressure gauges/switches used in applications where the temperature exceeds 100°C, shall have bourdon/bellows type element. The bourdon/bellows shall be selected to withstand temperature upto 200°C.

17. However, in vacuum service, if the temperature exceeds 200°C, diaphragm seal shall not be used.

18. The working range of pressure switches shall be selected in such a way that the set pressure is between 35% and 65% of the range.

19. The switch enclosure shall be weatherproof to IP 65. Additionally, in hazardous areas, switch enclosure shall be explosion-proof conforming to IS: 2148: 2004/IEC 60079-1:2001 and suiting to the area-classification of the hazardous area.

20. Dry contact type micro switches with minimum rating of 240V AC, 5A / 110VDC, 0.4A shall be used for pressure switches in non-hazardous area applications.

21. In hazardous areas, hermetically sealed micro switches with minimum rating of 240VAC, 5A / 110VDC, 0.25A shall be used.

22. Pressure switches shall have an accuracy of at least ±2% of span and repeatability of at least ±1% of span.

23. Accuracy of DP gauges shall be ±1.5% of span. Accuracy shall include the combined effect of linearity, hysteresis and repeatability.

24. Pressure gauges shall be supplied with three-way gauge cock. DP gauges shall be supplied with 3-valve manifolds of AISI 316 material of suitable pressure and temperature rating. The above items shall be in addition to the process isolation valves/root valves at the process tapping point.

03.05.01 Transmitters

1. Pressure, flow, differential pressure and level transmitters shall be rugged, industrial, microprocessor based ‘Smart’ type. Transmitters shall work on 24 V DC
power supply having 2-wire, 4-20 mA DC output & ‘HART’ protocol based digital communication.

2. Accuracy of all transmitters shall typically be 0.1% or better, of calibrated span for turn-down ratio of minimum 10:1 and rangeability of 100:1. Accuracy shall include the combined effects of linearity, hysteresis and repeatability. In any application, the worst case error (WCE) consisting of static pressure effect, temperature effect, humidity effect and stability (1 year) shall not be greater than 0.75%, unless specified otherwise. Zero and span adjustments shall be non-interacting to each other.

3. Transmitters shall be suitably compensated against any thermal effects in the process medium.

4. Transmitters shall be able to withstand a minimum over pressure of 150 % of the rated pressure.

5. All the transmitters shall be weather-proof to IP-67.

6. Zero suppression & elevation features, built in surge protection and provision for selection of different damping levels shall be provided in each transmitter. Absolute pressure transmitters shall have provision for compensation of barometric pressure.

7. All transmitters shall have integral local linear digital indicators calibrated in engineering unit. DP transmitters for flow applications shall have built-in square root extractors. Local indications shall be adjusted / calibrated through hand held calibrator.

8. Power supply effect on transmitters shall be less than ± 0.05 % of calibrated span/10 V.

9. Pressure transmitters shall be supplied with 2-valve manifolds of AISI 316 material. Flow, DP and level transmitters shall be supplied with 3-valve manifolds of AISI 316 material having suitable pressure and temperature rating. Standard zero suppression / elevation facilities and output reversal facility shall be available for all transmitters. All the required accessories for mounting shall also be supplied with the transmitters.

10. All transmitters shall be provided with traditional mounting arrangement along with manifolds

11. One hand-held calibrator with required software, rechargeable battery and battery-charger shall be supplied for calibration checks of the transmitters.

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**03.06 Level Measurement**

**03.06.01 General**

Selection of primary elements shall be based on the service conditions. A general guideline is given below. However, selection of particular type of sensor shall be decided on the basis of application requirement.

1. For Liquid Service
   1. Pressure / differential pressure type level transmitter with/without diaphragm seals
   2. Float or Displacer type level transmitters
   3. Ultrasonic type
4. Radar type  
5. Vibrating fork type  
6. Gauge glasses  
7. Magnetic level gauges  
8. Capacitance type  
9. Conductivity type  
10. RF Type  
11. Time domain reflectometry type

2. For Solid Service  
   1. Ultrasonic  
   2. Nucleonic  
   3. Load Cell (weighing) system  
   4. Electromechanical servo gauges  
   5. Tilt switches  
   6. Capacitance switches  
   7. Vibration rod  
   8. RF Type  
   9. Time domain reflectometry type

3. For sumps  
   1. Conductivity switches  
   2. Capacitance switches  
   3. Bubbler Tube System

4. Tank gauging  
   1. Servo gauges  
   2. Radar

5. Level instruments shall have weatherproof, dust and corrosion resistant enclosures of minimum IP-65 grade.  
6. Additionally, explosion-proof enclosures shall be provided for hazardous area applications.  
7. In Tank Gauging applications, communication port shall be provided in level instruments, for connectivity to a computer.

03.06.02 Gauge Glasses  

1. All gauge glasses shall normally be steel armoured reflex or transparent type. Magnetic level gauges may also be used when liquid temperature permits and liquid specific gravity is greater than 0.9.

2. Reflex gauges shall be used on clean, clear, non-corrosive liquids.

3. Transparent gauges shall be used for the following applications:  
   1. interface service  
   2. when the process is dirty or viscous  
4. For corrosive medium, (such as caustic, hydrofluoric acid and steam applications above 250 PSIG), transparent gauge glasses shall be used with internal mica or plastic shield to prevent chemical attack or discoloration of the glass.
5. If the process is a solvent that can dissolve the internal coating of the chamber of the reflex gauge, thereby reducing the effectiveness of the prisms, reflex gauges shall not be used.

6. Reflex gauge glasses shall not be shielded

7. Transparent level gauges, in general, shall be equipped with minimum 40 W illumination and switch (ex-proof for hazardous area).

8. For high temperature applications, level gauges with flexible end tube coupling or expansion loops (top/bottom) shall be used to take care of high temperature expansion.

9. Large chamber type gauge glasses shall be used for boiling / evaporating and heavy viscous liquids.

10. Gauge glass material shall be toughened borosilicate glass having adequate resistance to thermal and mechanical shock.

11. Gauge glass body and cover shall be made of carbon steel with rustproof finish, unless otherwise specified.

12. Gauges shall be provided with safety ball check offset type gauge cocks, vent and drain connection (with 1/2” vent & drain valves), nipples, caps etc.

13. Gauge glasses shall be provided with top and bottom or side connections. Where side connections are specified, the gauge glasses shall have two connections at each end, 180° apart, with one connection at each end plugged.

14. Unless otherwise specified, gauge cocks shall be of the quick-closing type with bolted bonnet, outside screw and renewable seats.

03.06.03 Displacer & Differential Pressure type

1. External displacer type instruments with ratable head shall usually be used for level measurement upto 1200 mm (48”), wherever process permits.

2. Displacers shall be made of AISI 316 with Inconel torque tube, unless otherwise specified or unless the process calls for any special material.

3. Side-side flange connection shall normally be used. Heat insulator / finned extension shall be used for temperatures above 230°C.

4. All such instruments shall have drain valves and vent plugs.

5. Stilling wells shall be provided for internal displacer type level instruments.

6. Differential pressure transmitter shall be used for level measurement in boiler drums and in other cases, where displacer type instruments are not suitable (e.g. level measurement beyond 1200 mm, applications requiring purge or where liquid might boil in external portion).

03.06.04 Vibration fork type

Vibration fork type level switches shall generally be used instead of float type level switches. Further, external cage type construction shall generally be used. Process connection to the cage shall be 1” socket weld type, unless otherwise specified.
03.06.05 Ultrasonic type

1. Ultrasonic type level transmitters shall be microprocessor based and shall use digital signal processing technique for signal conditioning. Possible to calibrate through universal HART calibrator. Ultrasonic transmitters shall be located in the control room. Only sensors shall be located in the field.

2. Suitable protection box for mounting ultrasonic type level transmitters shall be provided for mechanical protection & dust. Swiveling arrangement shall be provided for proper aiming/ focusing of ultrasonic type level transmitters.

3. The transmitter shall have facilities for storing the echo profile, manipulation of the echo profile to remove noise, multiple profile-averaging etc.

4. The transmitter shall have the capability to use statistical filtering techniques, wherever required, to compensate for rotating agitator blades or to suppress false signal due to heavy dust or fill-stream interference.

5. In very dusty applications or in silo / bunker, etc. filling applications, high power and long range (i.e., low frequency) transducer shall be used to overcome the detrimental effect of the dust. This type of instrument shall not be used for level measurement in process medium consisting of particles of sizes (~ 6 mm diameter).

6. The sensor shall have inbuilt temperature sensor for ambient temperature compensation.

7. Chemical compatibility of the sensor material with the process material shall be ensured, to avoid corrosion.

8. In applications, where material build-up on the sensor is expected, the transducer shall have suitable build-up compensation (i.e. repetitive, pulsating displacement at its face shall be used to remove the material build-up).

9. Ultrasonic transmitters shall be supplied along with necessary calibration & noise suppression software, HART to RS 232C modem, plug connector, cable, etc. for connection to a desktop PC/ Laptop.

10. Provision for the nitrogen purging facility in the ultrasonic level sensor shall be provided for cleaning the build up of the material.

03.06.06 Nucleonic type

1. Nucleonic sources shall have adequate shielding to limit radiation level at any point on the surface to below 6 milli-Roentgen per hour. At the same time, nucleonic type measurement systems shall not be excessively bulky or heavy.

2. Nucleonic sources shall have facilities for complete shielding during shipping, storage and transportation (in the form of rotary shutter, etc.).

3. The supplier shall furnish necessary certification of nucleonic type instruments from statutory bodies, as applicable.

03.06.07 Capacitance & conductivity type

1. Capacitance / conductivity type probes shall be as follows:

   1. Rod type : for lengths up to 2000 mm.
2. Rope type with gravity weight: for length exceeding 2000 mm.

3. For level measurement in non-conducting tanks or sumps or when the tank profile is non-linear, capacitance type instruments shall be provided with a reference electrode / ground probe.

3. Capacitance type level probes may be used for both switching as well as for continuous level measurement in liquids.

4. Capacitance type level probe shall not be used for level measurement in solids when there is likelihood of material build-up on the probe. Capacitance type level probe shall not be used in liquid service where there is a chance of di-electric value change (due to oil spillage etc.).

03.06.08 Radar Type

1. Radar type level instrument shall be used when the physical properties of the medium between the sensor and the measured interface may vary.

2. The Radar type level instrument shall be microprocessor based with HART protocol and shall use digital signal processing techniques for signal conditioning. Possible to calibrate through universal HART calibrator.

3. Suitable antennae shall be considered for the intended application.

4. Radar type level transmitter shall have facilities for storing echo profile, manipulation of the echo profile to remove noise, multiple profile-averaging etc.

5. The transmitter shall have the capability to use statistical filtering techniques, wherever required, to compensate for rotating agitator blades or to suppress false signal due to heavy dust or fill-stream interference.

6. The sensor shall have inbuilt temperature sensor for ambient temperature compensation.

7. Chemical compatibility of the sensor material with the process material shall be ensured, to avoid corrosion.

8. In applications, where material build-up on the sensor is expected, the transducer shall have suitable build-up compensation (i.e. repetitive, pulsating displacement at its face shall be used to remove the material build-up).

9. Necessary software, cables, connectors, HART to 232C converters etc. For calibration, noise suppression, etc. of Radar type level transmitters through windows based desktop PC / Laptop shall be supplied.

10. Suitable protection box for mounting radar type level transmitters shall be provided for mechanical protection & dust. Swiveling arrangement shall be provided for proper aiming / focussing of radar type level transmitters.

11. Provision for the nitrogen purging facility in the ultrasonic level sensor shall be provided for cleaning the build up of the material.

03.06.09 Time domain reflectometry type (TDR)

1. TDR type level measuring system shall be mainly used.
a) For level measurement of Liquids, interface in immiscible fluids, 
granules & fine powders  
b) For medium having dielectric within 1.8 to 100.

2. Co-axial type, twin rods, twin cables, single cable / rod type probes shall be selected depending on tank height, properties of medium/media & application.

3. For interface level measurement top layer shall be of lower dielectric and minimum difference of dielectric between top & bottom layer shall be as per manufacturer's recommendation.

4. For adhesive/sticky in nature materials, coated probes as per manufacturer’s recommendation shall be used.

03.06.10 Radio frequency (RF) type

1. Radio frequency (RF) continuous/ point level measuring system, based on capacitance or admittance shall be used for level measurement of liquids, slurries, granulars, and liquid-liquid interface.

2. RF transmitter shall be

   a) Smart type
   b) Self-calibrating type i.e. as the level rises in the vessel, the span is set automatically and electronically by the smart transmitter.

3. For high temperature application, remote mounted transmitters shall be used.

4. RF type shall also be used for detection of absence or presence of liquids, slurries, interfaces and granules.

5. One hand-held calibrator with rechargeable battery and battery-charger shall be used.

6. It shall be possible to calibrate RF transmitters using calculated or known levels of capacitance directly entered by the hand held calibrator.

03.06.11 Others

Tilt Type, paddle type, bubbler type, electromechanical type, etc. level instruments may also be used, depending on application specific requirement.

04. GAS ANALYSIS SYSTEM

The gas analysis system shall be complete with the following units:

1. Gas sampling probe, complete with filters, isolation valves, ring heaters, insulator jackets etc, as required. Dual probes shall be used, wherever required as per process criticality.

2. Swagelock/ Parker fittings shall be used for sample handling system of gas analysers

3. Gas preparation & conditioning system including sample conditioning, pumping, cooling, cleaning, drying etc. as applicable along with filter panels, scavenging panels complete with valves, tubing, fittings, accessories etc, as required.
4. Gas analyzer panel with analyzer instruments, monitoring devices viz., flow, pressure, temperature etc., tubing, fittings, accessories, as required.

5. UPS & non-UPS type electrical power supply for the complete gas analysis system, complete with isolation transformer, Circuit breakers, MCBs, relays, 24 V DC regulated power supply units, earthing system etc, as required for efficient performance of the analyzer system.

6. Calibration equipment with calibration gas cylinders. Facility for both automatic & manual mode of calibration shall be provided. Cross sensitivity correction shall be provided wherever applicable.

7. Suitable display unit with key-board/ switches shall be provided on the analyzer panel front for monitoring & display of different parameters, status of analyser & sample conditioning equipment etc.

8. Condensation monitors, complete sampling system shall be designed & supplied by the analyser manufacturers only. All components & fittings of the analyser & sample conditioning system shall be of reputed make, preferably imported.

9. Before the filter unit, SS isolation valves shall be provided for each probe to facilitate online changing of the filter unit. Sample gas coolers shall be provided with redundant sample gas path & peristaltic pumps.

10. Sampling of dusty, hot, dry, cold or wet gases shall be done using dual probes with automatic switchover and with intermittent purging facility.

11. Analyser shall be microprocessor-based and the analyser PLC shall do all related sequencing & logic functions. Analyser PLC shall preferably have the same series & model no. as envisaged for the main unit / plant to ensure reliable & trouble-free communication.

12. System & application software for configuring and diagnostics of the analyser. PLC shall be provided.

13. Response time of the Analyser system shall be designed to comply with process requirements.

14. Unless otherwise specified, accuracy of analyzers shall be within ±1% of span. Repeatability of analyzers shall be within ±1%.

15. Where there is a possibility of choking of analyser inlet filters, automatic inert gas purging facility initiated by the analyser PLC shall be provided.

16. All solenoid valves used in gas analysis system shall have manual override.

17. Separate analyser room shall be provided in the vicinity of gas sampling points. However, storage of calibration gas cylinders shall be arranged outside the analyser room. Ambient CO monitoring unit shall be provided in the analyser rooms.

18. Analyzers in explosion hazardous area shall be installed in ex-proof shelters.

19. Exhaust tubing shall be provided for the sample gas after analysis and will be either vented into atmosphere at safe elevation/ distance, or fed back into the process stream. Gases containing hydrogen shall have separate outlets.
20. Analysis system of Hydrogen & other explosive gases shall bear the approval of statutory body.

21. Wherever analysis of harmful gases has to be done, unmanned gas analyser room with proper air conditioning facility shall be planned. At least one inert gas and / or steam purging point with flexible hose connection and isolation valve shall be provided at the entry point of this room.

22. In analysis of explosive gases (or gases forming an explosive mixture), approval of design and installation of analyser system shall be obtained from competent authority.

23. Poisonous and explosive gas detection systems shall have safety-limit alarm annunciation. Safety limits of different gases shall be as per OSHA norms.

24. Normally, the following types of gas detectors / sensors shall be used. However, type of sensor shall be selected, depending on the application:

1. Electro-chemical cell
2. Semiconductor/ solid state cells
3. Thermal conductivity
4. Paramagnetic
5. Catalytic poison resistant
6. Non-dispersive Infra-red radiation type

05. LIQUID ANALYSIS SYSTEM:

1. Analysis of pH or Oxidation–Reduction Potential (ORP) of industrial liquids shall be done using a measuring electrode and reference calomel electrode sensing system. The type of electrodes shall be selected based on the electrochemical and physical properties of the liquid.

2. Material of construction of conductivity analysis cell shall be based on the chemical corrosion activity and physical properties of the process medium. The type of electrodes shall be selected based on the electrochemical and physical properties of the liquid.

3. Buffer solution shall be provided along with the analyser for calibration purpose.

06. CONTROL VALVES

1. Control valves shall be provided with by-pass valves, except where the valves are used in split-range service.

2. Control valve characteristics shall be chosen in accordance with process requirement.

3. Control valves shall be sized in accordance with ISA-S75-01.

4. Valve sizing software, wherever used, shall be submitted along with sizing calculation.

5. Control valves shall be sized so that at minimum and maximum flow, the valve lift is always between 10% to 90% for equal% and 20% to 80% for linear characteristics.

6. All control valves shall be provided with hand wheel.
7. Wherever required (such as, in high temperature applications) or wherever specified, hard-faced or stellited valve trims shall be provided.

8. In extreme temperature applications, seal-welding of threaded seat-rings, etc. shall be done.

9. In very low temperature applications, valve trim materials shall be chosen to have adequate cold impact strength.

10. ‘Trim’ of a control valve shall include those parts of body assembly (excluding body, bonnet and bottom flange), which are exposed to and in contact with, the process medium. These parts shall consist of but not be limited to the seat ring, valve plug, plug stem, plug guide bushing and cage.

11. Valve guide bushing shall be of sufficiently hard material to resist side-thrust on the valve plug.

12. For temperature applications below 200°C, ‘Teflon’ valve packing shall be used.

13. For temperature applications exceeding 200°C, ‘grafoil’ packing shall be used.

14. Steam / electrical tracing shall be provided to control valves, wherever process demands.

15. Control valves in steam service shall be provided with IBR certification.

16. Valve body size shall be minimum 25mm. However, reduced trim may be provided with 25mm valve body, if the process demands.

17. Globe type control valves shall be, in general, used in throttling applications for valve applications up to 500 mm line size, when the line pressure is not very low & fluid is non-viscous.

18. Single seated globe valves with top guided plugs shall be generally used for low & medium flow applications & for clean fluid applications as well as fluid with suspended particle applications. Cascaded trim shall be used for cavitating services.

19. Globe valves with cage guided plugs are pressure balanced & shall be used for high flow applications where the fluid is clean or if there is a chance of flushing/cavitation. Generally, single seated globe valves with cage-guided plug shall be used from the viewpoint of maintenance & for better leakage class. However, double seated cage guided valves shall be used for better pressure balance, based on the process application.

20. Top & bottom guided double port double seated straight through type globe valves shall be used for very high flow applications & where wide rangeability is required. Wide rangeability is possible, as the valve operation is quite steady through out the stroke due to relatively low unbalanced force & because of the guiding at top & bottom. Another advantage of this type of valve is that valve action can be reversed without change of actuator.

21. Extension-bonnets shall be provided in control valves for services above 200°C or below (-) 30°C, or as recommended by the manufacturer.

22. Other types of valves (e.g. butterfly, angle, eccentric-disk, ball, V-notch ball type, etc.) shall be used only when operating conditions do not allow globe type valves.
23. For high viscous liquids, V-notch ball valves shall be used.

24. Angle valves shall be used wherever piping layout so desires. It is devoid of dead pockets & possible to achieve fine control through it. It can be used in slurry application also. In case of high-pressure drop application, multistage single seated cage guided angle valves shall be used. In very high-pressure drop applications, the multi stage pressure reduction trim prevents the liquid pressure falling below the saturation pressure at vena contracta, thereby eliminating the chance of cavitation. Due to its geometry, the chance of erosion & noise level is comparatively less than similarly constructed conventional globe type valves.

25. Three-way valve shall be used in mixing & diverting services.

26. Concentric disc type/ eccentric disc type butterfly valves shall be used in large line sizes & mainly in low-pressure applications or where allowable pressure loss across the valve is very low. Concentric disc type butterfly valves shall be designed for maximum opening angle of 60°. The maximum permissible opening for eccentric disk type butterfly valves shall be 90°. Applications where wide rangeability is required, eccentric disc type butterfly valve shall be used instead of concentric disc type butterfly valves.

27. Noise generated from operation of control valves shall be limited to OSHA specified levels.

28. Large size piston-operated and diaphragm-actuated type control valves or dampers shall be provided with positioners. Such valves or dampers shall have signal bypass facilities for manual local operation.

29. However, the maximum allowable noise is 85 dBA SPL. In case, the predicted noise level during calculation exceeds 85 dBA, the control valve shall be treated for noise. Only source treatment of noise shall be resorted to.

30. Control valve leakage class (in accordance with ANSI FC 70.2 / API) shall be selected as per process requirement.

31. Valve stem-position indicator shall be provided for all the control valves.

32. All diaphragm-type control valves shall have hysteresis (without positioner) less than 2% of spring range.

33. Fire-safe valves, wherever required, shall be as per API 607 and design shall be as per API-6D

34. Control valve accessories, such as solenoid valves, positioners, limit-switches, air-filter regulators etc., shall be firmly mounted on the valve body or yoke and shall be properly tubed using PVC-jacketed copper tube.

35. Valve position feedback & end limit switches shall be provided for all the control valves

36. Solenoid valves installed in the control air supply line shall be of Universal type having minimum class ‘F’ insulation and shall be continuously rated direct-acting type. Solenoid valves shall be full-bore type with minimum bore size 3 mm.

06.01 Actuators

1. Actuators shall be sized for shut-off differential pressure.
2. Actuators shall be pneumatically operated, unless otherwise specified.

A) Pneumatic actuators:

1. For spring-opposed diaphragm type actuators, the spring shall be corrosion-resistant and cadmium or nickel-plated.

2. Actuator operating range shall be 0.2 to 1.0 kg/cm².

3. Valve positioners or boosters may be considered for actuators for the following applications:
   
a) To split the controller output to more than one valve.
b) To amplify the controller output beyond the standard signal range (i.e., 0.2-1kg/cm²), in case of actuators with greater thrust or stiffness.
c) To achieve minimum overshoot and fast recovery in control action, as in the case when long control air lines have to be used.

d) In all the above applications, whether or not a positioner or booster is to be used, shall depend on the speed of response of the system.

e) Wherever required, boosters shall be used for systems with a fast response (e.g., pressure and flow control loops etc.) and positioners shall be used for relatively slower control loops (e.g., temperature and level loops etc.).

f) Actuator casing and diaphragm shall be designed to withstand atleast twice the maximum pneumatic operating pressure of the control valve.

B) Electrical actuators:

1. The actuator shall have electric motor and gear box assembly for having low speed and high torque output.

2. The motor of electrical valve actuator shall be intermittent duty, high torque and high slip motor.

3. Gear mechanism shall be self-locking type.

4. The standard fitment of electrical actuator shall include as minimum:
   1. Torque and end limit switches (2 NO + 2 NC for each limit switch.)
   2. Intermediate limit switches as specified. (2 NO + 2 NC for each limit switch.)
   3. Continuous remote position transmitter.
   4. End travel indicator
   5. Overload protector by a thermostat embedded in the motor winding

5. Power supply to actuator shall be through fast acting fuse –switch unit or fast acting circuit breaker.

6. Local control box with open/close, emergency stop pushbutton, local/remote selector switch and open close indication shall be provided.

7. Power supply shall be 240 V, 50 Hz, single phase or 415 V, 50 Hz, 3 phase, 4 wire.
8. Insulation class of motor shall be selected as per NEMA standard depending on ambient operating temperature.

9. Separate cable entry & gland shall be provided for power supply, control signals and position transmitter.

10. In explosion hazardous area use of electrical actuator shall be avoided. However, in case, electrical actuator has to be selected, shall be ex-proof type.

11. Regulating duty motors shall be generally selected as per following guidelines:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Ambient temp. in °C</th>
<th>Duty cycle of motor, in %</th>
<th>Starts per hour</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-30 to 40</td>
<td>100</td>
<td>1200</td>
<td>For example, if 100 % duty cycle motor is selected for 1200 start/hour use between ambient temp. range of (-) 30 to 40 °C, then the same motor can be used for 630 starts/hr only, if ambient temperature range is increased to 40 - 60 °C.</td>
</tr>
<tr>
<td>2</td>
<td>40 to 60</td>
<td>100</td>
<td>630</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>60 to 70</td>
<td>100</td>
<td>516</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-30 to 40</td>
<td>50</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>40 to 60</td>
<td>50</td>
<td>315</td>
<td>Similarly, if 50 % duty cycle motor is selected then the start / hr of 1200 will be reduced to 600</td>
</tr>
<tr>
<td>6</td>
<td>60 to 70</td>
<td>50</td>
<td>258</td>
<td></td>
</tr>
</tbody>
</table>

06.02 Positioners

Valve positioners, wherever required, shall be side-mounted on the control valves and shall be direct-acting type, unless otherwise indicated.

Wherever the operating range of the actuator is the same as that of the control signal, the positioner shall be provided with an integral bypass switch.

All valve positioners shall have integral pressure gauges to indicate input supply, control signal and positioner output pressures.

All pneumatic connection points shall be of ¼” NPT(F), in accordance with ANSI B 20.1. In case they are different, suitable adapters shall be provided.

Positioners shall have corrosion-resistant linkages and rugged brackets.

Control valves positioners shall have repeatability within 0.5% of stroke, for a given input signal.

Valve positioners shall be SMART type with HART protocol.

All control valves shall be provided with position transmitters. Position transmitter shall be capacitive/ inductive type.

2 nos. of air filter regulator shall be provided with each control valve. One regulator for I/P converter and the other for positioner.

06.03 Limit switches
1. Limit switches, wherever specified, shall be suitable for mounting on the valve and shall be supplied along with all mounting accessories.
2. Limit switch enclosures shall be weatherproof to NEMA 4, or suitable for the specified hazardous area classification.
3. Limit switches shall be SPDT type, silver-alloy-plated, hermetically sealed and rated for minimum 240 VAC, 2A.
4. Flying leads are not acceptable. Terminal blocks of limit switches shall be located inside the switch housing.

07. **CALORIFIC VALUE ANALYSER**

The Calorific value analyser system shall be complete with required accessories from the following units, as applicable:

1. Tar separator
2. Sampling gas pump.
3. Silica gel container
4. Gas preparation (cleaning, cooling, drying etc.) unit consisting of: Water pot with drain valves, Ball valves, Water separator with automatic drain facility, Chemical Filter, Mechanical Filter, Aerosol Filter, Pressure reducer etc.
5. Steam purging facility
6. Analyser calibration equipment with calibration gas cylinders.
7. Automatic calibration and correction unit (wherever necessary)
8. Cooling air fan, Ceramic Burner, Safety pilots for burner, Thermopile, Pressure governor.
9. Mimic panel with LED indication (if required).
10. All necessary internal monitoring devices (for flow, pressure, temperature etc.)
11. The sampling system shall be suitably designed considering gas composition and its impurities
12. Analyser shall be microprocessor based.
13. Manufacturer’s software for configuring and diagnostics of the analyser shall be provided and loaded in the system for ease of maintenance.
14. Analyser system shall be designed to have dead time less than 15 seconds for the entire system and maximum possible accuracy.
15. Unless otherwise specified, accuracy of analysers shall be within ±1% of span. Repeatability of the analysers shall be within ±1%.
16. Purging facility, inlet filters, etc., shall be provided, wherever there is a possibility of choking of analyser.
17. All solenoid valves, used in analysis system, shall have manual override.
18. Separate analyser room shall be provided in the vicinity of the gas sampling points. However, storage of calibration gas cylinders shall be arranged outside the analyser room. Exhaust facility shall be provided in the analyser room. Tenderer shall indicate whether air conditioning facility is required for Cv analyser.
19. Analysers in explosion hazardous area shall be installed in ex-proof enclosures.
20. Suitable exhaust tubing shall be provided for the fluid under analysis, taking care of all safety means.
21. In analyses of explosive gases (or gases forming an explosive mixture), approval of design and pipe routing of the sampling system shall be obtained from the competent authority (viz, the Chief Controllers of Explosives, Nagpur).
22. Zero & span gas cylinders shall be provided as per the requirement.
23. Analyser panel shall have suitable digital display facilities in engineering units.
08. **FLAME DETECTOR**

1. UV type flame failure detector, suitable for the intended application shall be offered. Swiveling arrangement shall be provided for proper focussing of the flame detector.
2. The detector shall have self diagnostic facility.
3. For alarm output, potential-free contact (1 NO + 1 NC) shall be provided.
4. Suitable panel for housing the complete electronic system at field shall be supplied.

09. **CONTROL PANELS/CABINETS**

1. Panels shall be totally enclosed; flush-front, freestanding upright floor mounted type with welded construction. Panels shall be mounted on box-type base-frame.
2. Panels shall be made of cold rolled cold annealed (CRCA) sheet steel with thickness as follows:-
   - Front face, gland plate, equipment mounting plate : 3mm
   - and other load-bearing sections
   - Door, top, bottom and side faces : 2mm
3. Sizes of panels and cabinets, as approved by purchaser / consultant, shall only be supplied.
4. Height and colour of new panels, to be installed in any existing room, shall match with existing panels. Otherwise, panel height shall be 2250 mm. with an additional 100x50x6 mm base channel and 15 mm thick anti-vibration pad on top. The panel / cabinet shall have minimum depth of 600 mm.
5. If the width of a panel exceeds 800 mm, double-door type construction shall be provided. Otherwise, panels will have a single door.
6. Panel doors shall have flush-type and lockable door-handles.
7. Panel doors shall have mesh-covered louvers at top & bottom, for air circulation. Additionally, wherever necessary, push-pull type circulating fans shall be provided for cooling of equipment inside.
8. In general, mounting height of instruments in the panel shall be as follows:
   - 1. Miniature instruments (bottom levels matched):
      - Bottom row - 1000 mm
      - Middle row - 1350 mm
      - Top row - 1600 mm.
   - 2. Annunciator : 1900 to 1950 mm (bottom levels matched):
   - 3. Push buttons : 800 mm center line(excluding base channel)
   - 4. Hooter (for alarm) : Outside cabinet - preferably at panel top.

Panel-mounted instruments conforming to DIN size and mounted in the same row shall have their bottom levels matching.

9. All equipment inside the panel shall be located in such a manner that their terminals and adjustments are readily accessible. Panels shall be dust and vermin proof. Panels installed in control rooms shall be weatherproof having minimum IP42 degree of protection. Suitable gaskets shall be provided, for this purpose.
10. Panel / cabinets located in the field shall have minimum IP-54 degree of protection. Pressurised local cabinets shall be installed in dusty areas. Pressurisation shall be achieved inside the cabinet by introducing clean (i.e., dust-free) air.

11. A space of at least 1.5m shall be provided in front and behind panels / cabinets for ease of operation and maintenance.

12. If the length of a panel exceeds 5m, approach from both sides shall be provided.

13. No process fluid other than air shall be piped to the panel / cabinet.

14. Panels / cabinets / desks etc. shall be supplied in finish-painted, completely wired and tested condition.

15. Panels shall first be chemically de-greased, de-rusted and phosphated. Then, 2 coats of red-oxide shall be applied. Finally, 2 coats of synthetic enameled paint or epoxy-based paint shall be applied to have a non-glossy high class finish with aesthetically pleasing appearance and long life.

16. Colour shade of panels shall conform to RAL 7032. Outside shade of panels shall generally be RAL 7032, unless otherwise specified. The inside of panels shall be of brilliant-white. Panel base channel shall be painted black.

17. However, the supplier shall ensure uniformity of colour and height of all the panels as per customer’s choice, wherever instrument panels are installed along with electrical or other panels in the same room, or also as per existing plant standard, wherever applicable.

18. Panels shall have lifting hooks or eyebolts on the top at the four corners, for ease of transportation.

19. Instrument power supply shall be through a 1:1 isolation transformer to be installed in the instrument panel.

20. The inside of panels / cabinets / local panels shall be illuminated, preferably using incandescent type lamp. The illumination lamp shall be switched on/off using either a door switch or a toggle switch.

21. An inscription plate (with white letters on a black background) containing the tag no. etc. shall be provided for each instrument / device mounted on the panel. Separate nameplates shall be provided for rear-panel mounted instruments.

22. Anti-vibration mounting or shock absorber shall be provided for panel-mounted instruments in vibration-prone areas.

23. ISA symbols shall be used in Mimic panels. Graphic design, colours, materials, etc. used in mimics shall be in accordance with existing plant standard or as per Purchaser’s choice.

24. For panel wiring, following guidelines shall be followed:

**Signal wiring:**
1.0mm<sup>2</sup> PVC insulated, stranded Cu-wire: gray colour

**Power supply wiring:**
- For 240/110V, 50 Hz
  - 1.5 mm<sup>2</sup> PVC insulated stranded Cu-wire, colour code:
    - Live : red
    - Neutral : black / blue
- For 24V, DC
  - Earth : green
    - 1.5 mm$^2$ PVC insulated stranded Cu-wire, colour code:
      - Positive : brown
      - Negative : black / blue
  - Earth : 4.0 mm$^2$ PVC insulated stranded Cu-conductor,
    colour code: green-yellow spiral

25. Screen wires of screened signal cables from the field shall be earthed at the electronic earth-pit of the control system, which shall be separate and independent with respect to the power supply earth grid.

26. The following points shall be taken care of while deciding the internal layout of instrument panels or cabinets:

1. Electrical voltage higher than 240 V AC/DC shall not be brought inside the instrument panel / cabinet.

2. All internal wiring shall be housed in covered, non-flammable plastic raceways.

3. Separate wiring raceways shall be used for power supply wiring, signal wiring and intrinsically safe circuits' wiring.

4. Distance between the continuous edges of two adjacent terminal strips shall be minimum 100 mm.

5. Separate terminal strips shall be provided for 24 V DC, 240/110 VAC and intrinsically safe terminals.

6. Distance between cable gland plates & bottom of terminal strips shall be minimum 300 mm.

7. Terminal blocks shall be screw less clip-on type.

8. For signal wiring, 2.5mm$^2$ size terminals shall be used.

9. For power wiring, 4.0 mm$^2$ terminals shall be used.

10. A minimum of 20% spare terminals shall be provided, for power, signal and intrinsically safe circuits’ wiring.

11. Power supply terminals (e.g. 240VAC or 110VAC or 24VDC) shall be labeled.

12. In case a bus bar is used for power supply distribution, the bus-bar shall be shrouded with a transparent Bakelite plate.

27. Panels or cabinets shall be provided with the following items:

1. Power socket (of 240V AC, 15W rating) for soldering, etc.

2. Pair of earthing bolts on either side of the panel (at the bottom) for power earthing.

3. Copper bus-bar (of size 25x3mm) mounted on an insulated base inside the panel with holes and nut-bolts - for instrument signal earthing (i.e., electronic earthing).
10. **ELECTRICAL SYSTEM**

The instrumentation and control system including all field instruments and the process computer shall be provided with a power supply system with provision of continuous availability of power even in case of fault or failure of the local power supply source.

Instrument power supply shall be single phase 110/240 V A.C. All instrumentation equipment shall be suitable for power-supply fluctuation within 240V AC, +10%, -15% and 50Hz +3%, - 6%. OR 110V AC ± 10%, 50 Hz ± 3%.

Wherever, power supply through UPS is specified, shall be supplied through parallel redundant UPS with 30 minutes of battery back up.

415 V, three phase power may be used to derive instrument power. However, the same shall not be brought inside the instrument panel.

A 1:1 isolation transformer shall be installed in the instrument panel or cabinet for isolation of input power supply. A master circuit breaker (with short-circuit protection and overload release facility) shall be installed in the instrument power supply line.

Terminals of 110V and above shall be labeled and isolated from terminals of lesser voltages.

All electrical systems and installations shall meet the statutory requirements of the Indian Electricity Act and rules & regulations of Central & State Government.

No instrument contact shall be used directly for alarm annunciation or interlocking. Contacts after multiplication through relays shall be used for alarms and interlocks.

Instrument power supply shall be through circuit breaker (with adjustable short circuit and overload release facility) and isolating transformer. Circuit breakers shall also be provided on the secondary side of the isolating transformer. All 4–wire instruments shall be provided with individual circuit breakers. All DCS/PLC loop powered instruments shall be provided with individual fuse in the terminal blocks of DCS.

Derivation of necessary voltage grade from the available power supply, as may be required for the offered system & distribution of power shall be carried out by the Tenderer.

Power supply equipment for instruments as may be required shall be installed inside the instrument panel.

All signal, control, compensating cables & power cables for instrumentation use shall be of armored type. The conductor shall be electrolytic grade tinned copper as per IS 8130 : 1984.

All cables shall be PVC insulated and PVC sheathed. Insulation material shall be PVC type C and sheath material shall be PVC type ST2 as per IS 5831 : 1984. Additionally, asbestos, silicone or sintered Teflon sheath shall be provided in high-temperature-prone locations.

Instrument power supply and control cables shall be made of multistrand copper conductor of 1.5 mm² of 1.1 KV grade and other details as per IS 1554, Part 1.

500 V grade cables with multi-stranded, twisted pair copper conductor of minimum cross-sectional area of 1.0 mm² shall be used for signal cables. Cable pairs shall be individually and overall shielded.
Shield in screened cables shall have 25% overlap and 100% coverage. Shield shall be kept open at the instrument end and to be connected to the electronic earth pit at the control room end.

For shielded compensating cable the shield shall be earthed near the point of the circuit ground. For grounded junction thermocouples, this means at the thermocouple head. For ungrounded junction thermocouples this means at the control room end.

Compensating/Thermocouple extension cables to be used in high temperature zone or are to be laid on the top of the furnace/hot surface, shall be sintered Teflon insulated, sinter Teflon sheathed overall SS braided cables. Additional Glass fibre insulation shall be used for temperature zone > 250 Deg C. Mineral insulated extension cables can also be used for such application.

The individual cores in multicore cables shall be PVC insulated & numbered and/or identified by a definite colour code.

All cables, from field JBs to panels/marshalling rack in the control room shall have at least 10% (minimum 1 no.) spare cores

11. PNEUMATIC SYSTEM

1. Air supply to pneumatic instruments shall be dry and free from oil, dust and moisture as specified below. Air shall be supplied from oil free compressors. The air shall be filtered & dried in a drier and stored in storage vessel of suitable capacity to ensure at least 30 minutes of continuous operation. On the supply line to each shop, pressure gauge shall be provided before and after the pressure reducer. On air supply failure, audiovisual alarm shall be initiated.

2. Instrument quality air shall have following parameters:
   - Dust particles size : Not more than 5 micron
   - Oil not to exceed : 5 to 10 ppm
   - Pressure Dew point : 10°C below the minimum temperature attained in any time of the year at site. However, pressure dew point shall not exceed 4°C.

3. Nitrogen, if used as pneumatic power supply, standby facility complete with air drier, filter and regulator shall be provided.

4. Supply airline to individual instruments shall have air pressure reducers, filters and isolating valves separately for the instrument. These shall be installed as near to the instrument as possible.

5. Compressed air at a pressure of 6 to 8 kg/cm² shall be processed in the air drying and filtration plant to achieve the specified quality of instrument air which could then be supplied to individual or group of pneumatic instruments at a pressure of 5 kg / sq. cm after passing through air filter and regulator.

6. In case, centralized air drying and filtration plant is not provided, specially for small shop units, suitable air drier & filter regulator units with accessories shall be provided at each consumer point for achieving instrument quality air from compressed air.
7. Transmission of pneumatic signals shall be done by 6 mm or 8 mm (for longer distance) by seamless steel tube or properly protected copper tube or armored tube bundles.

8. Distribution of instrument air shall be through air main (bulkhead) with separate supply to each instrument through a valve.

12. CONTROL ROOM DESIGN

1. Control rooms shall be aesthetically and ergonomically designed as per modern features with adequate safety features.

2. Doors shall be provided with automatic door closer and double doors shall be provided in dusty atmosphere. Doors shall preferably open outside. Doors shall be made of glass in aluminum frame.

3. Windows shall be made of aluminum frames and the glass panes shall be long, preferably on sheet for each frame. Small glass panes shall not be used. Glass windows shall be about 1,000 mm in height and at 750 mm from floor level.

4. Control room shall have false ceiling, false floor and double wall. Fresh air entering the control room shall pass through chemical filters.

5. The control room shall be air-conditioned with the following parameters:
   
   Temperature : 23±2 °C
   Relative humidity : 50 to 60%
   Dust content : 0.1 mg / m3
   No. of air changes : 2 to 3
   Positive pressure in the room : about 2 mm of WC

6. Walls shall be paneled with aluminum strips and painted with dust free, wear and fire resistant paints.

7. Floors shall be of linoleum / hard rubber fire-inhibited asbestos filled vinyl floor with antistatic properties.

8. Ample room shall be provided around the instrument panel / boards (minimum 1.5 to 2 m).

9. Control room illumination level shall be adjustable in the range of 250-550 lux and generally maintained at 500 lux. Illumination shall be done with shadow less and glare free concealed fittings.

10. Mounting frames/ inserts for panel mounting shall be provided.

11. Cable troughs or openings in the floor shall be provided to bring the cables to the panels. The opening shall be sealed after completion of erection.

12. Normally gas impulse lines shall not be permitted in the control room. If however, gas lines do enter the control room, proper ventilation shall be provided with more air changes to ensure safety.
13. CABLE LAYING

1. All cables shall be supplied & laid in accordance with the cable schedules and cable layout drawings. Before laying, cables shall be meggered and tested.

2. All armoured cables shall be laid on trays. Un-armoured cables shall be laid in suitable conduits.

3. All cables routes/lengths shall be carefully measured as per site conditions and cut to the required lengths to prevent undue wastage. While deciding cable lengths, adequate extra length of each cable shall be kept at the termination points at both ends.

4. Cable shall have complete uncut lengths from one termination to the other. Joints are not acceptable.

5. Power and signal cables shall be laid in separate trays. A gap of minimum 300 mm shall be maintained between power and signal cables wherever they are laid in parallel in the tray/duct/trench.

6. Crossing between signal cables and power cables shall be done perpendicularly.

7. Cables shall be terminated using cable glands. Cable glands and other openings in the junction boxes shall be properly sealed by means of sealing compound to make them thoroughly dust and moisture proof.

8. At junction box and sensor end, metallic (Aluminum) cable tags with cable no., J.B. no. and sensor tag no. shall be used. At control room end, metallic cable tag with cable no. and J.B. no. shall be used.

9. All cables shall be properly terminated using lugs, sleeves, ferrules, etc. for connection to terminal blocks.

10. All cores of electrical cables shall be identified by their wire numbers by means of the PVC ferrules following finalised philosophy. Ends of all PVC insulated

11. Unused cores shall be taped with PVC or rubber insulating tape. Use of cloth or other fabric type is not permitted.

12. Each underground cable (either in concrete trenches or buried) shall be provided with identifying tags of made of Aluminum, securely fastened every 30m of its underground length with at least one tag at each end before the cable leaves/enters the ground.

13. Directly buried cables shall be laid underground in excavated cable trench wherever specified in layout drawings. Trenches shall have sufficient depth and width to accommodate all cables correctly spaced. Before cables are placed, the trench bottom shall be filled with 100mm layer of sand and leveled. Each layer of cables shall be covered with 100mm of sand on top and sand shall be lightly pressed. A protective covering of 75mm thick second-class red bricks shall be placed flat on the final layer of sand and cable. The remaining portion of the trench shall be then back filled with soil compacted and leveled. On completion of every group of cable laying, insulation test shall be carried out for every cables. Any cable found to be defective shall be replaced before the next group of cables is laid. Flags/ signboard shall be provided, indicating number of cables, depth and direction, along the cable route, on crossovers/turnings etc. to mark the cable route.
14. At each road crossings and other places, where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not get damaged by pipe ends after pack filling. After laying, the pipe sleeves shall be sealed using sealing compounds. Wherever the cable is going into/ coming out of ground duct/ conduits shall be extended in the ground.

15. After laying of all the cables, the cable entry to control room shall be suitably filled and sealed so as to achieve a positive seal against the entry of gas/ water.

16. When laid inside conduits, following guidelines shall generally be followed for selecting the conduit dia:

<table>
<thead>
<tr>
<th>No. of cables</th>
<th>Conduit diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.7 D</td>
</tr>
<tr>
<td>2</td>
<td>3.0 D</td>
</tr>
<tr>
<td>3</td>
<td>3.2 D</td>
</tr>
<tr>
<td>4</td>
<td>3.6 D</td>
</tr>
<tr>
<td>5</td>
<td>4.0 D</td>
</tr>
<tr>
<td>7</td>
<td>5.6 D</td>
</tr>
</tbody>
</table>

D = Outer diameter of cable.

17. For cable sheaths and cores, internationally accepted colour coding shall be followed.

18. Cable trays shall be made up of hot dip galvanized steel plates of minimum thickness of 2 mm.

19. Separate cable trays shall be used for low and high voltage.

20. Each tray shall be provided with 20% spare space.

21. Cables shall be clamped at every 1.5 m distance in horizontal runs and at every 2 m distance in vertical runs, in trays.

22. Cables, which are not laid in the cable trays, shall be laid through protective conduits.

23. Sharp bends in cables shall be avoided. Wherever necessary, junction and pull boxes shall be used.

24. Conduits, junction boxes and pull boxes shall be properly grounded.

25. In hazardous locations, detachable steel plate covers on the tray shall protect the cable.

26. All the cores of the cables shall be marked with ferrules. Metal tags shall be provided at both the ends of the cable for identification.

27. Cables in hot areas shall have asbestos sheaths / covering or other heat protection. After completion of cable laying work, all cable bushings on panels, desks and cabinets shall be filled with sealing compound against the floor.

28. After erection, cables shall be tested for insulation. At least two cables in each sub unit shall be tested.

29. Cables will be identified by corrosion resistant tags.

30. Shield grounding shall be realised at one end of the cable only.
14. IMPULSE PIPE LAYING

Impulse lines shall be kept as short as possible consistent with good practice and accessibility and shall follow installation/hook up drawings.

All welding shall be carried out as per welding procedures and codes with electrodes approved by client. Only qualified welders shall carry out welding.

For installation of impulse tubes with compression fittings, proper care shall be taken for handling, bending of the tubes and tightening of the fittings. Standard instruction of the manufacturer shall be followed strictly for the above cases.

Pipes/tubes shall be bent using pipe/tube benders only. Hot bending of impulse pipes/tubes is prohibited. Impulse line bending shall be circular and smooth. Flat bending shall be rejected. Pipes/ tubes shall be cut using pipe cutting device. Hot cutting will not be allowed.

All threaded joints shall be joined with Teflon tape and no other joining component shall be used except on high temperature service, where graphite sealing components shall be used. Pipe threading shall be made using suitable threading machine.

Impulse lines shall be properly supported and shall be clamped with the support. Impulse lines shall never be welded with the support, metal constructions and structure of building. Supports shall not generally be taken from process pipes, handrails etc. unless otherwise required.

Proper slope in impulse line (minimum 1:10) shall be maintained.

Impulse lines for explosive gases and air/inert gases shall not be laid together.

Impulse lines shall not be brought inside the control room.

Drainage pipes shall be connected to the plant drainage.

Impulse pipe sizes, type of fittings, flanges and number of pipes in multi-tubular bundle shall be standardized before engineering and shall be mutually agreed to.

Protection shall be provided where damage is likely to occur.

At the lowest points of air or gas impulse lines provision for drainage is to be provided.

In pipelines for liquids vent is to be provided at the highest points.

Horizontally laid steel pipes may be fixed at every 1.5 m and vertically laid ones at every 2.0 m.

Impulse pipelines and instruments used for oxygen service are to be degreased and cleaned with carbon tetrachloride.

The impulse lines for oxygen shall be clearly marked with colour code.
15. **EARTHING**

1. All junction boxes, local cabinets, field mounted instruments (having 110 V AC & above power supply) shall be connected to the nearby earth bus bar through 6 mm² (min.) stranded copper conductor with green sleeve.

2. Earthing network shall be realized with earth electrodes and/or buried bare conductors.

3. Two types of earthing system shall be generally provided –
   I. Main earthing system (ME).
   II. Electronic earthing system (EE).
   III. The electronic earth system shall be separate and independent from main earthing system. Main earthing system will be arranged by client.
   IV. The earth electrode(s) for EE shall be of the same type as those for the ME, but, in addition shall be placed in a galvanized steel pipe for a depth of minimum 4m to shield the electrode from surface earth stray currents, which may cause unwanted interference.

4. In general, the earth conductor between EE busbar of cabinets/ marshalling rack up to the earth pit shall be 16 mm² insulated copper conductor.

5. The following shall be applicable for earthing:
   - The metallic housing of electronic equipment/junction box /panel shall be connected to the main earthing system.
   - The active electronic parts of electronic equipment shall be connected to the electronic earth (EE).
   - The shield of the shielded cable shall be earthed to electronic earth at one end only i.e. at control room end.

6. For shielded compensating cable the shield shall be earthed near the point of the circuit ground. For grounded junction thermocouples, this means at the thermocouple head. For ungrounded junction thermocouples this means at the control room end.

16. **GUIDELINES FOR SELECTION OF ERECTION MATERIALS:**

01. **Instrument Fittings:**

   **Carbon steel Fittings**
   1. Fittings shall be as per ANSI B16.11.
   2. Fittings shall be socket-weld type forged pipe fittings of material cadmium plated ASTM A105. The minimum rating shall be class 3000.

   **SS tube Compression Fittings**
   1. Fittings shall be as per ISA RP 42.1.
   2. Fittings shall be flare less compression type and of three piece construction with ferrule, nut and body suitable for use on SS tube conforming to ASTM A269 TP316, hardness not exceeding RB 80.
   3. Hardness of ferrules shall be in the range of RB 85-90 so as to ensure minimum hardness difference of 5 to 10 between tube & fittings for better sealing.
   4. Threaded ends of fittings shall be NPT as per ANSI B1.20.1.
02 Instrument valves

1. The impulse line isolation and drain valves shall be forged gate/ball/globe valves with inside screwed bonnets. CS/SS valve material shall be used depending on requirement and as indicated in the enclosed installation diagrams.
2. For SS valves, body and trim material shall be ASTM A182 Gr. F316. For CS valves body material shall be ASTM A105 Gr.II and trim material shall be ASTM A182 Gr. F316.
3. For screwed valves packing material shall be teflon only. However, for socket-weld valves packing material shall be grafoil only.
4. Valve hand-wheel material shall be cadmium or nickel plated steel.
5. Minimum valve rating shall be 800 class.

03 Impulse pipes & tubes

1. Impulse pipe shall be fully annealed, seamless and cold drawn 316SS tube as per ASTM A269 with compression fittings as per guidelines indicated in typical installation drawings enclosed with this specification.
2. Tube wall thickness shall be 0.065” unless otherwise specified.

04 Cable trays and conduits

1. Perforated cable trays with sheet thickness of min. 2 mm shall be used for laying of cables.
2. The width of cable trays shall be so selected that 20% of tray space is available for future use of the complete installation.
3. Conduits used for cable laying shall be as per IS-1239 class medium & galvanized.

05 Transmitter cabinets/enclosures/canopies

1. Transmitter cabinets/enclosures/canopies shall be made of 2 mm thick MS sheet.
2. All cabinets shall be provided with external earthing lugs.
3. Sizes of cabinets/enclosures/canopies, as approved by purchaser/consultant, shall only be supplied and outside colour of panel shall be as per RAL 7032 and inside white.
4. Enclosure/canopies shall be suitable to protect the instrument from direct exposure to sun, rain water & dust.
5. Cabinets shall be provided with lockable door-handles.
6. All equipment inside the cabinet shall be located in such a manner that their terminals and adjustments are readily accessible.
7. Cabinets shall be dust and vermin proof. Suitable gaskets shall be provided
8. Pressurised local cabinets shall be installed in dusty areas. Pressurisation shall be achieved inside the cabinet by introducing clean (i.e., dust-free) air.
9. Cabinets shall be supplied in finish-painted, as per standard practice, completely wired and tested condition.
10. Cabinets shall have lifting hooks on the top at the four corners, for ease of transportation.
11. An inscription plate (with white letters on a black background) containing the tag no. & application shall be provided below each instrument.

06 Junction Boxes

1. Junction boxes shall be weather-proof. Enclosure degree of protection shall be minimum IP 65 as per IS 12063. Construction and testing shall conform to IS-2147.
2. Material shall be Die cast aluminum (LM-6 alloy).
3. Weather proof junction boxes shall have hinged type doors with door handle.
4. Terminal shall be spring loaded, vibration proof, clip-on type (Wago/Phoenix), mounted on nickel plated steel rails complete with end cover and clamps for each row. All terminals in JB shall be suitable for accepting minimum 4.0 mm² copper conductors.
5. Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines.
   - 50 to 60 mm between terminals and sides of box parallel to terminals strip for up to 50 terminals and additional 25 mm for each additional 25 terminals.
   - 100 to 120 mm between terminals for up to 50 terminals and additional 25 mm for each additional 25 terminals.
   - Bottom/top of terminals shall not be less than 100 mm from bottom/top of the junction box.
6. All junction boxes shall be provided with external earthing lugs.
7. Junction boxes shall be provided with adequate supporting/fixing arrangement with nuts, bolts, washers, brackets etc, as required for installation on wall/structures.
8. All junction boxes shall be provided with 20% spare cable entries (minimum 1 no.) and terminals. All spare holes shall be covered with plugs.
9. For outdoor installation of JBs, cable glands and plugs shall be of SS 316/304 material and nickel plated brass material for indoor installations.
10. All junction boxes shall be provided with double compression glands and will be threaded to junction boxes.
11. JB shall have provision for keeping terminal detail’s of JB inside the junction box.

17. INSTALLATION OF INSTRUMENTS

1. For installation of instruments and primary sensors, standards practice of instrumentation according to the international standard shall be followed.
2. For installation of any kind of special type of instrument/ sensor manufacturer’s recommendation for installation shall be followed.
3. Plugging of extra holes in JBs, panels, cabinets, etc., plugging of extra holes for conduits, filling up the conduits & conduit opening with water proof sealing compound shall be done after completion of erection.

18. CALIBRATION

1. All instruments shall be calibrated as per manufacturer’s instructions prior to installation.
2. During the loop checking and commissioning, if required, to obtain the satisfactory performance of the instrument, the same shall be recalibrated as and when required.
3. All instruments shall be calibrated at 0%, 25%, 50%, 75% & 100% of the measured range for both increasing and decreasing values. Discrete instruments, switching devices shall be functionally checked for general performance and specially for assigned set points.
4. Hand-held calibrator shall also be used for calibration checks of transmitters.
5. All calibration reading shall be recorded in proper format and submitted.
19. TESTING & COMMISSIONING

01 Testing

1. All cables shall be tested for insulation with 1000V/ 500V megger before termination at panel & field. Insulation shall be checked from conductor to ground and between conductors in a cable. All conductors shall also be tested for continuity.

2. All impulse piping shall be tested hydrostatically/ pneumatically to 1.5 times the operating pressure after isolating the instruments. Lines shall be blown after hydro-testing.

3. Instrument air headers (N2) & air supply lines shall be cleaned and tested for leaks at a pressure 6-8 bar, before they are placed in service.

4. For all measurement & control circuits, loop testing shall be properly carried out. For overall integrated loop testing involving Automation System, Tenderer shall work in close co-ordination with the system supplier.

5. All results of site inspection, instrument site calibration, impulse pipe leak test, panel site test report and loop test results shall be recorded in the approved format. These results shall form part of the completion documents. Any work not conforming to the execution drawings, specifications or codes shall be rejected and the Tenderer shall carry out the rectification at his own cost.

6. Magnetic flow meters & Vortex flowmeters shall be tested by injecting frequency signal. Temperature transmitters shall be tested by simulating millivolt signals.

7. All the equipment required for erection shall be brought by Tenderer to site, on returnable basis.

8. All the required testing & calibration equipment shall be brought by Tenderer to site, on returnable basis, for testing & calibration work at site.

9. Quantity of all these items shall be as per actual requirement at site, to meet the erection schedule. All test & calibrating equipment shall be approved by NPL/IDEM/ ERTL authorities.

10. Loop test shall be performed after calibration of all instruments and leak test of instrument impulse lines. It shall be carried out to check the functional performance of all elements comprising the loop thereby ensuring proper connection of the following:

   I. All elements are properly installed, calibrated and function properly.

   II. All scales are introduced with proper ranges in DCS/PLC.

   III. All alarm units and shut down devices are set properly and accomplish their intended purpose.

   IV. Controller settings for various modes of operation in DCS/PLC (proportional band, reset and rate action) are at nominal values.

   V. The action (direct or reverse) of the controller is set as prescribed.

   VI. DP transmitter with DCS/PLC in the control room shall be loop tested by applying impulse signal to the transmitter by means of a squeeze bulb and a U-tube manometer at the field and performance of the receiver instruments/display in automation system in the control room shall be checked at 0%, 25%, 50%, 75% and 100% FS inputs in both ascending & descending modes.

   VII. Pressure transmitter with DCS/PLC in the control room shall be loop tested using a dead weight tester and a standard gauge with accuracy better than +
0.1% at field and performance of receiver/display in automation system in the control room shall be checked at 0%, 25%, 50%, 75% and 100% FS inputs in both ascending & descending modes.

VIII. For temperature loops with resistance thermometers in field and DCS/ PLC control room, known resistance shall be injected at signal cable near the resistance thermometer in the field through decide resistance box and DCS/ PLC display shall be checked for input signals of 0%, 25%, 50%, 75% and 100% FS in both ascending & descending modes.

IX. For temperature loops with thermocouple in field and DCS/PLC display in control room, a known milli-volt signal shall be injected at the compensating cable end in the field from milli-volt simulator and DCS/PLC display shall be checked for input signals of 0%, 25%, 50%, 75% and 100% FS in both ascending & descending modes.

X. In case of control loops, the set point of PID controllers shall be adjusted manually from HMI for output of 0%, 25%, 50%, 75% and 100% FS and control valves shall be checked for rate strokes in both ascending & descending modes.

XI. Alarm system shall be checked by simulating abnormal conditions in the field mounted differential pressure switches by shorting the wires at terminals and the function of the alarm system.

02. Commissioning

1. This activity shall be planned in consultation with & as per the directives of Client/Consultant.

2. Before commissioning, loop checking for all the measurement & control loops shall be completed and results shall be recorded in approved formats.

3. Initially, the instrumentation equipment & systems shall be checked & tested to establish their specified performance and to ensure readiness for integrated testing with the automation system and commissioning of the plant. All these results shall be properly documented for records.

4. Subsequently, when the plant units are to be commissioned, Tenderer shall actively participate in these activities by providing required manpower in general shift as well as in three shifts round the clock to ensure reliable & trouble-free performance of all the instrumentation equipment & systems supplied by him.

5. All the data/ performance of Instrumentation equipment/ system during commissioning & acceptance tests shall be properly documented & submitted.

20. QUALITY ASSURANCE PLANS (QAP):

Quality Assurance Plans shall be submitted by the vendor for each category of instrumentation & automation equipment, based on the sample QAPs included with this specification. The vendor’s QAPs shall include all tests / inspection procedures indicated in the sample QAPs, as minimum, which, after finalisation, shall form the basis of inspection procedures to be followed and complied with.

Inspection calls shall be issued only after ensuring and confirming complete readiness of all the equipment/system in compliance with the finalized/approved drawings & documents. Inspection calls shall be accompanied with internal test, calibration certificates and material certificates, as applicable. If required, waiver of inspection can also be decided depending on type of instrument, completeness and correctness of
test and calibration activities as per the report submitted. Inspection can take place on either 100% of all the equipment or on a selective basis.

In addition, Vendor’s responsibility shall also include the following:

a) Issue of inspection call only after ensuring & confirming readiness of total/substantial amount of all the instrumentation & automation equipment at one location/manufacturer’s premises.

b) Minimum of 15 days prior intimation for each inspection.

c) Ensure participation of competent representative of vendor during the inspection.

d) Making available all the required drawings & documents, catalogues, relevant standards, norms, etc. as may be required for carrying out inspection activities successfully.

e) Arrange and provide facilities for test, calibration and performance of each equipment individually & also in integrated mode as per requirement.

f) Modify/repair/replace defective and damaged items/equipment, if found during inspection, to the satisfaction of the inspector.

g) Submission of results of tests, inspection reports etc. in required number of sets.
21.00 DCS BASED AUTOMATION SYSTEM

21.01 General

Adequate and appropriate automation systems shall be designed and engineered using state-of-art and field proven technology to facilitate monitoring, control and all other functions associated with operation of all the plant/shop units through user-friendly human-machine interfaces.

The Automation system shall be designed with geographical & functional distribution of hardware in a multi-level hierarchy, viz, Level-0, Level-1, level-2, level-3 etc, as applicable, to meet specific plant requirements for monitoring, control, process visualisation & optimisation of all the plants/shop units.

The instrumentation & automation system shall be structured in general, considering the following hierarchical levels:

Level-0: This level, also called field level, is functionally responsible for generation, transmission & conversion of signals for the process parameters compatible to the higher level equipment as well as signal based activation for the final control elements.

This level is realized based on the primary sensing elements, transmitters, switches, converters, microprocessor based intelligent systems and final control elements. The components of this level shall be grouped and distributed geographically around the plant as per main process equipment location.

Level-1: This level, also called supervisory level, is functionally responsible for supervision of the individual process equipment & functions, monitoring, control, visualisation and regulation of process parameters to the desired level based on the signals generated from the field level. This level is also responsible for processing of signals for generating compatible control commands to control the process parameters by activation of the final control elements.

This level is realized based on the controllers & systems, input & output systems, data base units, data communication, visualization system (HMI stations) and interface units for connectivity to the other levels of the instrumentation & automation system. In addition to routine PID functions, advanced process optimization functions comprising special control algorithms, mathematical computations etc. will be able to permit distribution of control and data acquisition functions throughout the entire plant.

Level-2: This level is functionally responsible for the process control functions through the Level-1 automation system by process guidance & optimization and control of process parameters to the desired level of perfection based on the available signals from the supervisory level. This level is also called process control level and is responsible for generating set points / control commands to the Level-1 equipment based on the pre-loaded process specific mathematical models. This level is realized based on the process computer & its own data base units, input & output systems, data communication systems, visualization system (HMI stations) and interface units for connectivity to the other levels of the instrumentation & automation system. Level-2 automation system has been covered under a separate General Specification.

The Level-1 automation shall basically comprise:

- Either a Distributed Control System (DCS) based automation system
- Or, a Programmable Logic Controller (PLC) based automation system
- Or, a combination of both, depending on project / application specific demands & requirements.
Basic design & selection criteria for Distributed Control System (DCS) based automation system have been indicated in this section of the General Specification, which read together with the main Technical Specification, shall cover the total requirements of DCS based automation system of the plant/shop units. In case of any conflict/discrepancy arising in these documents, the requirements indicated in the main Technical Specification shall prevail. DCS based automation system can also be designed using Foundation Field bus/ Profinbus PA compatible field instrumentation equipment & Field bus interface modules in DCS, depending on plant specific applications.

The General Specification of Programmable Logic Controller based automation system has been separately covered under Electrical part the GS and shall be referred to wherever PLC based automation systems are to be used for any application. Where both the DCS and PLC based automation systems are required to be used in plants, these shall be interfaced on a common network under Level-1 for smooth and integrated operation of the plant.

21.02. Salient Features

This specification of Distributed Control System defines the minimum requirement of the system for smooth, reliable, safe, efficient & trouble-free operation with optimum monitoring and control of process plant and equipment.

1. The DCS shall be of proven technology, microprocessor based, built around minimum 32 bit processors with its control and monitoring functions distributed geographically & functionally and designed for fault avoidance by proper selection of components.

2. The system shall be based on the latest state-of-the-art technology and must be successfully operating in Industries for the last few years. It shall have high availability, high reliability & high maintainability.

3. The system shall be modular in nature and shall have facilities for easy expandability & upgradation of modules to enhance its functionality or performance, if required, in future.

4. The system shall be versatile, rugged and suitable for continuous duty in normal industrial environment.

5. The DCS shall be suitable to meet the specific process requirement including monitoring, control, interlocking & sequential operation of the process and shall also be designed accordingly. Application software of the DCS shall be developed by the system manufacturer/ supplier based on the functional requirements of the process.

6. The system shall comprise of a standard library of control, logic and computational functions that are preprogrammed and stored in memory. During the system configuration, user shall be able to select the appropriate functional blocks from the library, link them together, set the various inputs and tune parameters associated with each block. In case the process demands, the system shall also include fuzzy logic functional blocks in the library.

7. In addition to the required measurement and control of process parameters, DCS shall have provision for sequential logic functions, safety interlock logic function, real time monitoring & display of process operating conditions alongwith alarm & event recording functions.

8. The system shall be OPC compliant and based on the concept of open system architecture to enable easy integration with Level-2 automation system, Management Information System (MIS) and other systems for plantwide automation. The DCS shall also allow use of third party software (e.g. operation interface, optimization software or expert system) to make it an integral part of the overall automation system of the plant, if required. Communication with other systems/devices shall be via industry standard
protocols. System architecture & programming shall generally comply with IEC 61131.3 standard.

9. In case Level-2 automation system is envisaged for the plant, the DCS shall efficiently communicate with Level-2 automation system and proper interface modules shall be provided accordingly. The DCS shall be able to change its control algorithms and set points based on the process demands generated by the Level-2 automation system and control the process to have better co-ordinated operation of the complete plant.

10. The DCS shall be configured with independent work stations.

11. It shall be possible to remotely access the automation system using any standard off-the-shelf web browser such as Netscape’s Navigator or Microsoft’s Internet Explorer. All hardware and software needed to allow users to view process graphics and displays, events, and historic as well as real-time trends shall be listed. All information viewed remotely shall update in real time. All web browser access shall be secure. It shall be for viewing purposes only. It shall be possible to configure different security access privileges for each user.

12. In addition to the normal features to monitor & control the process, the DCS shall also have following software features as minimum:
   - Multi-tasking
   - Operation on Windows NT platform
   - Object linking and embedding (OLE)
   - OLE for process control (OPC)
   - Open Data Base System (ODBS)
   - 3D Graphics

13. For various signal inputs interfaced with the system, the DCS shall be capable of preventing noise errors due to EMI or RFI including disturbance signals from near by radio stations, walkie-talkie, Electrical storms, solenoids & relays or contactors carrying heavy current. Equipment shall meet all electromagnetic compatibility requirements of the IEC 61000-4-2, 61000-4-3, and 61000-4-4 standards. The system shall also be internally protected against system error & hardware damage resulting from electrical transients for both power & signal wiring, connecting/ disconnecting devices or removing or inserting PCB on DCS.

14. A single failure anywhere in the system shall not result in the loss of regulatory control to more control loops than those associated with a single process input/output card. Failure of any single device shall not affect the ability of the system to communicate with other devices in the system. Switchover shall not disrupt any system functions. Redundant equipment and software shall be continuously monitored for errors. All modules shall be diagnosed on-line. Errors shall be alarmed with an error message identifying the failed module.

15. The system shall work satisfactorily in hot & dusty atmosphere of steel plant, without any type of failure. It shall have the operating limit as per the following:
   - Operating Temperature: 0-45 degree C.
   - Storage Temperature: 20-60 degree C.
   - Relative Humidity: maximum 95% not occurring simultaneously with maximum temperature.

21.03. Basic Structure

The DCS shall comprise of Process I/O units, multiplexers, A/D converters, Communication electronics, hot (dual) redundant CPUs & its memory units, hot (dual) redundant Power supply modules for both controller & I/O racks, hot (dual) redundant I/O bus system with corresponding interface units for both controller & I/O racks, hot (dual) redundant main Data
Highway with corresponding interface units, Operator’s consoles with peripherals, hot (dual) redundant Network communication modules for Level-2 automation system (if applicable), marshalling/ field termination racks, desks, panels, etc., as may be required for completeness of the system to meet operational & functional requirements of the plant.

The above equipment/ items based on their specific functions shall be divided into modular subsystems classified as —Data Acquisition subsystem; Controller subsystem; Communication subsystem; Operator’s interface subsystem consisting of Engineering & Operator’s workstations.

21.03.01 **Data Acquisition Sub-system**

i. This subsystem basically comprises input / output (I/O) units alongwith other accessories. It provides the main interface between process/ instrumentation system and the control room automation system.

ii. Data acquisition subsystem shall interface all analogue and discrete inputs from various equipment/ instruments envisaged for this plant and shall also provide the final output to respective equipment/ instrument. The inputs shall include 4-20 mA DC, 1-5 V DC, all types of thermocouples (T/C calibration standard shall be DIN 43710/ ANSI-MC96.1/ IS 2054/ IEC60584, etc.), 2-wire/ 3-wire/ 4-wire RTD, pulse and discrete (digital) contact, etc., as may be required for this project. The outputs shall include 4-20 mA DC, 1-5 V DC, pulse and discrete (digital) contact, etc., as may be required for this project. Control valve actual position (in 4-20 mA) shall also be interfaced & displayed in the system for the respective control loop.

iii. I/O racks with necessary slots with complete wiring shall be provided for installing the analog and digital input/output cards and other modules & interface units. All the cards shall be modular & plug-in type. It shall have suitable mounting base for easy installation and online replacement without switching of the power supply or affecting other cards in the I/O rack.

iv. The field cables shall not be brought directly to the I/O cards. The same shall be routed through the field termination / marshalling racks and will be part of DCS. All wiring inside racks / cabinets / back of the panels shall be housed in covered nonflammable plastic raceways arranged to permit easy accessibility to various equipment. The cable ducts inside DCS cabinets shall be of fire retardant type as per UL 94 VO.

v. The system shall be capable of checking signal validity, broken sensor check, input processing, linearisation & compensation for T/C inputs, linearisation of RTD inputs, square root extraction for flow inputs, temperature and pressure compensation & totalisation of flow inputs alongwith other mathematical functions as may be required for this project

vi. 20% spare I/Os over and above the total requirement for respective type of inputs/ outputs shall be provided. Number of I/O cards shall be supplied & installed in the I/O racks accordingly. These installed spares shall be wired up to the terminal block.

vii. 4-20 mA DC analogue signal shall be with load driving capability of minimum 600 ohms at 24 VDC. Digital signals will be generally potential free contact type with load driving voltage derived from the in-built power supply of the DCS.

viii. Suitable redundancy shall be provided for data acquisition subsystem including processor. This redundancy shall be in such a way that the failure of processor, single hardware like I/O module, communication interface & cable, power supply, etc. in data acquisition subsystem shall not affect more than the analogue & digital inputs/ outputs connected to a particular I/O module. The redundant component shall take over in case of main component failure automatically. This shall exclude redundancy of I/O modules.
ix. The I/O units shall have suitable galvanic isolation. It shall have insulation voltage level of 1.5 kV between each terminal to ground, between input & output terminals, between power & ground, as applicable.

x. Individual fuse for each unit shall be provided for protection against fault.

xi. LED Status indication shall be provided for respective card/ channels.

xii. The I/O cards shall have protection against polarity reversal of signals.

xiii. Both analogue & digital output cards shall have configurable fail safe options such as, drive to zero or maintain last output value. These fail-safe actions, if configured, shall come into picture incase of processor halt or communication break between the controller and I/O module.

xiv. All digital I/O circuits shall be properly designed to ensure that accidental normal mode connection of upto 300 V AC/DC for an unlimited period of time shall not cause damage other than to the I/O module to which it is connected.

xv. For analogue input & output card, the best available accuracy in the manufacturing range shall be provided.

xvi. Analogue input cards shall be differential type and shall be of 8 or 16 channels. Analogue output cards shall be of generally 8 or 16 channels. Analogue input & output cards shall have necessary A/D / D/A converters having 12/14 bit resolution.

xvii. All the analogue I/Os shall be differential type with channel to channel isolation & isolation with power supply.

xviii. Digital input/ output cards shall be of 16 or 32 channels.

xix. Analog input modules shall be able to power 24 VDC power supply to 4-20 mA field instrumentation loops with a loop resistance of 600 ohms. Vendor shall properly clarify whether in case, each channel of input card is unable to provide the required 24 VDC power supply, separate dual redundant diode 'OR'ed bulk power supply units shall be provided.

xx. The analog input card shall be intelligent type capable of carrying out functions like signal conditioning, conversion and limit checking. It shall also detect open and short wire condition. For connectivity of smart transmitters, corresponding terminal strip of the marshalling rack shall be provided with suitable resistance. Connection shall be such that on-line configuration (through handheld calibrator) of transmitters are possible from the marshalling cabinet itself without disconnecting any cable.

xxi. The digital input cards shall be capable of supporting both on/off and latched discrete input applications. Digital signal shall be sensed using 24 VDC power supply. This power supply shall be either generated internally in the card itself or by using separate bulk power supply units.

xxii. Digital input/ output card shall have suitable ON-delay & OFF-delay, for proper sensing and further operation.

xxiii. Digital output can be either discrete (ON/OFF) or single pulse. Duration of the single pulse output shall be configurable from the engineering workstation. All outputs shall be through separate 24 VDC relay with contact rating of 5 A, 240 VAC. Separate relay boards with mounting base shall be used for the mounting of the relays. Relay powering shall be arranged through separate bulk power supply units.
xxiv. For all the close loop controls, actuation of the electrical actuator of control valve shall be carried out through either by 4-20 mA DC outputs & separate hardware positioner or digital/pulse outputs, depending on system design. For digital/pulse outputs, the outputs through relays shall be interfaced with auxiliary contactor of MCC connected to power circuit of electrical actuators for phase reversal required for forward-reverse movement. For pneumatic actuator, 4-20 mA DC outputs shall be used. PID blocks/ algorithms shall be suitable to take care of such applications.

xxv. For internal wiring of all inputs/outputs up to marshalling terminals, flexible copper cables of minimum 0.5sq.mm size shall be used. No field inputs shall be terminated in terminals of I/O cards directly. Screened cables shall be used for milli-ampere/ milli-volt signals from I/O rack to terminal block.

xxvi. Compensating cables shall be used for thermocouple signals from I/O rack to terminal block compatible for compensating cable, if thermocouple signals are to be directly interfaced with input card. Separate cold junction temperature sensor shall be provided for each thermocouple input module.

xxvii. Fused Terminal Blocks with LED indication shall be provided for all input & output analog & digital signals, except for RTD & T/C inputs. The terminals shall be screw-less, clamp-on, single tier type and shall be suitable for termination of minimum 2.5mm2 copper cables from field.

xxviii. For different type of inputs /outputs, different coloured wires and terminal blocks shall be provided. All internal wires shall be neatly dressed, bundled together and routed in PVC channels / cable alleys with removable covers. The terminals for connection of external cables shall be located in marshalling panels: The size of marshalling panels shall be decided during detail engineering considering number of field cables to be terminated.

21.03.02. Controller Sub-system

i. The controller subsystem shall be built around 32-bit processor, easily configurable/programmable using user friendly software. The central processor shall be modular & plug-in type and shall have independent processor rack.

ii. Controller subsystem shall be provided as configured in dual redundant hot standby mode with smooth change over from working to standby unit without affecting the system and process.

iii. Hot standby processor shall regularly update the I/O information and shall also execute the program. However, the main/ master processor shall only provide the final output.

iv. It shall carry out open loop process monitoring, closed loop control, sequential and logical operations including alarms & interlocking function alongwith other functions as may be required for operation of the process & control system.

v. The controller shall have advanced control algorithms to implement regulatory and advanced control strategies. These shall include PID adaptive, feedforward, cascade control, dead time, lead lag, high-high, high, low, low-low signal selection, realtime computational capability. The controller shall also have auto-tuning facility. Necessary software & functional blocks shall be provided accordingly.

vi. The central processor system shall be capable of handling 30% additional (future expansion) I/Os, over and above the installed I/Os. Maximum processor loading shall be limited to 60% for the intended applications.

vii. It shall have response time of less than 200 ms, which includes times for on-line system self-tests, data acquisition & validation, processing, synchronisation, redundancy
management, network communication, application software & commanding for all the applications. This response time shall include response time of less than 100ms for close loop control operation. Response time shall not be affected with inclusion of future I/Os as per the requirement indicated in the specification.

viii. The system shall have response time of 1 second from the instant of commanding from operator station, to the actual execution of command at the output module during peak load.

ix. The system shall have response time of 1.5 seconds from the time a change takes place at the input module, to the time it is displayed at the operator’s station.

x. The system shall have built-in simulation features to check the I/O channels individually, without activating technological elements.

xi. Each processor rack shall have hot redundant rack based power supply modules.

xii. The program memory shall be stored in EPROM/EEPROM or battery backed RAM. It shall be modular & plug-in type. It shall have 40% free space for future use. It shall be expandable in blocks. In case of rechargeable batteries, necessary charging circuit shall be provided. The system shall have provision for battery replacement without loss of data.

21.03.03. Communication Sub-system

i. For communication between controller and data acquisition system, hot redundant I/O bus shall be provided. It shall be capable for high speed data transfer.

ii. For interfacing of this redundant I/O bus, redundant communication interface modules shall be provided in each controller rack and in each I/O rack.

iii. Respective I/O rack shall act as a node to the I/O bus for interfacing with processor rack and shall not be interfaced through back plane extension between two or more I/O racks.

iv. Each controller rack shall communicate with operator workstations and other peripheral units through dual redundant Data Highway. The communication network shall be real time, switched Ethernet IEEE802.3 & IEEE802.3v compliant TCP/ IP type with modbus protocol and bus speed of 10/ 100 MBPS.

v. If more than one DCS based automation system have envisaged for the plant, then the above Data Highway shall be common for both the DCS for interfacing with the work stations and information exchange.

vi. Both the buses of redundant I/O bus and redundant Data Highway shall be active at all times. Periodic health diagnostic of each bus and communication interface modules shall be carried out automatically at regular intervals without affecting system operation. In case of any failure, it shall automatically transfer to the redundant device without interrupting the system operation and without any operator’s intervention. It shall also be possible to change the communication from the main bus to the redundant bus manually without affecting the system operation.

vii. Failure or planned shutdown of any one device connected to communication network shall not affect the ability of the system to communicate with any other device on the network.

viii. The system shall also have proper interface modules for communication with Level-2 automation system, if envisaged for the plant. These interface modules shall be hot redundant type.
ix. For applications involving interfacing of DCS with Level-2 automation and other systems, details of hardware/software, as may be required for establishing communication and integrated performance shall be provided.

x. Suitable isolation shall be provided between the bus and various nodes interfaced with it.

xi. Various communication links including bus shall be suitably designed to take care of the total requirement of information exchange including future expansion requirements. The overall system performance including display update time shall be independent of the loading of the bus and the bus loading shall be decided accordingly.

21.03.04 Foundation Field bus system

i. The Field bus interface modules (FIM) of the DCS shall be chasis based modules. These modules shall completely integrate Field bus devices with the DCS controller & HMI software. These FIM modules shall deliver system wide integration of data access, control, connections, diagnostics and alarms with the DCS system. LED indication of power, error condition & status shall be provided in each FIM module.

ii. DCS shall provide graphical support to the Field Bus Interface module to perform the functions of Link Active bus scheduler for a network. This will allow the system configuration engineer to see what’s going on and shall provide complete flexibility to adjust schedules based upon the needs of the control scheme. DCS shall also support Back-up Link active scheduler.

iii. All Foundation Field bus (FF) devices shall be registered with the Field bus Foundation at level ITK 4.0 or higher. Field bus interface modules & Field Bus Library manager shall be compatible with ITK 4.0 or higher version compliant devices. Field bus usage license shall be provided. All FF devices provided shall be polarity insensitive. All FF cables shall be of Type A.

iv. The DCS shall be certified for the Field bus Host Inter operability Support Testing (HIST) from Field bus organisation. HIST procedures provide a common methodology for assessing host inter-operability with registered devices.

v. DCS Software shall have the capability either to directly read Device description (DD), files from the Field bus devices or add these DDs/Files to the library for Off-line & On-line configuration, or it shall perform this task through a separate software tool, Field bus library manager. It shall be possible for DCS based automation system to upload field device configuration changes implemented in the field. Once the configuration information is stored in the automation system, it shall be possible to download it to any other similar device, whether a new or replacement device.

vi. In case of a new device added to a Field bus segment, its presence shall be immediately shown in that segment. Important information about the new device including tag name, address, model and revision shall be immediately available.

vii. Downloading new software to Field bus devices shall be possible from the DCS. There shall be no need to physically change the firmware and to disconnect or remove devices for updating to the latest available revision. It shall be possible to simultaneously download the latest firmware to multiple field devices.

viii. Each Field bus interface module shall support minimum two segments. Each segments shall have the following features:

- Each segment shall be limited to twelve (12) devices with monitor only measurements if the loop execution rate is one (1) second.
• Each segment shall be limited to twelve (12) devices including four (4) control valves if the loop execution time requirement is one (1) second.
• Each segment shall be limited to six (6) devices including two (2) control valves if the loop execution time requirement is Five hundred (500) milli seconds.
• Each segment shall be limited to three (3) devices including one (1) control valve, if the loop execution time requirement is two hundred fifty (250) milli seconds. Accordingly, number of Field Bus interface modules shall be decided. Maximum number of FIM module handling capacity of the DCS shall be indicated.

ix. The Network shall generally carry 50 messages per second and as such, shall be limited to only one (1) segment considering the scan rate required for the different process variables, measured by the Field bus devices, connected to the same network. Thus the use of repeaters (repeater relay messages between segments & a repeater also counts as one device) shall normally be avoided.

x. The power for each Field bus segment shall be provided through a power conditioner to prevent the communication signal from being attenuated by the power supply & to eliminate cross talk between FF segments through a common power supply.

xi. Each device on a segment must receive at least 9 V DC. Voltage drop calculation shall be submitted for each segment of all the networks during detail engineering. Power supply on each segment shall be designed taking into account the power drawn by different devices connected in that segment. However, from modularity & spare inventory point of view, the power supply module of all the Non – I.S. of segments shall be designed considering the power requirement of that segment which requires maximum power + 30 % extra power for future provision.

xii. The Field bus segment shall be implemented either following Tree on Branch Topology or any combination of the two. The Tree topology consists of a trunk line (main segment) with multiple spurs coming off the trunk line at one point. The Branch topology consists of a trunk line with multiple spurs coming off the trunk line at multiple points.

xiii. A Branch topology shall be used to connect individual devices to the Field bus segment. Conduits, junction boxes and pull box assemblies shall be used to implement this topology. Wherever possible, quick disconnect junction boxes & quick disconnect ‘T’ devices shall be used to reduce wiring errors & simplify maintenance in the field. A daisy-chain topology shall not be used as disconnecting a single device may result in the loss of downstream devices.

xiv. All field bus devices on the field bus segment shall be able to communicate at 31.25 Kbits/sec. It should support peer-to-peer communication.

xv. The field bus device shall use device description technology in addition to having standard field bus function block as specified by the Field bus Foundation. The field bus device shall be able to perform continuous self-diagnostic to check its own health.

xvi. All the transmitters (based on FF) shall have the capability to become a device link master which means it can function as a Link active scheduler if both the Field bus interface module fails.

xvii. All field bus devices that require bus power shall be capable of utilizing voltage supply levels of any level between 9.0 and 32.0 V DC. Field bus devices that do not require bus power shall be capable of operating on the field bus without affecting the existing supply voltage on the segment. No device shall be used that requires more than 28 mA from the bus power supply.

xviii. Installation of all instrumentation devices in hazardous areas shall be made using intrinsically safe systems. A Field bus segment in a hazardous area may consist only of
the type and number of devices which will not cause the segment current draw to exceed the rating of the I.S. barrier. Area classification includes both class I Div 1 and class 1, Div 2 hazardous areas.

xix. The Terminators shall be impedance matching modules to be used at or near each end of a segment. There shall be two terminators per segment. The terminators prevent distortion and signal loss and shall be supplied as a pre-assembled, sealed module. Terminators shall be provided as per the requirement.

xx. For Field bus use, a power supply impedance matching network shall be provided. This shall be a resistive/inductive network and built into the Field bus power supply module.

xxi. Connectors as coupling devices shall be employed to connect the wire medium to a field bus device or to another section of wire. Standard field bus connectors shall be used. Specification shall be as per annexure A of the ISA physical layer standard and annexure A of the IEC physical layer standard.

xxii. Couplers shall be the physical interface between segment and spur or segment and Field bus device. Field bus couplers shall be as specified in the IEC/ISA physical layer standard and provide one or several points of connection to a field bus segment.

xxiii. Field bus Network/segment naming convention
The following recommended network/segment naming convention shall be followed:

# NN MM P
- #: Indicates the plant/area number to which the segment shall be connected.
- NN: Indicates the node number/controller name.
- MM: Indicates model number/card number.
- P: Indicates segment or port number.

Loop & Instrument Naming convention
- Loop & Instrument naming convention shall be decided during detail engineering.

Spur Naming convention
- All spurs shall be labeled with Instrument tag name.

xxiv. Grounding: The instrument signal conductors shall not be used as a ground. Instrument safety ground shall be made through a separate conductor outside of the signal cable. The conductor may be in the same cable as the instrument signal conductors and shield, but shall be located outside the shield within this cable. Field bus devices shall not connect either conductor of the twisted pair to ground at any point in the network. The Field bus signals are applied & preserved differentially throughout the network. Network cable shield shall be earthed/grounded in one location only, at the field termination assembly (Host) end. At any field instrument, cable shield shall not be connected to the instrument earth/ground or chassis. The cable shields from different networks shall not be attached together in a field junction box. This will create ground loop & noise onto the network.

21.03.05. Operator Interface Subsystem

i. Operator interface subsystem shall provide centralised operation, control and information of the plant as well as engineering of the automation system.

ii. These workstations shall be used for operator interface, engineering, data logging, trending, alarm & graphic generation and Management information system.

iii. Irrespective of independent workstations, in the event of failure of any one station, the other stations shall be able to monitor and operate the complete plant.
iv. The system shall have global database available at each workstation. It shall be possible to change control assignments to allow control of any plant area from any operator workstation by using the appropriate access password.

v. The Operator workstations shall be provided with various menus, command buttons, facilities for selection of mode of operation, selection of working/standby, start/stop & facilities for control & monitoring of complete plant equipment.

vi. All displays & operation of the operator’s workstations shall be interchangeable. Under normal operating condition, each workstation shall be able to assign a specific task. However, in case of failure of one workstation, all the tasks assigned to that shall be possible to be done through any other workstation interfaced with the same bus.

vii. Any change made in the database of one workstation shall automatically update the database of other workstations of the same network system.

viii. All real time clocks in the system shall be synchronized with each other at regular intervals.

ix. The operator, as a minimum, shall have access to the following through the keyboard of operator workstations whenever required:

- Selections of all the displays including the direct selection of loop in alarm, page turning facility for overview, group display, loop display selection etc.
- Selection of loop for operation.
- To acknowledge alarms as and when they are annunciacted on the workstation.
- Facility for easy selection of any parameter.
- Facility to enter any changed parameter like set point, manipulated variable, digital commands and to cancel any wrong entry while making such change.
- Auto/Manual/Cascade/ Computer mode changes for each control loop.
- Selection of print outs for graphic page, log sheets, alarm history and assignable trend recorder points.

x. Operator workstations with its graphic interface shall have the following minimum features & display facilities with user friendly navigation keys:

- Overview display of the plant & process.
- Group display.
- Loop display including control loop with facility for modification of its parameters.
- Graphic display including 3D Mimic.
- Alarm overview display.
- Individual alarm page display.
- Real time trend display.
- Historical trend display.
- Periodic Event & Alarm logging, report generation and printing.
- System fault & error detection, broken sensor detection and their reporting.
- Configuration display.

xi. Engineering workstation shall have the following minimum facilities for restricted user/engineer through keylock:

- Data base configuration, including over view, group, loop, multi loop & multivariable control configuration.
- Group or multi group alarm inhibits from a plant under maintenance.
- Configuration of alarm settings and their values, addition & deletion of components in a loop.
- Tuning of control loop including change of P, I & D parameters, dead time etc.
- On line compilation of graphic displays using standard symbols. Graphic symbol library shall be developed & provided as per ISA-5.1 & 5.3. Additionally, standard industrial symbols shall also be provided. User defined symbols shall also be generated & used.
- Report generation and modification
- System access configuration
- File access
- Diagnostics
- Workstation/monitors and keyboard plant area assignments.
- Utility program access.
- Setting of parameters to be logged and its addition/deletion.
- Setting of real time clock.
- Assigning parameters for historical trending.
- Access of detailed self-diagnostic for maintenance.

- A configuration tool shall be provided to generate or modify database and configuration data. The configuration tool shall employ fill-in-the-blanks or graphical block connecting format. It shall have step-by-step prompts to guide sequential actions followed by validation responses on completion of the actions. It shall request only applicable information based on previous responses.
- A common configuration tool shall be used for traditional and Field bus based control. It shall allow for selecting the location of control in the system controller or in the field device. Configuration of the control module shall be the same regardless of where the control is located.
- Configuration displays shall be provided to aid in system configuration. All displays and tags will reside in one global database shared by the entire system. No data mapping between systems shall be allowed. It shall be possible to show:
  - All tags in the system.
  - All parameters for each tag, including (as applicable) tag ID, tag descriptor, the hardware address, tuning constants, mnemonics associated with the tag, algorithm relating to the tag, and input/output details.
  - All configurable (or soft) keys and their function.
  - All hardware modules in the system and the configuration parameters for each.

xii. For the engineering workstation, access shall be restricted to some select users with user identification & password. All programming shall be suitably protected from unwanted interference.

xiii. When configuration data are downloaded to the automation system, invalid configuration entries shall be identified and the parameters affected shall be indicated.

xiv. Saving of all database and configuration data on both removable and non-removable media for back up purposes shall be possible without taking the system off-line.

xv. Redundant on-line storage media for configuration database.

xvi. After completion of configuration & programming, any change made therein shall be properly logged with user identification and time. This shall also be identified with proper revision number.

xvii. Changes made for any parameter in a particular display page shall be automatically updated on all displays configured for that input.

xviii. Engineering station shall be capable of ON line & OFF line programme development with necessary hardware interface and software. Facility shall be available for loading of programme developed on EPROM and CD/floppy.

xix. Faults with description, date & time of occurrence shall be displayed on the Operator workstation with sound and shall flash with acknowledging facility. Once the fault is acknowledged, the flashing shall become steady. The fault shall remain on VDU screen till it is rectified.
xx. Shift-wise, daily, weekly, monthly, yearly logging of faults, events for various process & mechanisms and reports/data etc. shall be provided. Format for logging of reports/data shall be discussed with operation department, which shall be modified, if required, at site during testing and commissioning. Printing facility for the same shall also be provided.

xxi. Display of dynamic graphic of different section of plant on the VDU shall be provided. Graphic displays shall be field configurable. Different plant section's dynamics shall be displayed on different pages. Graphic display shall be interactive type through which it shall be possible to control the process. It shall also be possible to send various start/stop & open/close commands and shutdown command etc., from graphics or loop display.

xxii. Moving from any graphic page to other related graphic page or any group view or alarm summary shall be achieved in single key stroke using soft key functions.

xxiii. The dynamic components (both binary state & analogue value) display the actual state of the plant section. Analogue values shall be represented as bar charts and/or numerical.

xxiv. Critical plant status shall be highlighted by different colours or by blinking. Description in clear text shall be provided to simplify Operator understanding.

xxv. All the display screens shall be finalised/designed taking care of plant & process requirement during detailed engineering and also commissioning.

xxvi. Double clicking on any of the control valves in any of the menu/submenu pages shall invoke the corresponding PID loop display screen with controller facia displaying status and parameters (both in bar graph & digital) of each variable and real time trend for all variables of the loop. The remote manual functions and change of set points under auto mode shall be possible to be performed from these facias.

xxvii. In case of Cascade/Ratio control, the page shall show facia of all the controllers with the facility of maximising view of one of them, when selected. PID parameters can be changed only after validation of software password.

xxviii. Software lamps & push buttons as per the requirement shall be provided in respective graphic pages.

xxix. In any menu/sub menu page, double clicking on any tag shall invoke the trend menu of that particular tag. Based on the selection by the Operator either Historical or Real Time Trend menu shall be displayed. Provision shall be there so that Operator can include additional trends by entering the tag nos., in the same page, using the same time base for comparison purpose.

xxx. It shall be possible to configure any analog point for trending and also to trend at least six different analog points simultaneously on one real time & historical trend display. Real time trending for digital signal shall also be possible. Each trend display shall consist of the plotted trend graph(s) and a table showing trend parameters. When an analog point is not available (point off scale, out of range etc.) an unavailable code shall be entered in the history.

xxxi. The automation system shall support historical process information recording & retrieval. This historical information shall be available for use in logs, trends, etc., requested at any workstation.

xxi. The recorded process information shall include – measured value; alarm status; set point or desired value; control mode.

xxiii. For both logging & historical trending the operator shall be able to specify the points to be recorded, the frequency with which the data is to be collected and the time base.
xxxiv. Historical data shall support the protocols like – OPC (Open Process Control); OLE (Object Linking & Embedding); ODBC (Open Data Base Connectivity) & API (Application Programming Interface).

xxxv. Zoom in/out and moving forwards and backwards in time shall be possible with no more than two operator actions. A mechanism for selecting a location on the trend, such as a hairline cursor and reading the digital values of the trends at that point in time shall be provided.

xxxvi. Scan time for trending of any tag shall be adjustable & user selectable. Display of trend shall have:

(a) Operator scalable X-axis from 60 seconds to 24 hours. For 24 hours history, trend shall be stored as 10 seconds scan for each variable.
(b) Operator scalable X-axis from 8 hours to one month. For one month history, trend shall be stored as 2 minutes average value for each variable.

xxxvii. Each event history file entry shall contain the time and date of occurrence, the tag ID, the tag description and Value/ State and the type of event.

xxxviii. All discrete process events like inputs changing state, analog inputs going into or out of alarm, equipment changing state (running/stopped, open/ closed), etc. shall be stored in history files.

xxxix. All operator actions, which affect the process, such as opening/ closing isolation valves, starting/stopping of pumps and motors, changes to set points, changing control blocks between automatic & manual, etc. shall be stored in history files.

xl. Irrespective of Operator activity and choice of display, an alarm situation shall always have priority and shall be brought to the attention of the Operator, quickly and automatically.

xli. Display containing alarms shall be selected by a single keystroke action. Alarms should automatically update in the event of an alarm operating i.e. it should not require operator intervention to update alarms either on process mimics or alarm summary format.

xlii. Alarm messages shall be time tagged to within 100 milliseconds (from detection at input card or receipt from data link) or less and are required to be displayed within 1.5 seconds from the time it has been sensed in the input module. Alarms shall be displayed in order of occurrence, and/or priority.

xliii. In order to facilitate easy recognition of alarm status by operators, annunciator colours and audio tones shall be easily distinguishable. All alarms and trips shall be annunciated by a screen message and an audible alarm. The alarms and trips shall flash in a highlighted form (e.g. reverse video) until acknowledged. When acknowledged from any CRT, the flashing and audible tone shall stop on all CRTs. When an alarm returns to normal, flashing shall return to normal on all CRTs provided the alarm has been acknowledged. Different display colours shall be used for various types of alarms.

xliv. All process variables and composed points shall have the possibility of being assigned at least two levels of high and two levels of low alarm values. All control loops shall have the possibility of being assigned high and low deviation alarm values. All alarms shall have a user-definable dead band. In addition to the above, an alarm shall be provided when analogue signals are less than 3.8 mA or greater than 20.2 mA. Rate of change alarms and set point deviation alarms shall be provided. All discrete inputs shall have the possibility of being assigned a change of state alarm.

xlv. It shall be possible to inhibit alarms by point of priority when the initiating device is faulty or being maintained. While inhibited, the point must still be scanned and archived. The removal of the inhibit shall be logged. A summary display containing all inhibited points shall be provided on demand. Alarm inhibition shall be permitted from any of the work stations by
authorized user only. Facilities shall be provided to mask out alarms from equipment which are not operational. These alarms shall be automatically or manually via keyboard, reinstated when the equipment is put back into service. Initiation and removal of inhibition shall be logged as an event and printed.

xlv. Alarm displays shall take the form of a summary display of all points in alarm, and/or integrate the alarm message with associated item, group or overview data. Alarms shall be listed in order of occurrence, and for specific alarm displays the most recent alarm shall be shown at the top of the display. All alarms shall be identified by tag, description and the date and time of the occurrence, in hours, minutes and seconds. A banner type display showing a summary of alarms shall always be present at the top of the screen irrespective of main display.

xlvii. Alarms from an area shall be capable of being grouped in one or more Alarm Groups. A minimum of 30 Alarm Groups shall be provided. At least four levels of alarm priority shall be available, with configurable presentation/ background colour. A global alarm acknowledgment and reset facility shall be available. If unacknowledged, Alarm message stays on display until it is cleared.

xlviii. In addition to the alarms included in the point count, the DCS shall be capable of handling alarms and status points received via any interface module from any third party device to which it is connected.

xl. All actions by engineer/authorised persons, which change the control and monitoring of the process, such as placing stations and devices on-line or off-line, changes in alarm set points, inhibiting/enabling alarms, changes in tag parameters, etc. shall be stored in history files.

lx. System events like failed process input/output modules, communication errors, program error message, switch over between primary & backup, failed controller modules, other function module failures, etc. shall be stored in history files.

li. Each operator workstation shall be capable of storing sufficient number of events of each type and details for the same shall be indicated.

l. Required utility packages shall be provided to generate report formats using a conversational, fill-in-the-blank approach. No software programming shall be required to generate the reports. It shall be possible to use any variable in the system in a report. It shall be possible to activate report on the cases like on Operator’s request; Shift, daily and monthly; Event driven, etc.

liii. Facility to configure a report to accept manually entered data for specified fields shall be provided.

liv. The system shall provide facilities to program user defined reports using a high level programming language. The programming language shall be provided with the necessary system calls and access to generate a report from the real time database and the event history collection files.

lv. Reports to the same device are to be queued.

lvi. Graphic page shall not be locked for more than 5 seconds while taking the print for the display page. The configuration should not be erased even in the event of power failure and the system shall be operational immediately after power is resumed.

lvii. Each Operator & Engineering workstations shall comprise minimum configuration of :- Pentium-IV Processor with clock speed of 2.4GHz or higher; 21” high resolution colour LCD TFT monitor with touch screen facility; minimum 80 GB HDD with controller & 1 GB RAM; 1.44 MB FDD; 52x CD ROM drive & 52x DVD read-write drive/ Combo drive; Graphic Accelerator Card with minimum 8 MB on board RAM; Dual redundant interface modules for communication with system Data Highway; necessary serial ports, parallel ports, USB ports
& PS2 ports for interfacing with peripheral devices; Dust & drip proof flat keyboard; Built-in speaker with different type sound levels; etc. All the hardware & software shall be provided as per the latest proven & available models at the time of supply.

lviii. The Operator & Engineering workstations shall be housed in suitably designed consoles to be finalised during detailed engineering stage. All the units shall be functionally assignable & interchangeable.

lix. In addition to all the standard keys required for system, operation and data entry, the keyboard shall also have required numbers of one touch function keys with LED to initiate any application programme, calling any display pages/ graphic pages/ trend pages, etc. LED lamps shall blink for alarm condition.

lx. System hard disk shall have capacity to take care of extra load due to future expansion of the DCS.

lx. Printers as per the following details shall be provided:
- A3 size colour ink-jet printer for graphic page printing.
- A4 size monochrome laser printer for report printing.
- A3 Dot matrix printer for alarm/ event printing.

Number of printers shall be as per the configuration diagram. All the printers shall be network compatible so that any workstation can access any printer whenever required. All the required printer papers, ink cartridges and other consumables shall be provided till handing over of the plant & equipment.

21.04. Self-Diagnostic & Monitoring Features

i. Respective DCS shall have exhaustive self diagnostic & monitoring features including the following:
   - Fault detection upto card level including failure/ status of central processor unit, memory, I/O status and power supply.
   - Parity errors, cycle errors and under voltage
   - Address monitoring.
   - Bus & Communication signal monitoring & all types of failure feedback.
   - Network diagnostic displays.
   - Broken sensor detection.
   - Automatic turning OFF of all outputs or optionally holding of all outputs in their last state on failure detection.
   - Indication of all other type of failures.

ii. On-line displays shall indicate the results of self-diagnostic tests. Failure diagnosis shall be sufficiently specific to indicate which modules, or devices are at fault. The displays shall be designed to help maintenance and engineering personnel to diagnose faults in the system and communications paths. Each category of diagnostic display shall be organized hierarchically.

iii. All events generated by the system shall be captured and electronically logged chronologically to the event database on a hard disk on one or more designated
workstations. Events shall be time-stamped by the event generator. Events and their associated time stamp are passed on to the event handler for capture.

iv. It shall be possible to retrieve and sort events by time (ascending or descending order) or by type. The Operator shall be able to filter the events on certain criteria such as time, tag name, area name, or any specific event. Events and the historical trend information for a control tag shall be integrated into a single view.

v. All events shall be time stamped at the point of origin. Events generated in the controller shall be time-stamped in the controller. Those generated in the workstation shall be time stamped in the workstation.

vi. Print on demand shall be included for all views possible with the event viewer application.

vii. Invalid value status shall be generated for inputs and calculated variables. A value shall be declared invalid if any of the following conditions are true:
   a) If a value is out of range.
   b) If a value can not be measured or calculated.
   c) If a value is declared invalid by an application program.
   d) If a value is declared invalid by the source instrument.

Invalid value status shall be propagated through control schemes.

viii. It shall be possible to inhibit the detection and propagation of an invalid value status. This selection shall be available on individual tag basis.

ix. It shall be possible for an invalid value status to be used as a logical input to initiate control algorithm changes.

21.05 Power Supply & Distribution System

i. Power supply to DCS shall be from UPS :240V AC or 110 V AC, 50 HZ, as per plant standard.

ii. Power supply feeder to Controller subsystem, Data acquisition subsystem and other peripheral units shall be provided using individual DP MCBs. Further distribution of power supply within the panel/ rack for respective modules/ units and derivation of required voltage level shall be carried out as per the requirement.

iii. Each processor rack of Hot redundant Controller Subsystem and the I/O racks shall have hot redundant rack based power supply modules.

iv. For output relay powering, powering field instruments (2-wire transmitters), input interrogation (if required), etc., separate & independent dual redundant 24V DC power supply units of suitable ratings and quantity shall be provided. Each I/O panel shall have one set of such dual redundant power supply units.

v. The dual redundant 24V DC power supply units shall be Diode ‘OR’ed.

vi. Power supply equipment and the distribution system shall have surge voltage protection, fuse protection in the input and output circuits, electronic over current protection, thermostat protection against over temperature, etc.

21.06 Software

i. Each DCS shall be supplied with all the required software for satisfactory operation of system & process taking care of requirements stipulated in TS. All the software shall be of proven
technology and latest with copy right or trade mark registration and shall be from principal manufacturer.

ii. DCS system software shall be latest, Windows based, menu driven and shall support the following as minimum:

- Cyclic, Time Controlled, Interrupt controls.
- Retentive/ Non-Retentive timers, Bi-directional counters, Latches, etc.
- Internal Flag generated by the DCS along with internal timer & counter blocks.
- All Boolean Logic Functions.
- Data transfer, Block Transfer.
- Sub Routines.
- Computational Functions such as Addition / Subtraction, Ramp generator, Lead-lag, Integrator / Accumulator, Dead time, High/low select, Tangent, Multiplication / Division, Time averaging, Signal selection switch, Exponential polynomial, Logarithms, Square root, Absolute value etc. shall be supplied as standard function blocks.
- Communication functions with Remote I/O as well as Engineering station, Operators station.
- Closed loop PID control functions including cascaded loops. Number of PID Control loops including cascade loops which can be handled, shall be highlighted.
- For all the close loop controls with electrical actuators, actuation shall be carried out either by, 4-20 mA DC outputs & separate hardware positioner, or digital/ pulse outputs, depending on system design. For digital/ pulse outputs, the outputs through relays shall be interfaced with auxiliary contactor of MCC connected to power circuit of electrical actuators for phase reversal required for forward-reverse movement. Closed loop controls with electrical actuators shall be preferably independent of position feedback from the valve actuators, in which case, the position feedback signal shall be used for indication purpose only.
- For pneumatic actuator, 4-20 mA DC outputs shall be used. PID blocks/ algorithms shall be suitable to take care of such applications and shall have all the required software function blocks.
- PID Controller shall be able to operate in manual, auto or computer mode as configured or selected. Mode change over shall be easy selectable and bumpless.
- In computer mode, controller shall be able to communicate & track computer-generated set point and shall hold the last generated value in case of computer failure. In such case, controller shall change over to auto mode and continue to operate at the last received set point, in general. Other options like pre-defined set point operation & fail safe condition shall also be possible. On the resumption of computer set point, the controller shall not return to computer mode automatically and user intervention shall be required. Computer failure indication shall be provided at local & central level.
- PID Controller shall have auto-tuning facility.
- Linearisation function block shall be such that a table of values (X against Y) can be entered in a menu driven manner and for any particular field input X, the value of Y can be calculated using the values of table by interpolation method. Minimum 30-point
linearisation function block shall be considered and within this block number of linearisation point required in actual shall be user selectable.

- The following discrete control functions shall be supplied as standard configurable items:
  Logic functions -- and, or, not, nand, nor, xor; Change of state detect; Set/reset flip-flops; Timers and counters; Comparison elements -- greater than, less than, equal to, not equal to; Multiplexer; Positive, negative, and bi-directional edge trigger.

- The system shall be capable of performing the following sequential control without any modifications to the standard configuration software.
  Sequence Language: A structured, IEC 61131-3 compliant high-level control programming language shall be available and shall conform that:
  a) It shall provide the necessary facilities for real-time control of sequential processes.
  b) It shall have access to process control and other database information. It shall be possible to modify the program logic while other sequences are active.

- Totalisation of flow inputs.

- Broken sensor detection, Cold junction compensation for thermocouple inputs, etc.

- Other function libraries, etc.

iii. The application programme software of the DCS shall be based on Block diagram, statement form/etc. On-line programme editing facility shall be available. Necessary software debugging facility shall also be provided.

iv. Required software package for HMI programme shall be loaded in respective operators station & engineering station. It shall have the facility to perform multitasking, data acquisition, supervisory control, monitoring & control function development and routine software. It shall also have feature for graphic/mimic generation, alarming, trending, data logging, production backup history, creation of shift reports, on-line printing of events. It shall have sufficient amount of tag (both analog & digital) handling capacity.

v. Operating System of the workstations shall be Windows or Windows NT or Windows 2000 or Windows XP, as applicable (Latest at the time of supply). HMI Software shall be Windows based. Latest version, at the time of implementation, of HMI software with application development package shall be supplied. Data Base shall be ORACLE, SQL, etc. based with suitable front-end software, as per the requirement & supported by the system. It shall also have open database connectivity. Details of the same shall be indicated.

vi. All the above packages/software shall have comprehensive self-diagnostic utilities, system & I/O configuration utilities, synchronisation utilities, various device drivers including network, its administration & redundancy management. This shall also include all the required testing software to check performance of the automation system. Details of all such software packages shall be indicated.

vii. Required numbers of software license for Purchaser shall be provided for DCS programming & application software including operating system, HMI operating system & programming software, redundancy management software, etc., as may be required to carry out engineering & operation activities from the complete automation system. Details of the same shall be indicated.

viii. The system shall allow for upgradation of operating software on all the applicable equipment without shutting down the process, without loosing operator interface and control functions.

21.07 System Cabinet & Console
i. The controller subsystem and data acquisition subsystem shall be mounted in suitable racks, which shall be installed inside system cabinets. All the workstations shall be installed on console desk.

ii. All the cabinets required for system, power distribution, marshalling, shall be of floor mounted, free standing, enclosed type. Cabinet structure shall be sound and rigid and shall be provided with removable lifting lugs to permit lifting of the cabinets.

iii. Cabinets shall be fabricated from cold rolled steel sheet of minimum 2.0 mm thickness for load bearing side & 1.5 mm thickness for the doors/ non-load bearing sides. These shall be suitably reinforced to prevent warping and bucking. Cabinets shall be thoroughly deburred and all sharp edges shall be grounded smooth after fabrication.

iv. Each cabinet shall be of maximum 2100 mm height with a base channel of 100 mm & minimum depth of 800 mm. Width shall be suitably decided depending on requirement and considering ease in maintenance.

v. Construction of cabinets shall be preferably modular to accommodate 19” standard racks. Empty slots of the racks shall be provided with dummy cards for protection against dust and damage. All racks shall be of same height. Maximum swing out for pivoted card racks, doors and drawers shall be limited to 600 mm.

vi. Cabinets shall be equipped with front and rear access doors. Doors shall be equipped with lockable handles and concealed hinges with pull pins for removal of each door.

vii. Cabinets shall be designed for bottom cable entry with necessary gland plate & double compression cable glands.

viii. Suitable anti-vibration pads to withstand vibration shall be provided.

ix. For effectively removal of dissipated heat from the cabinets, suitable louvers, fan filter units, fan trays, etc as required, shall be provided within the cabinets.

x. Illumination shall be provided for all cabinets & consoles by fluorescent lamps and door operated micro switches. Switch & power socket shall also be provided inside the cabinets.

xi. Equipment within the cabinet shall be laid out in an accessible and logically segregated manner. Clamping rails shall be provided for incoming cables to prevent excessive stress on the individual terminal. All metal parts of the cabinet including doors shall be electrically continuous and shall be provided with a common grounding lug.

xii. For installation of workstations consisting of PCs, colour monitors, keyboards, mouse, printers, etc., suitable aesthetically designed consoles made up of 2.5mm thick CRCA sheet steel shall be used. The operator’s console shall also be provided with filler desks, corner pieces etc., as required. The console shall be designed considering ease of operation & maintenance. The console shall also be provided with fan-filter units.

xiii. All the cabinets and consoles shall be completely wired. Interconnections between cabinets shall preferably be done with the help of pre-fab cables.

xiv. All terminal blocks of marshalling rack shall be suitable for termination of maximum 2 numbers of 1.5mm2 copper cables from field. All the terminal blocks shall be screw less clamp-on type. For signal wiring, 2.5mm² size & for power wiring, 4.0mm² size terminals shall be used.

xv. Electrical voltage higher than 240 V AC/DC shall not be brought inside the instrument panel / cabinet.
xvi. Separate terminal strips shall be provided for 24 V DC, 240 VAC and intrinsically safe terminals.

xvii. Gland plate (to be located at bottom of panel) with single compression type brass cable glands shall be provided. Distance between cable gland plates & bottom of terminal strips shall be minimum 300 mm. For I/O cabinets installed outside the control room, double compression type SS cable glands shall be used.

xviii. A minimum of 20% spare terminals shall be provided in each terminal block.

xix. Power supply terminals (e.g. 240VAC or 110VAC or 24VDC) shall be labeled. In case a bus bar is used for power supply distribution, the bus-bar shall be shrouded with a transparent Bakelite plate. A power socket (of 240V AC, 15W rating) for soldering, etc. shall be provided.

xx. The panels shall be provided with earth strip made of copper, 25mm(W) x 3mm(T) and of required length. A pair of earthing bolts on the inner side of the panel door shall be provided for power earthing.

xxi. The panels shall also be provided with earth strip made of copper, 25mm(W) x 3mm(T) and of required length, mounted on an insulated base inside the panel with holes and nut-bolts, for instrument signal earthing.

xxii. Cabinets & consoles shall be dust and vermin-proof conforming to minimum IP-22 class, when located in air-conditioned room. Cabinets located in ventilated rooms shall have minimum IP-42 protection class & minimum IP-54 class in non-ventilated rooms.

21.08 Earthing

Vendor shall provide a separate electronic earthing system. Electronic components of workstations, cabinets, consoles etc. of DCS and drain wires of the instrumentation signal cables shall be connected to this earthing system.

The body earth of the DCS cabinets and workstations / consoles shall be connected to the ‘Electrical Earth grid’ in the plant, which shall be separate from the ‘Electronic Earth’. The electronic earth pit(s) shall be at least 3 m away from the nearest electrical earth pit.

The design of the electronic earth pit shall be as per IS:3043, 1991 or based on the manufacturer’s recommendation.

21.09 Training

Basic and advance training shall be provided on programming, operation and maintenance of DCS both at the factory & also at site. The time period and number of persons to be trained shall be decided as per requirement.

21.10 Quality assurance, Inspection and Testing

The automation system shall be designed, selected & supplied ensuring proper quality & performance. Vendor’s procedures for Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT) shall be submitted at least 60 days prior to the scheduled conduct of these tests for review/acceptance.

The proposed FAT & SAT procedures of vendor shall be reviewed and modified as required to generate mutually agreed & finalised procedures, based on which these acceptance tests will be performed and supervised by authorized agency.
All system hardware & software used for testing shall be complete as specified and shall use actual equipment to be shipped to the site as per scope.

21.10.01 **Factory Acceptance Tests (FAT)**

i) The factory acceptance test shall be held at vendor’s works. Prior to the FAT, all the equipment shall be fully assembled, wired and properly connected & tested to establish all the specified features & functional requirements of the systems.

ii) During FAT, functional integrity of the system hardware and software shall be tested & demonstrated. All the necessary simulation kits as may be required for testing of software shall be arranged.

iii) Vendor shall perform functionality tests of complete system and satisfy himself of the results before giving notice regarding readiness of the system and its availability for FAT. Such notice shall be given minimum 15 days before the scheduled start of the FAT.

iv) The factory acceptance tests shall include visual and mechanical testing to establish correctness, completeness, good workmanship and functional testing.

v) The tests shall systematically, fully & functionally establish performance of all the hardware & software in presence of authorized representatives. All the sub-systems shall be interconnected to simulate, as close as possible, the total integrated system. Each test carried out shall be documented. Simulators shall be used for simulating field inputs. Any deficiency or problem faced shall be clearly brought-out and corrected.

vi) Before start of the FAT, the complete integrated system shall be kept powered on for 72 Hrs.

vii) All assemblies shall be aligned & adjusted and all test results shall be documented.

viii) For System Power up Test, Vendor as a minimum shall check the functions of all the system hardware and software including diagnostic software at sub-system levels with stimulated inputs.

ix) Functional testing shall include the simulation of each input and output to verify proper system response for both analog and discrete signals. This shall also include checking of various control loops, system scan time, checking of system loading including data highway, checking of system shutdown, alarm & interlock functions, checking of redundancy management, checking system diagnostics, checking various display parameters, etc.

x) The test log book shall contain the following information about the tests:

- Date/ time
- Assembly/loop tag number
- Test input
- Test results and sign off with personnel name
- Action required (if deficiency is detected).
- Actions taken, date of completion and sign off.
- Special test methods (including special equipment requirement, bypass used etc.).

xi) The automation system shall be shipped to site only after successful completion of FAT and receipt of dispatch clearance from authorized agencies.
21.10.02 **Site Acceptance Test**

At site, the system shall be properly installed taking care of manufacturer’s recommendation, after which Site Acceptance Tests (SAT) shall be carried out taking into the actual field instruments/equipment in the loops.

All the system and application software installed prior to FAT or during FAT, shall be reloaded from beginning at site as per standard procedures & demonstrated in presence of client’s personnel.

The Site Acceptance Test shall be held at site after the system has been installed as per the finalised SAT procedures. The tests shall be witnessed by authorized representatives.

The minimum tests to be carried out shall be as indicated in clause no. 10.3.

A log of all failed/ mal-operating components /modules in a sub-system shall be maintained by Vendor, with description of the affected components /modules, cause of failure, effect of failure on the sub-system and number of hours of operation before it failed. This will start from the date of powering on of the system for cold commissioning.

21.10.03 **Test Details**

Following tests shall be performed as a minimum during both FAT & SAT, in presence of authorized representatives and documented test results shall be compiled:

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Test Description</th>
<th>FAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Check of supply completeness</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>Visual &amp; dimensional check</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>Check of complete system configuration loading</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>Check of system diagnostic features. These shall include failure of any sub-system, module, power supply, interface unit, failure of transfer to redundant module on main module failure etc.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>Power-off and power-on of any single unit</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6.</td>
<td>Test of alarm system</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7.</td>
<td>Check of correct functionality of keyboards</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>8.</td>
<td>Testing of proper working of the printers</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>9.</td>
<td>Simulation of power failure and restart. Self-booting up of system configuration &amp; program after power restoration.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>10.</td>
<td>Fieldbus / Analog / digital input / output check</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>11.</td>
<td>Check of scan time for DCS</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.</td>
<td>Check of scan time, screen update time and loop cycle time</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>13.</td>
<td>Check of loop configuration for correct entry of ranges, limits etc.</td>
<td>✓</td>
<td>S</td>
</tr>
<tr>
<td>14.</td>
<td>Check of CRT displays (all kind of displays)</td>
<td>✓</td>
<td>S</td>
</tr>
<tr>
<td>15.</td>
<td>Checking of CRT refresh rate, data base update and display call-up time.</td>
<td>✓</td>
<td>S</td>
</tr>
<tr>
<td>16.</td>
<td>Check of system internal loading (processor, communication system etc.)</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Sl. No</td>
<td>Test Description</td>
<td>FAT</td>
<td>SAT</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>17.</td>
<td>Check of various log formats, shutdown reports etc.</td>
<td>✓</td>
<td>S</td>
</tr>
<tr>
<td>18.</td>
<td>Demonstration of all DCS system builder functions including addition/deletion of an input/output, addition/deletion of a rung or an element in a rung generation of dynamic graphics and other views, report generation etc.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>19.</td>
<td>100% checking of logic configured in the DCS by connecting switch/lamp at input/output.</td>
<td>✓</td>
<td>-</td>
</tr>
</tbody>
</table>
| 20.   | Redundancy check for DCS including correct change over of the back-up unit in case of failure of main unit. These shall be applicable for following:  
  - CPU Redundancy  
  - CPU Power supply redundancy  
  - Each CPU to host system communication interface & communication link redundancy  
  - I/O subsystem to processor system communication redundancy  
  - IO rack power supply redundancy  
  - Field bus interface module redundancy | ✓   | ✓   |

**FAT** = Factory Acceptance Test; to be performed at Vendor's workshop  
**SAT** = Site Acceptance Test; to be performed at site.  
✓ = Complete test; 100% of devices/ functionality will be tested.  
S = Sample test

All the necessary simulation kits as may be required for testing of software shall be arranged.

Acceptance of any equipment or the exemption of inspection shall in no way absolve the Vendor of the responsibility for delivering the equipment meeting all the requirement specified in this specification and also as may be required for satisfactory operation of the process.
STEEL STRUCTURES
&
AUXILIARY FACILITIES
(CHAPTER-04)
GENERAL TECHNICAL SPECIFICATION
FOR
SUPPLY, FABRICATION, ERECTION
SHEETING & PAINTING OF
STEEL STRUCTURES
(GS – 04)
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Structural
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GS-04
1.1 The general specifications for structural works furnished herein are intended as guidelines for execution of the works satisfying the Owner’s requirements as also complying with all technical norms in totality. This specification is to cover the design, preparation of design drawings and fabrication drawings, supply of all labour as well as materials and construction of all structural work on a turnkey basis for the Project / Works as described in the general conditions of contract.

1.2 Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as STRUCTURAL WORKS. The detailed scope of works covered under Structural works is given in Section -2.

1.3 The work to be performed under this specification consists of design, engineering, supply, fabrication, erection and cladding, as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour and staff colony, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.

1.4 Supply of all materials including structural steel, roof cladding & side-cladding sheets, fasteners, paints, consumables like gas, electrodes etc. and all other materials as deemed necessary for proper completion of the work, are included in the scope of the Contractor.

1.5 The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the Owner/Consultant.
For all buildings and structures, necessary layout and details are to be
developed by the Contractor keeping in view the statutory & functional
requirements of the plant and facilities and providing enough space and
access for operation, use and maintenance. Certain minimum
requirements are indicated in this specification for guidance purpose
only. However, the Contractor’s offer shall cover the complete
requirements as per the best prevailing practices and to the complete
satisfaction of the Owner.

1.6 Contractor shall inspect the site, examine and obtain all information
required and satisfy himself regarding matters and things such as access
to site, communications, transport, right of way, the type and number of
equipment and facilities required for the work, availability of local labour,
materials and their rates, local working conditions, weather, tidal / flood
levels, subsoil conditions, natural drainage, etc. Ignorance of the site
conditions shall not be accepted by the Owner as basis for any claim for
compensation or extension of time. The submission of a bid by the
Contractor will be construed as evidence that such an examination was
made and any later claims / disputes in regard to price quoted shall not
be entertained or considered by the Owner on account of ignorance of
prevailing site conditions.

1.7. Contractor shall comply with all the applicable statutory rules pertaining
to Factory act, Fire safety rule of Loss prevention association, Water act
for Pollution control, Explosives act etc. Provisions of Safety, health and
welfare according to Factories act shall also be complied with. Statutory
clearances and norms of State Pollution Control Board shall be followed.
Statutory body /Act requirements shall be fulfilled by the Contractor and
in case any modifications /additions to the building /Structures are to be
made as per the above, shall be carried out by the Contractor at no extra
cost to the Owner.

SECTION - 2      SCOPE OF WORK
2.0. The scope of work shall cover, but shall not be exclusively limited to, the following:

- collection of all site related data & conducting site investigations,
- design, preparation of all design drawings, fabrication drawings,
- obtaining Owner's/Consultant's approval on general arrangements and design of structures
- dismantling, retrieval, sorting and storing of any existing structures as directed by the owner, if dismantling is a part of the total work
- supply of all materials viz, raw steel, sheeting for roof and side cladding, and paints
- supply of fasteners like bolts, nuts, washers etc
- supply of consumables like electrodes for welding, gases for gas cutting etc
- supply of plant & machinery, tools tackles, instruments for fabrication and erection
- providing facilities for testing of materials and conducting NDT
- providing facilities for transport and handling
- deploying requisite skilled and unskilled manpower
- making arrangements for all services like approach to site, electricity, water etc
- fabrication of structures, their transport and proper storing at site
- erection of structures, claddings, gutters, down pipes etc
- application of paints at shop after fabrication and at site after erection
- providing all reasonable facilities for inspection by Owner/Consultant
- conducting NDT as stipulated by the Owner and making test results available to Owner / Consultant for evaluation
- compliance with primary acceptance tests / inspection, liquidation of defects; compliance with final acceptance tests / inspection, liquidation of defects;

- carrying out field-engineering decisions as desired by the Owner

- preparation of “As Built” drawings for all the structures and hand over to the Owner the completed structural work to the Owner’s full satisfaction.

- supply of all loading data for RCC foundation, layout drawing, HD bolt insert details and all other necessary information for requirement of Foundation/ RCC work, where future expansion is envisaged, the successful contractor shall furnish load data separately for present and future construction.

- any other work deemed incidental for the completion of the overall work but not included in the above detailed scope.

SECTION – 3 DESIGN OF BUILDING STRUCTURES

3.0 General

This specification shall apply to steel work in building and general structural steel work. For technological structures, additional stipulations shall be considered as per technical requirements.

3.1 Design considerations

3.1.0 General

3.1.01 Structures shall be designed such that they are economical and safe and meet the functional and service requirement of the technological process for which
they are designed. The architectural planning of the building shall be based on technological requirements.

3.1.02 The structures shall be designed conforming to the relevant safety regulations, Factory Acts, Electricity Rules and stipulations of Statutory bodies as applicable to the project.

3.1.03 Natural ventilation shall be provided ensuring that it does not permit rain water entry into the building. Scope of natural lighting shall be used to the maximum possible extent.

3.1.04 Mild steel gutters and down-pipes with gutter outlets having grating cover shall be provided to carry rain water from roofs of buildings to the drainage system at ground level. All gutters shall be designed as walkable with 600 mm sole width.

3.1.05 Adequate facilities in the form of monorails, hoists, platforms etc. shall be provided to facilitate repair and maintenance of overhead cranes, equipment, etc. Access to these platforms shall be provided by stairs / ladders from the nearest accessible floor or platform.

3.1.06 Access to all floors, gangways and landings shall be by staircases. Access to platforms and landing of secondary importance or where such access is used only rarely, shall be by vertical ladders with safety hoops.

3.1.07 Roofs with access shall be provided with safety handrails along the periphery of the roof.

3.1.08 Edges of floors, gangways, stairs and landings shall be provided with safety hand railings.

3.1.09 At gable ends of buildings, platforms shall be provided connecting the walkways at crane gantry level.

3.1.10 Floors, gangways and landings shall be covered as follows:

a) Gangways and landings shall have chequered plate with a minimum thickness of 6mm o/p suitably stiffened to meet design load requirements.

b) Floors and operating platforms other than the above shall have chequered plate flooring or hot dip galvanised open gratings, or RCC slab resting on steel structural framework, to suit the technological requirements.
3.1.11 Protective metal heat shields shall be provided for steel structures exposed to continuous heat radiation of temperature exceeding 150 °C and also where hot metal splashing on structures is likely to occur.

3.1.12 All buildings and their foundations shall be designed so that it shall be possible to extend them in the longitudinal direction at a later date without further strengthening of gable structures. Provision for transverse extension ,if any , shall also be made at the initial stage.

3.1.13 Sheeting on sides and gables shall generally terminate 3.0 m above ground floor level unless required to be otherwise. Sides below this level shall be generally screened by brick walls allowing sufficient air inlet to achieve natural ventilation, unless otherwise required from technological / ventilation requirements.

3.1.14 Connection by permanent bolts to structural elements subject to vibration shall be provided with lock nuts.

3.1.15 For Analysis/ design of steel structural frame work STAAD PRO soft ware shall be used . CD of input files shall be submitted to purchaser / consultant along with the hard copy of the document.

3.2 Elements of Structures

3.2.01 Columns

- a) At the location of passage/opening through columns web shall be suitably strengthened by vierendeel panel or modified lattice system.

- b) Shear force at the column base shall be resisted either by shear keys shop-welded to the underside of column base plates or by welding base plate to inserts provided in foundation.

- c) The level of underside of column base shall be so chosen such that the complete anchor table lies below the finished floor level, thus keeping the shop floor free from projections of anchor tables.
3.2.02 Crane Girders

a) Crane girders shall generally be of simply supported design, unless continuous crane girders are specifically required.

b) Top flange plate shall be welded to web plate with full penetration butt weld with fully automatic submerged arc welding. Bottom flange plate shall be welded to web plate by continuous fillet welds with automatic/semi-automatic welding.

c) All intermediate stiffeners shall be fitted against top flange and welded to it by fillet welds/partial penetration butt welds. These stiffeners shall terminate short of bottom flange with at least 25 mm gap. The stiffeners shall be fillet welded to web plate and corners shall be cut suitably to clear thermally affected area of web to top flange connection.

d) End bearing stiffener plates of crane girder shall be capable of transmitting the maximum reactions to the columns. The bearing surface of the bearing plate shall be planed/machined to ensure full contact.

e) Tension flange of crane girders shall be stabilised by horizontal latticed bracings, where required in order to limit the slenderness ratio of the flange to 150.

f) Generally for girders having span 12m and above, vertical auxiliary girder and horizontal girder at crane girder bottom flange level shall be provided.

g) All crane girders shall be checked for fatigue as per IS: 1024 (latest).

h) At crane girder level, walkway shall be provided on both sides. Walkway at column locations shall have minimum clear width of 500mm. Approach by staircase to this level shall be near the maintenance bay.

i) All crane girders and their supporting structures shall be designed for loading from loaded crane in worst position of crab and crane to create most unfavorable loading condition of the girders. For increase of load due to impact and crane load combination including lateral surge shall be taken as per provision of IS 875 (Part – 2) -1987.

j) Suitable approach to be provided for tightening of bolts of Crane Rail. Approach for Crane Rail fixing shall be properly planned for all types of sections of Crane Girders.

3.2.03 Surge Girder walkways and auxiliary beams.
a) Continuous maintenance walkways with safety hand-railing shall be provided along each column row adjacent to each crane gantry girder. These walkways shall be of non-slip plate construction connected to crane girder top flange by continuous fillet welds. Staircase at every 120m shall be provided from floor for access to this walkways so that stairs are available within 60m from any location.

b) Connections between surge girder and the main columns shall be designed to resist load due to lateral braking of crane trolley.

c) On the periphery of the building, full length handrails shall be provided along the edge of the maintenance walkway at crane girder level.

d) Handrail and its clearance from crane end carriage shall conform to provisions of relevant safety regulations.

### 3.2.04 Crane Stops

a) Crane stops shall be provided at the ends of each crane girder system, or as required to limit the movement of crane as per technological requirements.

b) Crane stops shall be bolted to crane gantry girder.

c) Only tested rail materials shall be used. Manufacturer’s test certificate, including chemical analysis shall be supplied.

d) Rails shall be free from twists, pitting, laminations and any other internal and external defects. The rail shall be straight and the deviation from the straightness shall not exceed +1.5mm. If necessary the rail shall be cold straightened.

e) Unless otherwise specified, the crane rail joint shall be butt-jointed (either by Thermit or fusion welding) or by fishplates.

f) For Butt-welding the contractor shall take prior approval of the Purchaser regarding method of edge preparation, welding procedure and sequence of welding to be done. Edge preparation shall be done by oxyacetylene flame and shall be neatly finished by chipping and grinding.

g) All position low hydrogen electrodes conforming to IS 814-1991 shall be used for welding. The rail end shall be preheated to 250 deg. C before welding. The electrode shall be preheated as per manufacture’ s instructions. The welded joint shall be allowed to cool slowly. It is recommended that the initial and intermediate layers of deposit may be by using ferron V, Superchord or equivalent. Top 3mm layer shall be deposited with Duroid 2A or equivalent, to obtain good wearing surface.
h) The joints shall be free from kinks, twists etc, and shall be grinded properly after welding to ensure smooth running of the crane.

i) Method of securing the crane rail to the crane gantry, alignment and expansion joints, if any, shall be subject to Purchaser’s approval. The crane rail clips shall be preferably forged or pressed from steel plates.

3.2.05 Roof Structures

a) The main supporting element for roof shall be roof trusses provided at uniform spacing to suit shop layout. Roof shall be provided with adequately sized roof monitor for natural ventilation, wherever required.

b) Roof shall have suitable slope to meet technological as well as rainwater drainage requirements. Hand railings at eaves level and gable ends of the roof of the building shall be provided.

c) System of bracings shall be provided in the roof top chord and bottom chord levels along with longitudinal ties to ensure stability and rigidity of the roof structures. Vertical bracings between trusses shall also be provided wherever required.

d) Galvanised wind tie (45x6 mm flat) shall be provided at the free edge of roof sheeting.

e) Suitable arrangement of anchors shall be provided at the ridge of roof sheeting for holding lanyards of safety belts.

3.2.06 Roof lighting walkways

a) Full length roof lighting walkways, generally 600 mm wide, shall be provided in each bay as required to match the number of rows of roof lights provided in the shop as per technological requirement.

b) These walkways shall span between roof truss members and will be decked with chequered plate floor. Walkways shall be provided with handrails on both sides.
3.2.07 Roof drainage system

a) Roof drainage system shall be designed for maximum precipitation for 5 minutes based on local meteorological data. A factor of safety of 1.3 shall be kept in the design.

b) All valley and eaves gutters shall be of pressed plate construction with a minimum sole width of 600 mm so as to function as walkways.

c) Eaves gutter shall be provided for eaves height ranging between 10 m to 25 m above apron/ground level.

d) The gutters shall be laid to slope towards down-pipes with welded outlets and having grills fitted flush with gutter sole. Slope of gutters and collector pipes shall not be flatter than the following limits:

   i) Longitudinal slope of gutter 1 : 500
   ii) Longitudinal slope of collector pipe 1 : 300

e) Poking holes with cover shall be provided in the down-pipes at suitable intervals as well as at accessible levels, to clean the down-pipes.

f) Collector pipes shall be provided with covered manholes at 6 m intervals.

g) Eaves gutter shall be provided with safety handrails.

h) When rain water falls from higher to lower roof, double layer of sheets shall be provided for the portion of roof sheeting on which rain water falls, provided the drop of roof is in the range of 3 m to 6 m. In case the drop is more than 6 m, independent gutter shall be provided.

i) Down pipes shall be spaced preferably at 24 m centres. The down-pipes shall be connected to the gutter with suitably designed hoppers with gratings at sole level of gutter, made of 8 mm dia rounds at 50 mm centers.

j) Joints of gutter and collector pipes shall be by welding in order to be leak-proof.
3.2.08  Wall Structures

a) Wall runners with necessary sag rod arrangements shall be provided to support wall and gable sheeting, including internal partition wall, wherever required.

b) Hanging wall posts shall generally terminate at 3.5 m above ground floor level unless required to be otherwise (Refer Clause 3.1.13).

c) Gables of buildings shall have wall post spaced at intervals to suit bay width.

d) Walls shall be provided with louvres and translucent sheeting at appropriate levels, to provide natural ventilation and lighting.

3.2.09  Floor Frameworks

a) Floor beams supporting vibrating equipment shall be designed to avoid resonant frequencies. (Refer clause 3.3.01 (c))

b) Beams along-with framework, shall be provided with both horizontal and vertical bracing (wherever permissible) to achieve overall rigidity.

3.2.10  Vertical bracings

a) Vertical bracings shall be provided on all column rows for each expansion block.

b) Vertical bracings shall extend from ground level to roof level and shall be designed to transmit longitudinal forces i.e wind forces, crane tractive forces, seismic forces etc. to the foundation.

c) Below crane girder level, for two-legged columns, the bracings shall be of twin system in the plane of each column leg, suitably tied or laced together.

3.2.11  Access staircase, walkways, platforms and ladders.
a) Wherever possible, access shall be provided by means of stairs.

b) All walkways and stairs leading to working platforms shall have minimum 1000 mm width of walkways/flight of stair.

c) All other walkways and stairs leading to areas for maintenance purpose, or due to restriction of space, shall have a minimum width of 800 mm of walkway/flight of stair, unless required otherwise.

d) Staircases shall be generally designed with slope of approximate 37.5° with the horizontal. (in no case the slope shall exceed 40 ° with the horizontal). Intermediate landings shall be provided wherever required such that vertical rise of each flight does not exceed 3000 mm. Risers in one flight shall be equally spaced.

e) Walkway floors and stair treads shall be designed with chequered plate (or non-slip type plates). Ribbed floor/treads may be provided wherever the possibility of accumulation of dust exists, taking care that such provisions do not create a nuisance to the operating personnel on the shop floor.

f) Rise of treads in staircases shall not exceed 200 mm.

g) A minimum headroom of 2200 mm shall be provided over operating platforms, visitor's galleries, or other areas with possibility of public gathering. In all other platforms, walkways and stairs, a minimum headroom of 2000 mm shall be provided. Only in special cases, local headroom of 1800 mm may be allowed (i.e at intersection with structural members etc.).

h) Cat ladders shall be provided for access, wherever provision of staircase is impractical due to limitations of space, or the access is required very infrequently.

i) Wherever the height of cat ladder exceeds 4.0 m, safety cage shall be provided. Intermediate landing shall be provided to cat ladders such that vertical height of single rise does not exceed 8.0 m.

j) Cat ladders shall be designed with following provisions:

   i) Width of rung = 500 mm
   ii) Minimum rise of rung = 250 mm
      Maximum rise of rung = 300 mm
   iii) Minimum clearance from rung of ladder to back of cage (in case of caged ladders) = 700 mm
iv) Minimum clearance from the centre of cage all round  = 350 mm

v) Slope of cat-ladders:

I. For normal cat-ladders, slope shall be within the range of 75°-90° with the horizontal.

II. For ship-type ladders (i.e cat-ladders with short side handrails) the slope shall be within the range of 65°-75° with the horizontal.

k) All walkways, platforms and stairs shall be provided with safety handrails. All handrails shall be constructed with steel tubes / angles for posts, top and middle rail and plates/sheets for toe plates. In case of stairs, the toe guards need not be provided.

l) The vertical height of hand-railings on walkways and stairs shall be minimum 1000 mm above floor level.

m) Hand-railing along edge of roof and gutters shall have a minimum height of 600 mm over top edge of gutters/sheets. In such hand-railings toe guards need not be provided. (only top handrail and mid-rail shall be provided).

n) Access to roof of the building shall be provided by means of staircases at midway length of the building. Pair of staircases shall be provided with one at the near end and the other at far end length of building. Approach to monitor roof / high bay roof from the roof of the bay approachable by staircases at midway length of the building shall be by means of staircase (if height of roof > 3m) or cat-ladder. Approach shall be provided on the roof of the building along the cross-section of the building.

3.3 Design

3.3.01 Design of structures

a) Design of steel structures shall be done in accordance with IS:800-1984 or any equivalent international code of practice that may be applicable.

b) Structures subjected to fluctuating/reversal of stress (eg. Crane girders) shall be designed in accordance with IS:1024-1979.

c) Resonance in structures: Structures supporting vibratory/reciprocating equipments shall be designed so as to obviate occurrence of resonance. The ratio of applied frequency to natural frequency shall not lie within the range 0.7
to 1.5.
For wind load calculation the following data may be considered
- Basic wind speed (Vb) at 10 M ht = 39 m/ sec.
- Risk co-efficient (K1) = 1.0
- Terrain ht and Structure size factor(K2) shall be calculated with Category 2.
- Topography co-efficient (K3) = 1.0
Seismic load- Structure shall be designed as per IS- 1893-(Part1) 2002.

3.3.02 Description of design loads

Loads considered in design shall allow fully for all aspects of:

i) Dead weight of structures, wall, floors, equipment, wiring, machinery, pipe-work, cabling and any item of a permanent nature.

ii) Superimposed loads for roofs and floors plus any temporary machinery not allowed within the general superimposed loads.

iii) Crane loading.

iv) Temperature loads from process requirements because of the position of the structure relative to the heat source or from support of mains, pipes etc. subject to heat.

v) Maximum range of temperature variation for climatic conditions = ± 45°C

vi) Dust load.

vii) Dynamic loads from screens and other such reciprocating machinery.

viii) Maintenance hoists on Runway beams.

ix) Wind Loads

x) Seismic loads

xi) From future extensions.

xii) Any special erection requirements.

xiii) Erection loads on floor and structures

3.3.03 Loading codes
a) All live loads shall be considered in accordance with IS:875(Part-2)-1987. (Also refer clause 3.3.04)

b) Wind loads shall be in accordance with IS:875(Part-3)-1987 and any other consideration specific to the site.

c) Seismic loads shall be in accordance with IS:1893-2002.

d) Crane loading to be considered in design shall be as follows:

I. As per relevant clause of IS:800-1983.

II. IS:875(Part-2)-1987 for conditions not covered in IS:800-1983.3. unless more severe loads have to be considered for technological/operational conditions.

e) Crane stopper shall be designed in accordance with clause 6.1.4 of IS:875 (Part-5)-1987.

f) In absence of any suitable provision for design loads, any other recognised code of practice may be followed subject to prior approval of the Owner.

### 3.3.04 Additional Design Loads

Besides technological loads, all platforms, walkways, stairs etc. shall be designed for the following live loads:

i) Walkways and Platforms : 2 KN/m²

ii) Visitor's galleries : 4 KN/m²

iii) Maintenance platforms : 4 KN/m² including crane level walkway.

iv) Staircase and treads : 4 KN/m²

v) Monorail walkways : 4 KN/m²

vi) Handrails (Horizontal) : 0.75 KN/m run

vii) Ladder at middle of rung : 0.9 KN

viii) Dust loads (for buildings and structures located in dusty zone) : 0.5 KN/m²

ix) All structures supporting : Overloading vibrating equipment by 25 % on (motors, fans etc.) Static load unless specified otherwise of Equipment.
3.3.05 Combination of loads

Various design loads considered shall be combined in accordance with clause 8.0 of IS:875(Part-5)-1987 to give the most severe loading condition for design of structures.

3.3.06 Stress Enhancements

Permissible limits of stress may be increased wherever permissible, in accordance with IS:800-1983.

3.3.07 Limiting deflection

a) The deflection shall be limited in various elements of structures in accordance with IS:800-1984 (clause 3.13).

b) In addition, the following limitations in deflection shall be observed in design:

**Vertical Deflection**

i) Monorail track beams, main floor beams, equipment supporting beams & beams supporting brick walls : Span / 400

ii) Main roof trusses, roof girders main floor beams in operating platforms : Span / 400

iii) Secondary floor beams : Span / 325

**Horizontal Deflection**

i) Crane girders due to surge force: Span / 2000 (from one crane only).

ii) Main columns at crane rail level: H / 2500 in transverse direction due to action of crane surge (for surge force consider one crane for single bay and one crane each on adjacent aisles for multi-bay buildings)

iii) Open gantry for condition as in: H/4000 (ii) above.
Where \( H \) = Height of Column from bottom of base plate to crane rail level.

c) All deflections shall be calculated without dynamic factor.

### 3.3.08 Camber

Wherever excessive deformation is likely to cause operational problem or is aesthetically not agreeable, camber shall be provided to neutralise the effect of deformation due to dead load plus 50% of imposed loads.

### 3.3.09 Expansion joints

a) Longitudinal and transverse expansion joints shall be provided in buildings and structures in accordance with IS:800-1984 (clause 3.14).

b) Expansion joints shall be formed by providing double rows of columns, with overhanging gantry girders, secondary roof and wall framing being detailed to allow the maximum calculated movement for the specified temperature variation.

### 3.3.10 Miscellaneous design requirements

a) The minimum thickness of structural steel elements shall be in accordance with IS:800-1984 (clause 3.8). Minimum size angle shall be ISA50x50x6.

b) The diameter of structural bolts shall not be less than 16 mm except for those securing roof and wall sheets, windows, doors and stitching of thin coverings. For bolted joints, at least two bolts per joint shall be provided.

c) The size of fillet welds shall not be less than 5 mm.

d) Main structural elements shall be welded continuously. Intermittent welding shall be used only on secondary members which are not exposed to weather or other corrosive influence.

e) Field connection and splices shall be made as follows:

i) by welding
ii)  by permanent bolts (for secondary members such as purlins, wall runners etc.)

iii) by High Strength Friction Grip bolts (HSFG)

3.4  DESIGN OF CONVEYOR GALLERIES AND JUNCTION HOUSES

3.4.0  Design Considerations

3.4.01  The general parameters for conveyor galleries shall conform to the provision of IPSS:2-03-001-81 (Interplant Standards : Steel Industry - Design parameters for galleries and tunnels for belt conveyors in steel plant), and provisions of IS : 11592-1985 unless specified otherwise in Technical Specifications. The structures shall be designed so as to meet functional requirements and shall provide space for operation, maintenance and removal of machinery and give the workers good and safe environment.

3.4.02  Gallery floors shall be of pre-cast R.C.C slabs / Chequered plates (as required) supported on steel beams.

3.4.03  Steps shall be provided (rise not exceeding 130 mm) along the walkways if the gallery slope exceeds 12°. In case the slope of gallery is between 6° to 12°, suitable ribs shall be provided on floor (without any sharp edges) at 250 to 300 mm intervals.

3.4.04  Provisions shall be made for emergency exit from galleries to ground level and also for cross-over above conveyor at 100 m intervals (maximum). The width of cross over shall not be less than 600 mm.

3.4.05  Roof and side walls of conveyor galleries shall be covered with GCS/ Aluminium sheets. with a provision of gap of 300 mm below roof and 150 mm from top of floor level on the side wall for ventilation.

3.4.06  Adequate provision for natural light inside conveyor gallery shall be made through side walls by providing translucent sheets (FRP sheets as per IS: 12866-1989). Every sixth sheet on side wall shall be FRP sheet and shall be staggered on opposite wall.
3.4.07 Roof slopes of conveyor galleries shall be 1:5 (1 vertical, 5 Horizontal).

3.4.08 The level of underside of the base plate of gallery supporting trestles shall be 300 mm above the average ground level of the surrounding area.

3.4.09 Protective hand railing shall be provided along gallery walkways, open platform, stairways, landings, edges of walkways when the gallery is not enclosed, and around erection openings, if any, to ensure safety of operating personnel.

3.4.10 Conveyor galleries longer than 150 m shall be provided with expansion joints with twin trestles/supports. Each expansion block shall have fixed support/rigid trestle with adequate arrangement (provision of top chord and bottom chord bracing to gallery girder etc.) for transferring the transverse and longitudinal forces to the foundation.

3.4.11 Gallery girders near junction house shall be preferably supported on trestle located as close to the junction house as possible, with part of gallery girder between junction house and trestle cantilevered from the trestle. Supporting gallery girders on junction house shall be generally avoided.

3.4.12 The underside of the belt conveyor shall be fully covered with 3 mm sheet in case of conveyor is located within the boundaries of the plant. Wherever such covering is not provided (as in case of the mines area or cross country), the covering must be provided where the gallery crosses roads, railway lines or areas of public gatherings.

3.4.13 Conveyor gallery over hot metal track:

When underside of gallery is at less than 12m height from track level, heat shield shall be provided below gallery as well as on sides for a width of track 8 m (i.e. 4 m on either side of center line of the track).

3.4.14 When conveyor gallery crosses above or below H.T cables, a minimum clear distance of 1.0 m between the structural elements/cladding and HT cables shall be maintained.

3.4.15 When the conveyor bridge passes over plant roads, clearance between the road surface and the lowest points of the bridges shall not be less than 4.5 m or the height needed for the passage of the largest individual components of the plant equipment, whichever is the larger.

3.4.16 The junction house shall be designed to suit the technological requirements. Number of floors, height of building etc. shall be decided accordingly.
3.4.17 In general the junction house shall be designed as framed structures on shorter span side and vertically braced on longer side to achieve stability.

3.4.18 Floor of junction houses shall be of RCC slab supported on steel beams, unless required otherwise from technological consideration. The RCC slab will be connected to steel beams through suitable lugs.

3.4.19 Roof and side covering of junction houses shall be with GCS/Aluminium sheets / troughed colour coated sheets as specified. Roof slope shall be 1 : 5 (1 Vertical : 5 Horizontal).

3.4.20 Suitable access staircase and safety hand railing shall be provided to all floors of junction houses.

3.4.21 When hydro-washing of floor of junction house is envisaged, the floor beam supporting RCC slab shall be laid to a suitable slope to achieve the same, wherever the same is not practicable to achieve through screed concrete. (Minimum slope of floor shall be 1.5%).

3.4.22 Wall sheeting shall generally start from the lowest working floor and extend up to roof level with louvres at each floor level to ensure adequate natural ventilation.

3.4.23 Monorails for maintenance hoists shall be provided for maintenance and repair of various equipments located on the floors.

Components of structures

3.4.24 Gallery Trusses and Roof

a) Gallery truss shall be of latticed type construction and shall support roof (for covered galleries) as well as floor deck supporting conveyor system.

b) The trusses shall be adequately braced at top and bottom chord level to transfer the horizontal wind forces to end portals.

3.4.25 Stringer Beam

These beams shall be suitably spaced to support the conveyor stringer post and shall deliver load to gallery trusses. Walkways on either side of the conveyor shall also be supported on these stringer beams.
3.4.26  Supporting Trestles

Intermediate trestles shall be two legged and shall deliver loads from gallery trusses to the foundations. In addition, four legged trestles shall be provided which will act as fixed support to transmit all longitudinal forces between expansion block, in addition to other forces.

3.4.27  Junction Houses

a) Floors - Floor beam layout shall be arranged to suit equipment layout as well as equipment anchoring system.

b) Columns - In addition to loads from floor and roof, columns shall be designed to transmit horizontal load due to belt tension/snapping of belts to the foundation.

3.4.28  Belt Tensioning Device

Suitable structures shall be provided to accommodate belt-tensioning device which may be located either under the conveyor gallery or in the junction house itself.

3.4.29  Wall Structures

a) Wall runners with necessary sag rods shall be provided to support wall sheeting in conveyor galleries and junction houses.

b) Wall sheeting and louvres - refer clause 3.2.08

3.4.30  Access stairs, walkways, platforms, ladders, hand railing etc. - These shall be provided in accordance with clause 3.2.11 of this specification.

3.5  Design of Structures.

3.5.0  a) Design of steel structures shall be done in accordance with IS:800-1984.

b) In absence of specified dynamic factor to be considered for the load from the belt conveyor, a dynamic factor of not less than 1.3 shall be considered for the design of floor beams and gallery girders.
c) Gallery trusses and stringers as well as floor beams of junction house shall be checked for obviating occurrence of resonance and shall be designed in accordance with clause 3.3.01(c).

d) For wind load consideration the following may be considered:
- Basic wind speed \((v_b)\) at 10 M ht \(= 39\) m/s.
- Risk co-efficient \((K1)\) \(= 1.0\)
- Terrain ht and structure size factor \((K2)\) shall be calculated with category 2.
- Topography co-efficient \((K3)\) \(= 1.0\)

e) Seismic load – structure shall be designed as per IS 1893 (Part 1) 2002. site is located in zone II.

3.5.1 Description of loads and loading codes

3.5.01 Unless specified otherwise hereinafter, all the live loads shall be considered in accordance with IS:875 (Part-2)-1987.

3.5.02 Wind loads shall be considered in accordance with IS:875 (Part-3)-1987.

3.5.03 Seismic loads shall be considered in accordance with IS:1893-1984.

3.5.04 Live loads from conveyor on the gallery floor shall be as per conveyor suppliers load data.

3.5.05 While designing the fixed support/rigid trestles in an expansion block of conveyor gallery the following loads (in addition to wind load) shall be considered.

a) Forces due to difference in frictional resistance of top and return idle rollers of conveyor.

b) Forces due to inertia of rollers at the time of starting of conveyor belt.

c) Break down load caused by snapping of belt (in case of multiple conveyors, snapping of one belt at a time) shall be considered.

d) Special loads if any

3.5.06 Gallery girders and floor shall be designed for the following live loads, inclusive of spillage loads on floors.

a) Walkway/Supporting beams for floor - 4.0 KN/m²

b) Under the conveyor belt - 0.75 KN/m²
c) Gallery girder, for floor load of - 3.0 KN/m²

### 3.5.07
Dust load on roof of junction house and conveyor galleries shall be considered as follows:

a) For building and structures located at a distance of 300 m from the dust producing units - 0.5 KN/m²

b) At a distance of 300 m to 800 m from the dust producing unit - 0.25 KN/m²

### 3.5.08
As per technological requirements, provision of supporting the following, and load arising thereof shall be considered in the design of conveyor gallery.

a) Ventilation duct.

b) Electrical cables/cable racks.

c) Fire Fighting equipment.

### 3.5.09
Junction house floors shall be designed for the following loads:

a) Live load on floor - 4.0 KN/m²

b) Tension from conveyor belt

c) Load due to equipment located on floor.

d) Load due to jamming of chutes.

e) Erection loads anywhere on the floor.

### 3.5.10 Combination of loads

The various loads specified shall be combined in accordance with clause 8.0 of IS:875 (Part-5)-1987 to give the most severe loading condition for design of structures.
3.5.11 Stress enhancements

Permissible limits of stress may be increased, wherever permissible, in accordance with IS:800-1984.

3.5.12 Limiting deflection

a) The deflection shall be limited in various elements of structures in accordance with clause 3.13 IS:800-1984.

b) In addition following limitation in deflection shall be observed in design:

i) Gallery Trusses - Span / 400

ii) Top of End portal of gallery truss - H / 325 where H = Height of portal above beams

iii) Traverse deflection of top of supporting Trestle - H/1000 where H = Height of trestle above foundation.

3.6 PIPELINE SUPPORTING STRUCTURE

3.6.0 Design considerations

3.6.01 Bridges shall be provided to support pipelines of smaller diameters for which maximum permissible span is less than the distance between supporting trestles.

3.6.02 Trestles which are designed to transmit longitudinal loads (along the length of pipeline) to the foundation, shall be four legged construction. Other trestles which transmit only the vertical load to the foundation shall be two-legged construction.
3.6.03 Access stair and platforms shall be provided for maintenance of equipment installed in the pipeline (eg. valves etc.). Maintenance walkways with hand-railing shall also be provided along the pipeline, wherever required. Provision of access stairs, walkways platforms, hand-railing etc. shall conform to clause 3.2.11 of this specification.

3.7 Design of Structures

3.7.0 Design of steel structures shall be done in accordance with IS:800-1984.

3.7.01 Unless otherwise specified hereinafter, all live loads shall be considered in accordance with IS:875 (Part-2) 1987.

3.7.02 Wind load shall be considered in accordance with IS:875 (Part-3)-1987.

3.7.03 Seismic loads shall be considered in accordance with IS:1893-2002.

3.7.04 In addition, pipeline, bridge and supporting trestle shall be designed for the following loads:

   a) Weight of liquid or condensate, as is appropriate for pipeline.
   
   b) Weight of valves, compensators, fittings etc. in addition of self-weight of pipe.
   
   c) Load due to thermal expansion of pipeline

3.7.05 Maintenance platforms shall be designed for a service load of 4 kN/sq.m

3.7.06 Combination of loads

The various loads specified shall be combined in accordance with clause 8.0 of IS:875 (Part-5)-1987 to give the most severe loading condition for design of structures.

3.7.07 Stress enhancements

Permissible limits of stress may be increased, wherever permissible, in accordance with IS:800-1984.

3.7.08 Limiting deflection
a) Deflection of gallery bridge structure shall be limited to Span/400.

b) Traverse deformation of trestle shall be limited to H/1000 where H = Height of trestle above foundation level.

c) The deflection of other elements of structures shall be limited in accordance with clause 3.13 of IS:800-1984.

3.8 STEEL CHIMNEY

3.8.0 General
This specification shall apply to design of self supporting steel chimneys.

3.8.1 Design Consideration

a) Lining shall be provided in chimney shell as per technological requirements. In the case of lined chimneys, checking for stress and resonance due to wind shall be done for both the conditions i.e lined and unlined.

b) Annular platforms with minimum clear width of 1200mm shall be provided at locations of environment monitoring equipment, in addition to the stipulations of IS:6533 (Part-2)-1989. Landing/resting platforms to ladders shall be provided at intervals not exceeding 10.00 M where annular platforms are provided at intervals of height greater than 10.00 M.

c) Approach to platforms shall be with ladders with safety cages. (Refer Clause 3.2.11(j) of this specification.

d) Chimneys shall be provided with adequate number of Painter's trolleys for inspection and maintenance unless categorically agreed to otherwise with Owner. In case where Painter's trolley is not provided, suitable alternative facility shall be provided for inspection and maintenance.

e) Chimneys shall be fitted with helical strakes of three rail system, and shall be strong enough to withstand the additional wind load from the strakes.

3.8.2 Design

a) Steel chimneys shall be designed in accordance with IS:6533(Part-2)-1989.
b) Elements like platforms, hand-rails, ladders, anchor bolts etc. shall be designed in accordance with IS:800-1984.

c) For wind and seismic refer clause 3.3.01 (d) and (e).

3.8.3 Limiting Deflection

The maximum deflection at the top due to the action of wind, without considering the dynamic factor shall not be greater than $h/200$, where $h$ is the unsupported height of the chimney.

3.9 STANDARISATION AND UNIFORMITY

3.9.0 General

Every endeavour shall be made to achieve standardisation and uniformity amongst the steel structures of different units of the plant.

3.9.1 The following items shall be kept in view in design of structures:

a) Uniform layout module shall be adopted to the extent possible consistent with economy. It is suggested to adopt a basic module of 3 m for building width and 6 m for column spacing along building length.

b) Uniform slopes of roofs matching with existing buildings unless specifically required otherwise for any particular unit.

c) Provision of expansion joints by using twin columns.

d) Uniform adoption of clearance between structures and moving parts of equipment.

e) Provision of adequate natural ventilation by using louvres (canopy like structures) at appropriate location and roof monitors/natural ventilation systems at roof.
4.0  FABRICATION OF STEEL STRUCTURES

4.1  Drawings

4.1.1  The Contractor shall prepare design drawings indicating general arrangement, members, sections and details of important joints, fabrication drawings, erection drawings, bill of materials, drawing office despatch lists / shipping documents, schedule of bolts and nuts and as built drawings. All drawing work shall be in metric system and all writing work shall be in English. Drawings shall be prepared using Autocad software.

4.1.2  The fabrication drawings shall show full length layout with all connecting members and connections marked thereon. The fabrication drawings shall include all the necessary blown-up details required for the correct fabrication of the structures to meet the design requirements. These drawings shall be made in conformity with the best modern practices and with due regard to speed and economy in fabrication and erection. Each erection piece shall be clearly identified by an erection mark in these drawings.

4.1.3  The preparation / detailing of fabrication drawing shall be complete in all respects. In the case of bolted connections, the bolt dia., the hole dia.,
the actual location of holes and the coordinating scheme with connecting/ matching elements shall be clearly indicated. As far as possible, uniformity in the bolt dia shall be maintained. Where HSFG bolts are used, method of surface preparation shall be indicated. In case of welded constructions, the size and length of welds along the relevant weld lines should be distinctly marked. The length specified shall be the effective length excluding end crates. For all butt welds, details of appropriate edge preparation shall be indicated.

4.1.4 Detailing of structural steel members subjected to dynamic loading shall be so as to keep the stress concentration to a minimum. Cross welding shall be avoided as far as practicable.

4.1.5 For bolted connections subjected to dynamic loading, lock nuts or spring washers shall be used in addition to plain washers.

4.1.6 Erection drawings shall consist of line diagrams showing every detailed member in position with the respective erection mark. Erection marks shall appear on the left end of the members as detailed. All steel members shall be erected with marks in the same relative position as shown in plan or elevation. All loose members shall either be given part marks or wired on to the main erection mark for despatch.

4.1.7 The erection clearances for cleat-connected ends of members connecting steel to steel shall preferably not be greater than 10 mm. at each end. The erection clearance at ends of beams shall not be more than 20mm. at each end but where for particular reasons greater clearance is necessary, suitably designed seats shall be provided.

4.1.8 The fabrication drawings shall be prepared in such a manner that structures are despatched with maximum transportable lengths and work involved at site is minimum. Steelwork shall be shop-fitted and shop-assembled as far as practicable.

4.1.9 All edge preparations for welding shall conform to IS:9595.

4.1.10 The contractor shall ensure correctness & completeness of fabrication drawings.

4.2 Material of Construction
4.2.1 All steel and other materials used for steelwork and in association with steelwork shall conform to appropriate Indian standards. Only tested materials shall be used unless written authority is obtained for the use of untested materials for certain secondary structural members.

Unless otherwise specified in the drawings

a) All rolled sections and plates up to & including 20 mm thickness shall conform to Grade "A" as per IS : 2062.

b) Plates of thickness above 20 mm and Plated structures subjected to dynamic loading shall conform to Grade "B" as per IS: 2062.

c) For High Tensile steel requirements, material conforming to IS:8500 or SAIL- MA (HYA or HYB) shall be used.

4.2.2 Steel sheets shall conform to IS : 1079.

4.2.3 Steel tubes for structural purpose shall conform to IS : 1161 (of Grade Yst 240)

4.2.4 Corrugated Galvanised Sheets shall conform to IS:277 with appropriate Zinc coating for the selected thickness of sheet on roof and sides.

4.2.5 Aluminium industrial toughed sheets conforming to IS : 1254 shall be used as follows:

i) In roof - 0.91mm thick
ii) In side walls - 0.71mm thick

4.2.6 Translucent sheets shall be fibreglass reinforced polyester sheets of matching profile as per IS:12866.

4.2.7 Colour coated sheets shall be as per appropriate standard. All roof, monitor roof galvanised / zinc aluminium colour coated sheets of total coated thickness (TCT) of 0.65 mm with base metal yield strength of 240 MPa or alternately sheets having TCT of 0.5mm with base metal yield strength of 550 MPa.

All side sheets, monitor sides colour coated sheets of total thickness (TCT) of 0.6 mm with base metal yield strength of 240 MPa or alternately sheets having TCT of 0.5mm with base metal yield strength of 550 MPa.

Ridging/ Flushing: colour coated sheets TCT of 0.8 mm with base metal yield strength of 240 MPa or alternately sheets having TCT of 0.5 mm with base metal yield strength of 550 MPa. For all above, minimum zinc deposition shall be 150 gms per sq.m.
4.2.8 Gutters shall be of copper bearing steel conforming to Grade "A" as per IS :2062

4.2.9 Crane Rails shall conform to IS : 3443.

4.2.10 All black bolts, nuts and locknuts shall conform to IS : 1363 and IS : 1364 (for precision and semi precision hexagonal bolts) of property class 6.4 unless otherwise specified. Washers shall conform to IS : 6610

4.2.11 All tapered washer shall be as per IS:5372 for channels, and IS:5374 for Joists. Spring washers shall conform to IS:3063.

4.2.12 All HSFG bolts shall conform to IS : 3757. Assembly of joints using HSFG bolts shall conform to IS : 4000. Nuts and washers for HSFG bolts shall be as per IS:6623 & IS:6649 respectively.

4.2.13 Covered electrodes for arc welding shall conform to IS: 814. Coding of electrodes shall be as follows:

a) ER421 ‘C’ X for mild steel of Grade 'A' and Grade 'B' as per IS : 2062

b) EB 542 ‘C' H3X for Mild steel of Grade 'B' as per IS 2062 for dynamically loaded structures (arising out of crane, vibratory screen, equipments etc.) ‘C’ is the value of the current as recommended by the electrode manufacturer.

4.2.14 Certified mill test reports of materials used in the work shall be made available for inspection by the Owner / Consultant upon request.

4.2.15 All materials shall be straight and if necessary before being worked shall be straightened and / or flattened by pressure including de-coiling of plates unless required to be of curvilinear form and shall be free from twists.

4.2.16 The MS / GI gratings shall be electro-forged and shall be of approved brand and manufacturer unless otherwise agreed to by the Owner. The type of grating selected shall be based on the loading in the area in which the grating is provided and shall be subject to approval of Owner.

4.3 **Material preparation**
4.3.1 Cut edges shall be finished smooth by grinding or machining wherever necessary. Sufficient allowance (3 mm to 5 mm) should be kept in the items in case machining is necessary.

4.3.2 Cutting may be effected by gas cutting, shearing, cropping or sawing. In gas cutting of high tensile steel, special care is to be taken to leave sufficient metal to be removed by machining so that all metal that has been hardened by flame is removed.

4.3.3 Sufficient shrinkage allowance (@ 1mm/M) shall be kept wherever heavy welding is involved.

4.3.4 Straightening and bending shall be done in cold condition as far as practicable.

4.3.5 If required, straightening and bending may be done by application of heat between 900°C and 1100°C. Cooling down of the heated item shall be done slowly.

4.4 Drilling and punching of holes

4.4.1 Drilling and punching of holes for bolts shall be done as per clause no.11.4.4 of IS:800:1984, unless otherwise specified by the Owner.

4.4.2 Drifting of holes for bolts during assembly shall not cause enlargement of holes beyond permissible limit or damage the metal.

4.4.3 Holes for bolted connection should match well to permit easy entry of bolts. Gross mismatch of holes shall be avoided.

4.4.4 Permissible deviation in holes for mild steel bolts of normal accuracy and high strength bolts are given in the ANNEXURE-A.

4.5 Assembly for fabrication
4.5.1 Fabrication of all structural steelwork shall be in accordance with IS:800-1984 and in conformity with various clauses of this specification, unless otherwise specified in the drawings.

4.5.2 Fabrication of structures shall preferably be taken up as per the sequence of erection.

4.5.3 All erection units shall bear erection mark no. and reference drg no. at a prominent location on the structures for easy identification at site.

4.5.4 Fabricated structures shall conform to tolerance as specified in this standard and in IS:7215-1974. In case of contradiction, tolerances specified in this standard shall prevail.

4.5.5 All the components of structures shall be free from twist, bend, damage etc,

4.5.6 Assembly of structures shall be carried out by using suitable jigs and fixtures in order to obviate distortion during welding.

4.5.7 Cutting of items specially for truss, bracing, bunker, hopper, galleries surge girder, portal etc, shall be done only after checking of sizes as per Layout.

4.5.8 Surface, wherever machining is specified, shall be either planed or milled or ground to ensure maximum contact.

4.5.9 If end-milling or machining is planned after the assembly is over, sufficient allowance (5 mm to 15 mm) shall be kept in the items where milling/machining is to be done.

4.5.10 If pre-bending of the plate is required to avoid welding distortion, it shall be done in cold condition.

4.5.11 Sufficient trial assembly of fabricated components (despatch elements) shall be carried out in the fabrication works to control the accuracy of workmanship.

4.5.12 Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads of nuts and bolts satisfactory bearing.

4.5.13 The threaded portion of each bolt shall project through the nut at least by one thread.
4.5.14 Tolerance of assembled components of structures are given in TABLE -

4.5.15 Permissible deviations from designed (true) geometrical form of the despatch elements shall be in accordance with IS:7215-1974.

4.6 **Method of Construction**

4.6.1 The method of construction shall be either by welding or by bolting limiting the site work to the minimum possible.

4.6.2 Bolt diameter shall not be less than 16mm. except for bolts securing roof and wall sheeting, windows, doors and stitching of thin coverings. For bolted joints, min. two bolts shall be used.

4.6.3 The size of fillet welds shall not be less than 5mm for load-bearing joints.

4.6.4 Main structural elements shall be welded continuously. Intermittent welds shall be used only on secondary members, which are not exposed to weather or other corrosive influence.

4.6.5 Connections and splices shall be made by welding, or by bolting with appropriate property class. Black bolts shall be used in connections and attachments of secondary members such as purlins, wall girts, etc. Bolts shall be prevented from loosening by means of lock nuts, single coil spring washers or similar devices.

4.6.6 Method of splicing shall be similar to the method of construction adopted for structures. All splices shall be full-strength splice unless exception is specified.

4.6.7 Roof and wall sheets shall be fixed to purlins and wall girts by stainless steel top speed screws/galvanized J-hook bolts, each complete with neoprene and stainless steel /galvanized washers. The connections shall ensure water-tightness into the buildings. The spacing of these screws/bolts shall be sufficient to prevent uplift of sheets by suction. The roof and wall sheets shall be stitched together at their edges by using studs, rivets or screws. The end and side overlaps of sheeting shall be sufficient to prevent ingress of rainwater. End lap shall not be less than 75mm and side lap shall not be less than one and half corrugation for
GCS sheets. For troughed aluminium sheets manufacturer’s recommendations shall be followed.

4.7 **Structural steel connection**

4.7.1 The Contractor shall be responsible for the design and the detailing of all connections. The design of connections shall provide for adequate strength for the transfer of force in the structural elements indicated on the design drawings. For purposes of detailing of connections, the allowable stresses in material, bolts and welds shall be as per IS:800 and IS:816 or as specified in the design drawings.

4.7.2 For all full strength butt welding of plates and sections thicker than or equal to 10 mm, edge preparation shall be done and got approved by the Owner / Consultant.

4.7.3 Two numbers of washers shall be used for all bolted connections, one washer bearing against the head and other bearing against the nut.

4.7.4 The magnitude of forces shown on design drawings shall be used at face values with no reductions for connections.

4.7.5 If extra joints are to be provided in column, crane girder etc, prior approval on the same shall be obtained from the Owner / Consultant However, as general guidance, the following is suggested:

- Splice joint on column and crane girder shall be of full strength butt weld, and, wherever possible, shall be located at the section of minimum or substantially lesser stress.
- Splice joints of web and flange should be sufficiently staggered in position.

4.7.6 All penetration for piping, conduit, cable trays, etc., through grating or plate flooring shall be cut and suitably banded in the field, except when such penetrations are dimensioned in the drawings in which case they shall be shop cut and banded.
4.8 **Fabrication**

4.8.1 Fabrication of all structural steelwork shall be in accordance with IS:800 or their equivalent foreign national standard of the country of origin of supply unless otherwise specified, and in conformity with various clauses of the Technical Specification.

4.8.2 Wherever practicable and wherever perfect matching of parts is required at site, members shall be shop assembled before despatch to minimise site work. Parts not completely assembled in the shop shall be secured, to the extent possible, to prevent damage during despatch.

4.8.3 All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials shall be kept free of dirt, grease and foreign matter and shall be protected from corrosion. All materials shall be stored properly on skids above the ground which shall be kept clean and properly drained. Girders and beams shall be placed upright and stored. Long members such as columns and chord members shall be supported on skids spaced near enough to prevent damage due to deflection.

4.8.4 Bolts shall be furnished according to bolt lists showing the location of their use and additional bolts shall be supplied to cover wastage.

4.8.5 All fabricated pieces shall bear erection mark numbers painted/punched according to appropriate erection and shop drawings at a prominent location on the structure for easy identification.

4.8.6 All workmanship shall be in accordance with the best practice in modern structural shops. Greatest accuracy shall be achieved in the manufacture of every part of the work and all identical parts shall be strictly interchangeable.

4.8.7 Shearing or flame cutting may be used at the Contractor's option provided that a mechanically controlled cutting torch is used for flame cutting and that the resulting edges are clean and straight.

4.8.8 Unless clean square and true to shape all flame cut edges shall be planed/cleaned by chipping or grinding. Where machine flame cutting is permitted for high tensile steel, special care shall be taken to leave sufficient margin and all flame hardened material shall be removed by machining/edge grinding.
4.8.9 Wherever shearing is used for cutting to size, sheared members shall be free from distortions at sheared edge.

4.8.10 The ends of all girder stiffeners shall be in contact with the compression flange and shall be planed or ground to fit tightly against flange plates unless otherwise stated on the drawings. Care shall be taken to ensure full bearing of the stiffeners at the supports by machining the contact surfaces of both bearing stiffeners and bearing plates. The ends shall not be drawn or caulked.

4.8.11 Column splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately machined and close butted over the whole section with a clearance not exceeding 0.1 mm locally at any place.

4.8.12 In column cap and bases, the ends of shafts, should be accurately machined so that the parts connected butt over the entire surface of contact. Care should be taken so that these connecting members are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm. On secondary members, where sufficient gussets and welds are provided to transmit the entire loading, the column ends may not be machined subject to the approval of the Owner / Consultant.

4.8.13 Holes for permanent black bolts shall not be more than 1.5 mm larger than the nominal diameter of the black bolts unless specified otherwise. All holes for turned and fitted bolts shall be sub punched or drilled and reamed at site under assembly of connected parts to a tolerance of +0.3 mm unless specified otherwise. Holes in purlins, side-sheeting runners, packing plates and lacing bars may be punched full size. Holes in light framing with the exception of joint holes, may be punched full size. All punching and sub-punching shall be clean and accurate and all drilling free from burrs. In block/batch drilling, parts shall be separated after drilling and the burrs removed. No hole shall be made by gas cutting process.

4.8.14 The component parts shall be so assembled that they are neither twisted nor otherwise damaged and specified cambers, if any, shall be provided. No drifting of hole shall be permitted except to draw the parts together. Drifts used shall not be larger than the nominal diameter of the bolt. Drifting done during assembling shall not distort the metal or enlarge the holes. Sufficient trial assembly shall be carried out in the fabrication works to prove the accuracy of workmanship of the and the number of such trials required shall be at inspector's discretion.
4.8.15 Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut by at least one thread.

4.8.16 In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness, under the nut so as to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. Column bases and caps, shall be in one solid piece, and except when cut from plates with true surfaces, shall be accurately machined over the bearing surfaces, and shall be in effective contact over the whole area of the machine end of the stanchion.

4.8.17 Each piece shall be distinctly marked before delivery, in accordance with an approved marking diagram and shall bear such other marks as well to facilitate erection. For easy identification at site a small distinguishing mark for each building shall be painted at each end of every member before despatch from fabrication shop. The fabricated steel work shall be despatched in sequence as per agreed programme and for such portion as may be found convenient for erection or as ordered by the Owner / Consultant.

4.8.18 The Contractor shall provide suitable packing wherever necessary to guard against damage during handling and transportation to site. All fabricated parts shall be adequately braced to prevent damage during transit.

4.8.19 The tolerances for fabrication of steel structures shall generally conform to IS:7215 and to suit the technological requirements as specified by the equipment supplier.

4.8.20 Any fabrication work which is considered not to be in keeping with the Technical Specification forming the Contract, or in absence of Technical Specification with recognized good practice, shall be rectified /replaced /corrected at the Contractor's expense as directed by the Owner / Consultant. Site fabrication work shall also conform to all specifications, stipulations, terms and conditions applicable for shop-welded structures as mentioned above.

4.8.21 Fabrication of steel structures shall not be allowed inside the plant premises.

4.9 **Wastage & Accountability**
4.9.1 For the purpose of accounting of materials where the same is supplied by the Owner, free or on cost recoverable basis, the following wastage including rolling margin, invisible wastage and cut pieces of less than one metre length and plates with lesser dimension less than 300 mm shall be allowed.

a) Structural Steel : i) Sections - 5% on the quantity by weight computed, based on Fabrication drgs.

ii) Plates - 7.5% on the quantity by weight computed, based on Fabrication drawings.

b) Other materials : 5% on the quantity by weight computed, based on manufacturing drawings.

For all cut pieces (plates & sections) invisible wastage (cutting and burning losses) of maximum 0.5% will be admissible.

4.9.2 Owner reserves the right to take back such sections or quantity of steel issued in excess of quantity as per fabrication drawings plus permissible wastage where raw steel is issued free of cost by Owner. The contractor shall return to the Owner all such steel supplied in good and acceptable condition. In case of failure of the Contractor to return such surplus steel on demand by the Owner, Owner reserves the right to recover the cost of such steel at a penal rate of twice the SAIL- Stockyard rate of that particular section of steel as on the date of accountability.

4.9.3 If the Contractor fails to return scrap / wastage generated as per the percentage mentioned at 4.9.1, recovery on account of such scrap / wastage shall be made by the owner at prevailing rate of steel+ 20 pc per tonne.

The charging of penal rate shall be without prejudice to any other remedies or action available to the Owner, against the Contractor.

4.10 Despatch Instructions

4.10.1 Each despatchable structure shall bear mark no. along with reference drawing number at two prominent locations (e.g. on flange and bottom of base plate of a column).

4.10.2 "As built" drawing shall be prepared after fabrication is completed to indicate additions / alterations made during the process of fabrication.
4.10.3 Control assembly of important structures shall be done in the shop floor before despatch to avoid mismatching. For all such important structures, match marking shall be given at the control assembly stage in the shop floor and such match markings shall be made clearly visible while assembling the structures at site.

4.10.4 Centre lines of column flanges and both sides of web shall be punched, preferably at top and bottom to facilitate alignment after erection.

5. **ERECTION OF STEEL STRUCTURES**

5.1 **Scope**

The scope of work under erection includes in addition to provision of erection and transport equipments, tools and tackles, consumables, materials, labour and supervision, the following:

a) Storing and stacking at site of erection of all fabricated structural components/units/assemblies till the time of erection.

b) Transportation at site of structures.

c) Receiving at site of structures including site handling/movement, unloading, storing and stacking at site of erection of technological structures such as bunkers and the related structures.

d) All minor rectification/modification such as:

   i) Removal of bends, kinks, twists, etc. for parts damaged during transportation and handling;

   ii) Cutting chipping, filing, grinding, etc., if required, for preparation and finishing of site connections;
iii) Reaming for use of next higher size bolt for holes which do not register or which are damaged.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication.

e) Other rectification work such as

i) Re-fabrication of parts, damaged beyond repair during transportation and handling or incorrectly fabricated.

ii) Fabrication of parts omitted during fabrication by oversight or subsequently found necessary.

iii) Plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt.

iv) Drilling of holes which are either not drilled at all or are drilled at incorrect position during fabrication.

f) Fabrication of minor items/missing items or such important items as directed by the Owner Consultant.

g) Assembly at site of steel structural components wherever required including temporary supports and staging.

h) Making arrangements for and providing all facilities for conducting ultrasonic X-ray or gamma ray tests on welds; getting the tests conducted by reputed testing laboratories, making available test films/ graphs, reports and interpretation.

i) Rectifying at site, damaged portions of shop primer by cleaning and touch-up paint.

j) Erection of structures including making connections by bolts/high strength friction grip bolts / welding.

k) Alignment of all structures true to line, level plumb and dimensions within specified limits of tolerances as per IS :12843 “Tolerance for Erection of Steel Structures”.

l) Application of second coat of primer paint and two coats of finishing paint at site after erection.

m) Grouting of all column bases after proper alignment of columns and only after obtaining clearance from Owner / Consultant.

n) Supply of labour in sufficient numbers, where necessary, as directed by the Owner / Consultant.

o) Conducting preliminary acceptance and final acceptance tests.
p) Preparation of as built drawings, preparing of sketches/drawings to suit field engineering decisions, availability of material, convenience of fabrication, transportation and erection and changes during fabrication and erection.

All such works are subject to approval by the Owner / Consultant.

5.2 **Erection Drawings**

5.2.1 The erection drawings prepared by the Contractor and any approved arrangement drawings, specifications or instructions accompanying them shall be followed in erection of structures and miscellaneous connected items throughout the project.

5.3 **Storing and Handling**

5.5.1 The fabricated materials on receipt at site shall be carefully unloaded, examined for defects, checked, stored out for each building and stacked securely on skids above level ground which shall be kept clean and properly drained. Girders and beams shall be placed upright and stored. Long members, such as columns and chord members, shall be supported on skids spaced near enough to prevent damage from deflection.

5.5.2 The fabricated materials shall be verified with respect to markings on the marking plan or shipping list which shall be supplied by the Contractor.

5.5.3 Any material found damaged or defective shall be stacked separately and the damaged or defective portions shall be painted in distinct colour for identification. Such materials shall be dealt with as ordered by the Owner / Consultant.

5.5.4 The handling and storing of the component parts of a structure shall involve the use of methods and appliances not likely to produce injury by twisting, bending or otherwise deforming the structures. No member slightly bent or twisted shall be put in place until the defects are corrected. Members seriously damaged in handling shall be rejected.

5.4 **Defects in material & fabrication**
5.4.1 All materials shall be straight unless required to be of curvilinear form and shall be free from twist. All cold straightening shall be done by pressure only.

5.4.2 During assembly and during erection of the units to position, the Contractor shall compare the structures with the drawings to ensure that there are no fabrication omissions or errors. Should any omission or defect be found the same shall be brought to the notice of the Owner / Consultant who will issue necessary instructions for the rectification.

5.5 Setting out

5.5.1 The Contractor shall prepare geodetic survey scheme of all embedded parts and holding down bolts and submit the same to Owner / Consultant. The Contractor shall inform the Owner / Consultant about any discrepancy with approved design drawings well in advance of erection and if necessary shall make necessary adjustments at site or during fabrication of structures.

5.5.2 The Contractor shall assume, full responsibility for the free and correct setting out of all steel work and erection correctly in accordance with position, alignment, dimensions and levels shown on the approved drawings and plumbing vertical members. Particular care shall be taken to ensure free expansion and contraction wherever provided. Notwithstanding any assistance rendered to the Contractor by the Owner / Consultant, if at any time during the progress of the work, any error should appear or arise therein, on being required to do so, the Contractor at his own cost shall remove and amend the work to the satisfaction of the Owner / Consultant.

5.6 Assembly and Erection

5.6.1 Before starting erection, the Contractor shall submit to the Owner / Consultant for his approval the method he proposes to follow and the number of types of equipments and temporary, works he proposes to use for the erection.

5.6.2 The approval of drawings by the Owner / Consultant will not relieve the Contractor from the basic approach to design as regards the loads which the erection equipment and temporary work shall be called upon to carry and support. Adequate allowance and provision shall be made for lateral forces and wind loads.
5.6.3 If in the opinion of the Owner / Consultant, the tools, tackles plant and equipment instruments, apparatus, etc. arranged by the Contractor are not sufficient or are inadequate for the fulfilment of the contractual obligations of the Contractor within the stipulated period, the Owner / Consultant will have the right to order the Contractor and the Contractor shall comply with the order to bring/arrange such additional tools, tackles, plant and equipment instruments, apparatus, etc. to the site and employ the same to complete the work in time. All charges in connection thereof shall be borne by the Contractor.

5.6.4 Proper consideration shall be given to the following items during erection.

i) Frame of building to be true and plumb.
ii) Temporary guying and bracing shall be used to align the framing during erection, if required.
iii) Temporary bracing may be required to sustain forces due to erection loads and equipments. Erected parts of the structures shall be made stable during all stages of erection. The stability of structures subjected to the action of wind, dead weight and erection forces shall be attained by observing specified sequence of erection of vertical and horizontal structural members and by installing permanent and temporary bracings.
iv) Erection members shall be held securely in place by bolts to take care of dead load, wind load and erection load.
v) Free expansion and contraction wherever provided
vi) No final bolting or welding of joints shall be done until the structure has been properly aligned and consent obtained from Owner / Consultant.
vii) Erection tools and machinery shall be of suitable capacity for handling the materials furnished and must be in safe operating conditions at all times to avoid danger to materials and personnel.
viii) In positioning beams, columns or other steel members the use of steel sledges shall not be permitted.
ix) The Contractor shall report all failures of the fabricated Steel to fit together properly to the Owner / Consultant and shall obtain approval prior to taking corrective measures.

5.6.5 Erection shall be carried out according to the best modern practices and as laid down in the IS : 800-1984 and other relevant standards referred
to therein and according to this erection Specification together with approved erection drawings and Technical Specification.

5.6.6 The Contractor shall design, manufacture, erect and provide false work; staging, temporary supports, etc. required for safe and accurate erection of structural steelwork and shall be fully responsible for the adequacy of the same.

5.6.7 The Contractor shall, if so required by the Owner Consultant, get his drawings, erection schemes and designs for such false work, staging, etc. approved by the Owner / Consultant, but such approval by the Owner / Consultant shall not relieve the Contractor of any of his responsibilities for the safety of such works. As far as possible, assemblies of structures shall be made on the ground itself.

5.6.8 The Contractor shall provide adequate supervision at all stages of the work and examine each portion of the work for accuracy before commencing the erection of the next structural member. The Contractor shall also provide facilities such as adequate temporary access ladders, tools and tackles, instruments, etc. satisfactory to Owner Consultant for his inspection at any stage during erection.

5.6.9 Instrumental checking for correctness of initial setting out of structures, and adjustment of alignment shall be carried out in sequence at different stages as determined by design as against checking and adjustment of alignment in one stage after completion of entire erection. The final levelling and alignment shall be carried out immediately after completion of each section of a building or when called for by the Owner / Consultant.

5.6.10 All structural members shall be erected with erection marks in the same relative position as shown' in the appropriate erection and shop drawings.

5.7 **Field connections**

5.7.1 The holes of erection joints required to be machine bolted shall be filled with temporary bolts and plugs after mounting the structures. The number of bolts and plugs shall be determined by design but it shall not be less than 50% of the total number of holes. In joints where the number of holes is equal to 5 or less, not less than 3 holes shall be filled. The number of plugs shall be about 20% of the holes filled.
5.7.2 The number of washers on permanent bolts shall not be more than two (and not less than one) for nut and one for the bolt head. Wooden rams or mallet shall be used in forcing members into position, in order to protect the metal from injury and shocks. Chipping of edges of plates shall be done without breaking parent metal. Chipped edges shall be finished with a file and all short corner and hammered rough faces shall be rounded off. Chipping with the use of sledge hammer shall only be permitted in exceptional cases and shall be done without resulting in fractured edges.

5.7.3 Where bolting is specified on the drawings, the bolts shall be tightened to the specified limit. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts having bearing on bevelled surfaces. Use of special bolts, such as high strength friction grip bolts, shall be according to the relevant Indian or other recognized standards and shall be subject to the prior approval of the Owner / Consultant before use.

5.7.4 Spring washers or lock nuts shall be provided as specified in the design/shop drawings. All machine fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structures. All field assembly and welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding, for a distance of at least 50mm on either side of the joints.

5.7.5 Erection bolts shall be retained in position permanently even after site welding

5.8 Assembly by high strength friction grip bolts

5.8.1 The mating surfaces shall be absolutely free from grease, lubricant, dust, rust, etc. and shall be thoroughly cleaned before assembly. The preparation of the mating surfaces shall be done as specified in the design drawings.

5.8.2 Nuts shall be tightened up to the specified torque with the help of torque wrench or by half turn method with the help of pneumatic wrench lever. Torque value has to be specified in design / fabrication drawings itself. The direction of tightening of the nuts shall be from the middle towards the periphery of the joint. The bolt head, nuts and edges of the mating surfaces shall be sealed with a coat of paint to obviate entry of
moisture. As far as possible, the diameter of bolts and nature of mating surface preparation shall be kept uniform to have specified unique torque.

5.9 **Bedding and grouting**

5.9.1 Base plates shall be set to elevations shown in the drawings, supported and aligned using steel wedges and shims or any other approved method. The supply of wedges, shims and any other material for alignment shall be the responsibility of the Contractor as part of his work. Plates shall be levelled, properly positioned and the anchor bolts properly tightened. The bedding/grouting shall not be carried out until a sufficient number of columns have been properly aligned, levelled and plumbed, and sufficient girders, beams, trusses and bracings are in position to the satisfaction of the Owner / Consultant.

5.9.2 Grouting shall be done before casting of elevated RCC floors, if any, and before equipments contributing to the loading on columns are placed in position. No moving equipment shall be tested and no trial run of any equipment conducted, before grouting has been done and cured to the satisfaction of the Owner / Consultant.

5.9.3 Grouting shall be minimum M25 grade or one grade higher than the grade of base concrete with 10 mm and below graded coarse aggregate. Ready-mix, non-shrink, free-flow grout from recognised manufacturer as approved by the Owner / Consultant shall be used with pressure grouting technique to ensure proper filling-up of all void spaces underneath the base plate. Manufacturer’s recommendations / instructions shall be followed for proper application of grout material.

5.9.4 The Contractor shall inform the Owner / Consultant when the base plates are ready for grouting for their verification. The Contractor shall be responsible for final vertical and horizontal alignment of all the base plates.

5.10 **Painting after erection**

The painting shall be as per painting specifications and instructions given in TS and, in GS for painting works.

5.11 **ACCEPTANCE OF WORK**
5.11.1 Acceptance of erected steel structures shall be either after completion of erection of the whole building or in blocks.

Intermediate acceptance certificates will be given in the following cases

i) Any steelwork or part thereof, embedded in concrete.
ii) Steel structures which are to be covered in the process of carrying out further work.

5.11.2 The following documents shall be prepared and produced by the Contractor at the time of acceptance of erected steel structures:

i) Documents showing approved deviations made during execution of erection work.
ii) Documents showing acceptance of embedded structural steelwork.
iii) Certificates / documents on control checking and test of materials (if any) and welds.
iv) Data and results of Geodetic measurements while checking the erection of structures.
v) Copies of "As Built Drawings" showing thereon all additions and alterations.

6.0 WELDING SPECIFICATIONS

6.1 General

6.1.1 The welding and welded work shall conform to IS:816 and other relevant codes unless otherwise specified. Electrodes shall conform to IS:814 and shall be approved by the Owner / consultant.

6.1.2 Welding shall be done by Electrical Arc Process. Automatic welding shall be employed for important structures as specified in the drawings. Generally, submersed arc, Automatic & Semi-automatic welding shall be
employed. Only where it is not practicable, Manual Arc welding may be resorted to. In case of Manual Arc Welding, recommendations of electrode manufacturer are to be strictly followed.

6.1.3 Welding shall not be done under such weather conditions which might adversely affect the efficiency of the welding and where necessary, effective protection and other safeguards shall be provided.

6.1.4 Only qualified welders suitable for the job shall be employed. The Owner / Consultant at his discretion can order periodic tests in accordance with IS:817 of the welders and / or of the welds produced by them at no extra cost. Welding shall be done using requisite jigs and fixtures to avoid distortions or damage to members during / after welding. Welds on exposed work shall be finished uniformly smooth to present a neat appearance.

6.1.5 The layouts and sequence of operations shall be arranged so as to eliminate distortion and shrinkage stress to the satisfaction of the Inspector. Welding work shall be under constant supervision of competent welding supervisor and shall be done in a properly organized manner with the approved quality welding sets and with automatic welding machines. Detailed welding procedure shall be submitted to the Owner / Consultant and approval of the same shall be obtained before fabrication is commenced.

6.2 **Welding Procedure**

6.2.1 Welding procedure to be prepared by the Contractor shall include the following:

i) Type and size of electrodes.
ii) Current and arc voltage. (for automatic welding)
iii) Length of run per electrode, or (for automatic welding) speed of travel.
iv) Number and arrangement of runs in multi-run welds.
v) Position of welding.
vi) Preparation and set-up of parts.
vii) Welding sequence.
viii) Pre or, post-heating.
ix) Specification and thickness of steel
x) Welding process ( manual arc / submerged arc welding )
xii) Thickness of components meeting at a joint
xii) Pre and post heating requirement
xiii) Weather condition – restrictions thereof
xiv) Use of jigs and fixtures
xv) Type of non-destructive testing to be carried out
xvi) Inspection procedure to be followed
xvii) Sequence and process to be followed in different multiple-pass butt welding for different plate thicknesses.

The welding procedure shall be subject to Owner's / Consultant's approval.

6.2.2 The welding procedure shall be arranged to suit the details of the joints as indicated in the drawings and the positions in which the welding is to be carried out. The welds shall meet the requirements of quality specified.

6.2.3 All electrodes for use in the work to which the specification relates shall be kept under dry conditions. Electrodes which are damaged by moisture shall not be used unless it is certified by the manufacturer that when it is properly dried there shall be no detrimental effect. Any electrode which has part of its flux coating broken away or is otherwise damaged shall be discarded.

6.2.4 Low hydrogen electrodes and flux for submerged arc welding shall be dried at 250-300 deg. C for one hour in drying oven before use.

6.2.3 At site, the electrodes shall be kept in proper coves while using them for welding

6.2.4 All metal arc welding shall be as per IS : 9595

6.2.5 Submerged arc welding of mild steel and low alloy steel shall be as per IS : 4353

6.2.6 For multi-run weld deposit the succeeding run shall be done only after the preceding run is cleaned of all slag and flux deposits.

6.2.7 The Contractor shall prepare the edges with an automatically controlled flame cutting torch followed by grinding correctly to the shape, size and dimensions of the groove, prescribed in the design and shop drawings. In case of U-groove joint, the edges shall be prepared with an automatic flame cutting torch in two passes following a bevel cut with a gouging pass, or by machining.

6.2.8 The welding surfaces shall be smooth, uniform and free from fins, tears, notches or any other defect, which may adversely affect welding.
Welding surfaces or the surrounding surfaces within 50 mm of weld shall be free from loose scale, slag, rust, grease, paint, moisture or any other foreign material. Pre-bending of plates for three plate welded sections shall be done where found necessary.

6.2.9 Manipulators may be used where necessary and shall be designed to facilitate welding and to ensure that all welds are easily accessible to the operators. Where full strength butt welds are specified run-on and run-off pieces shall be used. The welding shall be such that the face of weld deposit shall at all places be proud of the surfaces of the parent metal by 1 to 1.5 mm. Where a flush surface is required, the surplus weld metal shall be ground and dressed off.

6.2.10 After completing each run of weld, all slag shall be thoroughly removed, and the surface cleaned before starting the next run of weld. The weld metal, as deposited (including tack welds if to be incorporated) shall be free from cracks, slag, inclusions, gross porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without serious undercutting or overlapping at the toes of the weld. The surfaces of the weld shall have a uniform and consistent contour and uniform appearance.

6.2.11 All weld runs found defective shall be cut by using either chipping hammer, gouging torch, or suitable grinding wheel in such a manner that adjacent material is not injured in any way. Peeling of the welds involving deformation of the weld surface either during de-sludging or thereafter shall not be allowed.

6.2.12 Arc-strikes on parent surfaces of structures shall be strictly avoided.

6.3 **Control in Welding**

6.3.1 The extent of quality control in respect of welds for structural elements for both statically and dynamically loaded structures shall be as follows and shall be conducted by the contractor at his own cost:-

a) **Visual Examination** - All welds shall be 100% visually inspected to check the following:

i) Presence of undercuts
ii) Visually identifiable surface cracks in both welds and base metals.
iii) Unfilled craters
iv) Improper weld profile and size
v) Excessive reinforcement in weld
vi) Surface porosity

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter beads, scales etc. by using wire brush or chisel.

b) **Dye Penetration Test (DPT)** - This shall be carried out for all important fillet welds and groove welds for both statically and dynamically loaded structures to check the following

i) Surface cracks
ii) Surface porosities

Dye Penetration Test shall be carried out in accordance with American National Standard ASTME 166.

c) **Ultrasonic- testing:** Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by Owner, to detect the following

i) Cracks
ii) Lack of fusion
iii) Slag inclusions
iv) Gas porosity

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI/AWS DI.1-96. Before ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

d) **Radiographic Testing** (X-ray and Gamma-Ray Examination)

This test shall be limited to 2% of length of welds for welds made by manual or semi- automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of
weld to be tested by this method will be decided by Owner to detect the following defects:

i) gas porosity
ii) slag inclusions
iii) lack of penetration
iv) lack of fusion
v) cracks

Radiographic testing shall be conducted in accordance with American National Standard ANSI/AWSDI.1-96. Any surface irregularity like undercuts, craters pits etc. shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than 0.75 x focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.

6.3.2 The Contractor shall provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the Owner / consultant.

6.4 Acceptable Limits of Defects of Weld

Limits of Acceptability of welding defects shall be as follows:

a) Visual inspection & Dye Penetration Test

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with American National Standard ANSI/AWS D1.1-96.

b) Ultrasonic Testing - The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with American National Standard ANSI/AWS D1.1-96.

c) Radiographic testing - The limits of acceptability of defects detected during Radiographic testing shall be in accordance with American National Standard ANSI/AWS D1.1-96

General guidelines for permissible deviations in welding have been given in Section 11.0 of this document.
6.5 **Rectification of Defects in Welds**

In case of detection of defects in welds, the rectification of the same shall be done as follows

i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.

ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld, and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

7.0 **PAINTING OF BUILDING STEEL STRUCTURES**

All steel structural work shall be painted as follows unless otherwise stated in the drawing / Technical Specification. Relevant section of the GS shall be referred for further guidelines on painting.

7.1 **Surface Preparation**

The steel surface which is to be painted shall be cleaned of dirt and grease, and the heavier layers of rust shall be removed by chipping prior to actual surface preparation to a specified grade.

Following are the type and standards of surface preparation to be followed based on the requirement of a particular painting system or as specified in the design drawings.

**Manual / Power tool cleaning** Manual/Power tool cleaning shall be done as per Grade St-2 or St-3 of Swedish Standard institution SIS 05 5900 or cl. 7.2.1.1 & 7.2.1.2 of IS : 1477 (Part - I).


**Grade St-2** :- Thorough scraping and wire brushing, machine brushing, grinding, etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2.

**Grade St-3** :- Very thorough scraping and wire brushing, machine brushing, grinding etc. The surface preparation is same as for St-2 but to be done much more thoroughly. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3.

**BLAST CLEANING** – Blast cleaning shall be done by shot blasting as per Grade SA-2 or SA- 2 ½ as specified in the drawings.

If no grade of surface preparation is specified, St-2 grade of preparation as per Swedish Standard shall be followed.

7.2 **Paints and painting**

Guidelines stipulated here shall be considered along with those specified in GS separately for painting.

7.2.1 Manufacture of paints, mixing of paints, etc - shall be generally according to the relevant IS codes of practice and as per guidelines in the General Specification in the relevant chapter.

7.2.2 In the event of conflict between this General Specification for painting and the paint manufacturer's specification, this conflict shall be immediately brought to the notice of the Owner / Consultant. Generally in cases of such conflicts, manufacturer's Specification/recommendation shall prevail.

7.2.3 Generally compatibility between primer intermediate and finishing paint shall be certified by the paint manufacturer supplying the paints. Before the Contractor buys the paint in bulk, it is recommended to obtain sample of paint and establish “Control Areas of Painting”. On Control Area, surface preparation and painting shall be carried out in the presence of the manufacturer of paint.

7.2.4 Control areas shall serve as specimen of painted surfaces, for observing and recording quality and performance of paint.
7.2.5 In case of any doubts, the Contractor shall send samples of paint to recognized testing laboratories to establish quality of paint with respect to:

i) Viscosity

ii) Adhesion/bond of paint to steel surfaces

iii) Adhesion/simulated salt spray test

iv) Chemical analysis/percentage of solid by weight

v) Normal wear resistance as encountered during handling and erection

vi) Resistance against exposure to acid fumes, and such other tests as considered necessary by the Owner / Consultant.

Whole system of paint shall be obtained from the same manufacturer.

7.2.6 Guarantee period on paints and painting shall commence from the date of completion of finishing coat of paint on entire structures. The guarantee period shall be indicated depending on the type of surface preparation and system of painting. To fulfil this obligations, the Contractor may obtain from the painting manufacturer, guarantee for the performance of paint/painted surfaces.

7.2.7 The painting material as delivered to the Contractor/Applier, must be in the manufacturer's original containers bearing thereon manufacturer's name, brand and description. Paint/painting material in the containers without labels or with illegible labels shall be rejected, removed from the area and shall not be used. Thinners wherever used shall be those recommended by the paint manufacturer and shall be obtained in the containers with manufacturer's name and brand name of the thinner legibly printed, failing which the thinner is liable to be rejected and shall not be used.

7.2.8 Wherever shop primer painting is scratched, abraded or damaged, the surface shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted or as directed by the Owner / Consultant, and touched up with corresponding primer. Touching up paint shall be matched and blended to conspicuous marks. If more than 50% of the painting surface of an item requires repair, the entire item shall be mechanically cleaned and new primer coats followed by finishing coats shall be applied as per painting Specification.

7.2.9 All field welded areas on shop painted items shall be mechanically cleaned including the weld area proper, adjacent areas contaminated by
weld splatter or fumes & areas where existing primer / intermediate / finish paint is burnt. Subsequently, new primer and finishing coats of paint shall be applied as per painting Specification.

7.2.10 Application of paint shall be by spraying or brushing as per IS : 486 and IS : 487 and in uniform layers of 50% overlapping strokes by skilled painters. Painting shall not be done when the temperature is less than 5 degree C or more than 45 degree C and relative humidity is more than 85%; unless manufacturer's recommendations permit. Also painting shall not be done in foggy weather. During application, paint agitation must be provided where such agitation is recommended by the manufacturer.

7.2.11 Paint shall be applied at painting manufacturer's recommended rates. The number of coats shall be such that minimum dry film thickness specified is achieved. The dry film thickness (DFT) of painted surfaces shall be checked with ELCOMETER or measuring gauges to ensure specified DFT.

7.2.12 The inside surfaces of gutter which come in contact with rain water shall be provided with 2 finishing coats of water resistant, bitumastic paint of minimum DFT 75 microns, in addition to the primer coats of red oxide zinc phosphate in phenolic alkyde medium or 2 primer coats of epoxy based red oxide zinc chromate/epoxy based zinc phosphate of minimum DFT 25 microns per coat, as given in Specification and drawings. Other structures shall be painted as per painting system mentioned.

7.2.13 All structures shall receive one coat of primer paint at shop after fabrication before despatch after surface preparation has been done as per requirements. Unless otherwise specified all structures after erection shall be given one coat of primer and two coats of finishing paint of approved colour and quality. The under coat shall have different tint to distinguish the same from the finishing coat. Edges, corners, crevices, depressions, joints and welds shall receive special attention to ensure that they receive painting coats of required thickness.

7.2.14 Machine-finished surface shall be coated with white lead and tallow before shipment or before being put out into the open air. Part of steel structures to be embedded in concrete, shall be given a protective coat of Portland cement slurry immediately after fabrication after this part is thoroughly cleaned from grease, rust, mill scales etc. No paint shall be applied on such parts.
7.2.15 Zinc-rich primer paints, which have been exposed several months before finishing coat is applied, shall be washed down thoroughly to remove soluble zinc salt deposits. In similar circumstances, the surface of paint based on epoxy resin should be abraded or lightly blast cleaned to ensure adhesion of next coat.

7.2.16 Paints selection shall be based on Preferred make list of BSP. Type of paint (heat resistant/high corrosion resistant) required to be applied for a structure shall be approved by BSP and prior permission shall be taken before application of paint.

8.0 GENERAL REQUIREMENTS

8.1 Programme

The Contractor shall prepare a programme showing the date of supply of steel to his work, and the fabrication and erection of each section of the structure or structures. The erection dates shall be the dates for completion of all the follow-up work in addition to main erection keeping overall completion of project in view. The programme shall include quantum of different activities of work planned month wise to complete the work.

8.2 Drawings

8.2.1 The Contractor shall prepare steel structural arrangement drawings and design drawings along with analysis and design calculation of major elements and take their approval by Owner / Consultant within the time schedule as per contract. Necessary number of prints of drawings and documents; as per contract shall be submitted for approval. The Contractor shall prepare the fabrication drawings and bill of materials shall form part of the fabrication drawings which will be included in the body of the drawing or prepared separately.
8.2.2 Even if the drawings are Approved / Commented by the Owner / Consultant, the Contractor shall not be relieved of the responsibilities for the accuracy of the detailed dimensions shown in the drawings and the safety of all structural connections.

8.2.3 Notes on specifications shown on design drawings shall considered as superseding or overriding the specifications with which they conflict. On all drawings, dimensions shown in figures shall be acted on. Erection drawings in requisite number of sets shall be submitted to the Owner / Consultant showing thereon all authorized additions and alterations in the process of erection. These drawings shall show the "As-Built Installations".

8.2.4 Supply and distribution of fabrication drawings. and other documents like bolt list etc. for the contractors own use or for the use of his subcontractors shall be the responsibility of the Contractor.

8.2.5 The Contractor shall assume full responsibility for the correct setting out of all steel works and erecting correctly in accordance with alignment and levels shown on the approved drawings and plumbing of vertical members. Notwithstanding any assistance rendered to the Contractor by the Owner / Consultant, if at any time during the progress of the work, any error should appear or arise therein, on being required to do so, the Contractor at his own cost shall remove and amend the work to the satisfaction of the Owner/Consultant.

8.2.6 The Contractor shall provide his own measuring instruments for setting out, levelling and aligning work at his own expense.

8.3 **Co-ordination with other Contractors**

The structures shall have to be erected suitably detailed with erection of equipment or construction of civil works. The Contractor shall ensure spirit of co-operation with other contractors and strict adherence to the schedule so that erection schedules of the other parties are not affected.

8.4 **Staging**

Any staging necessary for the pre assembly work of structures shall be provided by the Contractor.
8.5 **Rules and regulations of safety, electricity boards, factory etc.**

The Contractor shall at all times comply with such rules and regulations as stipulated in relevant factory acts, electricity rules, safety regulations, etc.

8.6 **Deviations**

Should the contractor wish to deviate from any specifications or approved drawings and/or technical specifications, he shall obtain the Owner/Consultant’s written authority before proceeding with the deviations.

9. **INSPECTION OF STRUCTURES**

The Owner / Owner’s Inspector shall have free access at all times to those parts of Contractor's or his Sub-Contractor's works which are concerned with the fabrication of steel works and shall be afforded all reasonable facilities at all stages of preparation, fabrication and trial assemblies for satisfying himself that the fabrication is being undertaken in accordance with the provisions of relevant specification.

9.2 All gauges and templates, tools, apparatus, labour and assistance for checking shall be supplied by the contractor free of charge. The Owner / Inspector may at his discretion, check the test results obtained at the Contractor's works, by independent test at the Government Test House or elsewhere, and should the material so tested be found to be unsatisfactory, the cost of such test shall be borne by the Contractor.

9.3 Contractor shall make all necessary arrangements for stage inspection by Owner/Inspector during the fabrication at shop and incorporate all on-the-spot instructions / changes conveyed in writing to the Contractor.
9.4 Material improperly detailed or wrongly fabricated shall be reported to the Owner/Inspector and shall be made good as directed. Minor misfits which can be remedied by moderate use of drift pins, and moderate amount of reaming and slight chipping may be corrected in that manner, if in the opinion of the Owner / Inspector the strength or appearance of the structure shall not be adversely affected. In the event the Owner / Inspector directs otherwise, the items shall be rejected and a completely new piece shall be fabricated. The cost of correcting errors shall be to the account of the Contractor.

9.5 The Owner / Owner's Inspector shall have the power:

a) To declare, before any structure is submitted for inspection, that the same is not in accordance with the contract, owing to the adoption of any unsatisfactory method of fabrication and the same will be rejected.

b) To reject any structure as not being in accordance with specifications & drawings.

c) To insist that no structure or parts of the structure once rejected is resubmitted for inspection/test, except in cases where the Owner / Inspector authorised representative considers the defects as rectifiable.

9.5.1 If, on rejection of structure by the Owner/Inspector the Contractor fails to make satisfactory progress within the stipulated period, the Owner / Inspector shall be at liberty to cancel the contract and fabricate or authorise the fabrication of the structures at any other place he chooses, at the risk and cost of the Contractor, without prejudice to any action being taken in addition to terms of General Conditions of Contract.

9.5.2 The Owner / Inspector's decision regarding rejection shall be final and binding on the Contractor.

9.5.3 The specifications prescribe various tests at specified intervals for ascertaining the quality of the work done. If the tests prove unsatisfactory, Owner/Inspector shall have liberty to order the Contractor to re-do the work, done in that period and/ or to order such alterations and strengthening that may be necessary at the cost of the Contractor and the contractor shall be bound to carry out such orders failing which the rectification/redoing shall be done by the Owner through other agencies and the cost recovered from the Contractor.
9.5.4 Notwithstanding any inspection at the workshop the Owner/Inspector shall have the liberty to reject, without being liable for compensation any fabricated members or materials brought to site that do not conform to specifications / drawings.

9.5.5 All rejected materials shall be removed from the site of fabrication by the Contractor at his own cost and within the time stipulated by the Owner/Inspector.

10.0 QUALITY SYSTEM AND THIRD PARTY INSPECTION.

10.1 GENERAL

Inspection shall be carried out at the works of the Contractor during fabrication and on final product to ensure conformity of the same with the acceptable criteria of technical specifications, approved fabrication drawings and indicated standards.

10.1.1 This specification is in addition to the provisions laid down in Owner's General Condition of Contract (GCC) and special instructions to Contractor, if any.

10.2 QUALITY SYSTEM REQUIREMENTS.

The Contractor must recognise the importance of quality and follow the defined quality programme in all manufacturing and quality control activities of the product. The Contractor shall define and implement the tasks and controls that shall provide needed assurance in case manufacturing of product is sub-contracted either partly or fully and / or for the procured components of the product. All bought-out components, if any, shall be procured from approved list of vendors issued by the Project Authority.

Owner reserves the right to verify the quality programme and entire product characteristics to assure the intended and specified quality of the product.

10.3 QUALITY ASSURANCE PLAN (QAP)
10.3.1 The Contractor shall furnish the Quality Assurance Plan (QAP) for the respective structural unit / component after finalisation of billing schedule for Owner's approval at least two months prior to start of manufacturing.

10.3.2 The Contractor shall indicate the procurement source and furnish to Owner during discussions on QAP, copies of Owner Order, Sub-Owner Order, and data sheets as backup reference materials for scrutiny & finalisation of QAP.

10.3.3 QAP shall be prepared & furnished by the Contractor in the prescribed format (enclosed as Annexure- B) for structural components, in four sets.

10.3.4 Inspection and test requirements shall be decided with due consideration of factors like safety, duty cycle, operating conditions, equipment life, environmental conditions, place of installation and statutory regulations, as applicable, for a particular component. Any, additional type or special test or routine tests if found necessary to establish the intended quality, shall be incorporated in the QAP on mutual agreement without any commercial implication.

10.3.5 Detailed QAP shall be prepared by the Contractor based on the general plan given by Owner and shall be approved by Owner to avoid any complication later.

10.3.6 QAP shall clearly indicate the followings through use of codes in the appropriate columns:

   a) Range of inspection & tests to be done by the Contractor during fabrication of structures from raw materials to finishing stage.

   b) Suggestive check / hold points for Owner’s inspection and witnessing of tests during the fabrication and final product inspection.

   c) Details of test certificates, internal inspection reports and calibration certificates to be furnished by the Contractor to Owner.

   d) Inspection documents to be furnished by the Contractor to Owner for reference during inspection.

10.3.7 Sampling method for lot inspection of similar bulk items, if any, shall be indicated under column 16 of QAP with linkage to applicable standard.

10.3.8 While submitting the QAP, the Contractor shall indicate the acceptance criteria under column 15 of QAP form regarding check parameters of each
component. Acceptance criteria shall have reference of documents viz. Owner Order, Sub-Owner Order, T.S., Approved fabrication drawings. Wherever the acceptance criterion is not available in above documents, the same shall be specified with traceability to national / international specifications.

10.4 **INDICATIVE SURVEILLANCE BY OWNER.**

10.4.1 Surveillance level of Owner may vary from component to component as per product characteristics.

Indicative extent of inspection for buildings and structures is furnished below for guidance of Contractors in developing QAP.

<table>
<thead>
<tr>
<th>Categories of Equipment</th>
<th>Extent of Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Manufactured items</td>
<td>Material &amp; manufacturer’s test certificate to be submitted by giving inspection call for the main equipment in the final stage.</td>
</tr>
<tr>
<td>(Structural fabricated and welded)</td>
<td></td>
</tr>
</tbody>
</table>

Scrutiny of welding procedure and welder’s qualification record shall be carried out if required as per governing code.

Following checks / tests shall be carried out in the final stage:
- Visual inspection
- Alignment and fitment checking
- Dimensional checking
- Weld inspection - visual and NDT as per design requirements. Radiographs are to be shown and reports to be submitted to Owner for review during inspection, if applicable.

10.5 **CALIBRATION OF MEASURING EQUIPMENT.**

10.5.1 All the measuring equipment used for inspection & testing shall be calibrated and appropriate accuracy class of measuring equipment shall be used. Calibration standards used for calibration of measuring equipment...
equipment shall be traceable to national standards of National Physical Laboratory (NPL), New Delhi with unbroken chains of comparison.

10.5.2 Calibration Certificate of All Measuring Equipments.

Valid calibration certificates for all measuring equipments used during inspection and testing with traceability to national standards of NPL / NPL accredited laboratories shall be furnished along with inspection call prior to undertaking inspection by Owner.

Calibration certificates shall also indicate reference number of calibration standards calibrated by NPL / NPL accredited laboratories and copies of such calibration certificates of calibration standards shall also be furnished when asked for.

10.6 TEST CERTIFICATES AND DOCUMENTS.

10.6.1 For each of the items being fabricated, the following test certificates and documents, as applicable, in requisite copies including original shall be submitted to Inspection Agency. All test certificates must be endorsed by the Contractor with linkage to project, purchase order and acceptance criteria.

i) Raw materials identification & physical and chemical test certificates for all materials used in fabrication of the component (except IS 2062-1992).

ii) WPS, PQR & WPQ Documents as per applicable code.

iii) Details of stage-wise inspection & rectification records for fabricated items and machined articles.

iv) Control dimension chart with records of alignment, trueness of shape, etc.

v) Details of heat-treatment and stress relieving charts as per specification.

vi) Non-Destructive Test reports as per respective code.

vii) Hardness test certificate.

viii) Performance Test Certificates for all characteristics.
ix) Geometric accuracy and repeatability test reports of machine tools.

x) Surface preparation and painting certificates.

xi) Certificates from competent authority for the items coming under statutory regulations.

10.6.2 The Inspection Agency shall have the right to be present and witness all tests being carried out by the Contractor at their own laboratory or approved laboratories. Also, the Inspection Agency shall reserve the right to call for confirmatory test on samples, at his discretion.

10.7 MANUFACTURING AND INSPECTION SCHEDULE

The Contractor shall submit the schedule for fabrication and inspection indicating components/assembly/sub-assembly, date of approval of drawings/data sheets, address of Fabricator with contact person and scheduled date of inspection. Such reports shall be submitted to Owner with a copy to Inspection Coordinating Office once in a month. These monthly reports shall state the planning for next three months. Submission of first report must commence one month prior to commencement of fabrication activities of the component.

10.8 INTERNAL INSPECTION BY CONTRACTOR

10.8.1 The Contractor in accordance with approved drawings, T.S., Owner Order, and approved QAP shall carry out inspection and tests. The Contractor shall maintain records of each inspection and test carried out and signed documents shall be submitted to Owner for verification.

10.8.2 The Contractor shall carry out their internal inspection & obtain clearance from statutory bodies e.g. IBR, CCE, TAC, Weights & Measures, safety, IE rules etc. as and where applicable, prior to offering any component for Owner's inspection in accordance with approved QAP.

10.8.3 The Contractor shall ensure use of appropriate calibrated measuring equipment during their internal inspection, as well as, make available the same during Owner's inspection and tests. Also, they shall make necessary arrangement for access and use of Owner owned measuring equipment during inspection.

10.8.4 The Contractor shall identify all the inspected component / raw materials & shall maintain the record of status of inspection viz. inspected & found acceptable, require rectification / rework, rejected etc.
10.8.5 The Contractor shall establish and maintain procedures to ensure that product that does not conform to specified requirements, is prevented from inadvertent use or installation. The description of non-conformity that has been accepted subsequently by Owner by concession and / or of repairs shall be recorded.

Repairs and reworked product shall be offered for re-inspection to Owner along with records of corrective action taken.

10.8.6 The Contractor shall not despatch any equipment till receipt of despatch clearance from Owner.

10.9 METHOD OF UNDERTAKING INSPECTION & TESTING BY OWNER.

10.9.1 Agency Responsible:-

Inspection / Waiver of component shall be undertaken by various MECON Offices depending upon the location of manufacturers.

10.9.2 Method of Issuing Inspection Call to MECON:

(i) Inspection call shall be given only on readiness of the assembly / sub-assembly and approval of all relevant drawings and QAP. In case assembly sub-assembly offered for inspection are found not ready, all the cost of visit of Owner's personnel shall have to be borne by the Contractor. Also, if the assembly / sub-assembly after inspection found not acceptable, require rework and involve Owner's re-inspection, all the cost of such re-inspections shall also be borne by the Contractor.

(ii) Inspection call shall be floated to Owner with ten days clear margin, enclosing all documents like test Certificates, Internal Inspection Reports, Purchase Order, Sub-Purchase Order, T.S., Approved QAP, approved GA drawings/ data sheets and fabrication drawings with a copy of call letter to Inspection Co-ordinating Office. Inspection calls without above documents shall be ignored.

(iii) The supplier shall offer substantial quantities for economical inspection consistent with the size of order.

10.10 OBLIGATIONS OF CONTRACTOR.
10.10.1 The Contractor shall provide all facilities and ensure full and free access of the Inspection Engineer of Owner to the Contractor’s or their Sub-Contractor’s premises at any time during contract period, to facilitate him to carry out inspection & testing of the product during or after manufacture of the same.

10.10.2 The Contractor shall delegate a Representative / Co-ordinate to deal with Owner / Consultant on all inspection matters. Also, Contractor’s Representative shall be present during all inspection at Sub-Contractor's works.

10.10.3 The Contractor shall comply with instructions of the Inspection Engineer fully and with promptitude.

10.10.4 The Contractor / Sub-Contractor shall provide all instruments, tools, necessary testing & other inspection facilities to Inspection Engineer free of cost for carrying out inspection.

10.10.5 The cost of testing welds by ultrasonic, radiographic and dye penetration tests etc. in the fabrication workshop shall be borne by the Contractor.

10.10.6 The Contractor shall ensure that the assembly / component of the plant and equipment required to be inspected, are not dismantled or despatched before inspection.

10.10.7 The Contractor shall not offer equipment for inspection in painted condition unless otherwise agreed in writing by Owner / Consultant.

10.10.8 The Contractor shall ensure that the equipment and materials once rejected by the Inspection Engineer are not re-used in the manufacture of the plant and equipment. Where parts rejected by the Inspection Engineer have been rectified, as per agreed procedures laid down in advance, such parts shall be segregated for separate inspection and approval, before being used in the work.

10.11 STAMPING AND ISSUE OF INSPECTION DOCUMENTS.

Inspection Memo: -

For stage inspection & for rejected items / items which do not conform to Technical Specification in one or more quality characteristics requiring rectification / rework, Inspection Memo shall be issued in
standard form indicating therein the details of observation & remarks. Fabricator shall indicate all the non-conformities with respect to specification of the product in the Inspection Memo for further control.

Inspection Certificate: -

On satisfactory completion of final inspection & testing by Owner / Third Party Inspector, all accepted plant & equipment shall be stamped suitably and the Inspection Engineer for the accepted items shall issue Inspection Certificate in standard form.

Inspection Waiver Certificate: -

For the waiver category of items identified in the approved QAP, Owner shall issue Inspection Waiver Certificate after scrutiny of Contractor’s Internal Inspection Report, Test Certificates and other Documents as identified in QAP.

10.12. GENERAL CLAUSES

10.12.1 Inspection & tests carried out by Owner / Third Party Inspector shall not absolve the responsibility of the Contractor to provide acceptable product nor shall it preclude subsequent rejection.

10.12.2 Owner / Third Party Inspector reserves the right to inspect any product at any stage of manufacturing without prior notice to Contractor beyond pre-identified stages & hold points of approved QAP.

11. PERMISSIBLE DEVIATION IN ASSEMBLY OF WELDED JOINTS

A) SQUARE BUTT-JOINT

a) Gap between the ends of plates : + 1.0 mm
b) Stepping of one plate over the other : + 1.0 mm

B) SINGLE VEE-GROOVE JOINT

a) Bevel angle : + 5 deg
b) Gap between two plates : + 1.0 mm

c) Stepping of one plate over the other : + 2.0 mm

d) Root thickness : + 1.0 mm

C) LAP JOINT

a) Over lap : + 5.0 mm
b) Gap between the surfaces : + 1.0 mm

D) TEE FILLET JOINT

a) Gap between the edge of the web and the surface of the flange : + 2.0 mm

E) DOUBLE VEE-GROOVE JOINT

a) Stepping of plate over one another : + 2.0 mm
b) Deviation in value of root thickness : + 1.0 mm
c) Deviation in bevel angle : + 1.0 mm
d) Deviation in value of gap : + 1.0 mm

12. PERMISSIBLE DEVIATIONS IN FABRICATION & ERECTION

TABLE – 1

DUST CATCHER SHELL

<table>
<thead>
<tr>
<th>Description</th>
<th>Tolerance in mm</th>
</tr>
</thead>
</table>

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Structural
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### TABLE – 2

**BLAST FURNACE SHELL**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DEVIATION IN mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ellipticity (max. difference in diameters) of a course.</td>
<td>+ 0.002 of the theoretical diameter of the course.</td>
</tr>
<tr>
<td>Stepping of the edges of plates in the vertical and circular weld joint.</td>
<td>0.1 of shell thickness but not more than 3 mm.</td>
</tr>
<tr>
<td>Local warping of shell along the generatrix and periphery as measured by</td>
<td>Not more than 15 mm.</td>
</tr>
<tr>
<td>gauge over the length of 1500 mm.</td>
<td></td>
</tr>
</tbody>
</table>
Caving in or bulging of joints measured by gauge over a length of 200 mm.  

Note: H - height measured from the base of the point of alignment.

### TABLE – 3

**COVERAGE OF NDT FOR WELDS**

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>NORMS FOR CONTROLLING AS A % OF TOTAL LENGTH OF WELDING ( NOT LESS THAN ) FOR</th>
<th>PLACES TO BE SUBJECTED TO RADIOGRAPHIC TESTING COMPULSORILY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ULTRASONIC TESTING</td>
<td>RADIOGRAPHIC TESTING</td>
</tr>
<tr>
<td>BF Shell</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>Stoves, hot blast main &amp; bustle main</td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>
### TABLE – 4

**ERECTION TOLERANCES**

<table>
<thead>
<tr>
<th>Description</th>
<th>Dimension</th>
<th>Allowable Deviation</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust catcher, Junction &amp; places of variable cross sections by the following norms without ultrasonic testing</td>
<td>100</td>
<td>3</td>
<td>1.5 Crossing of welded joint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>0.5 Portions of the welded joints found defective by ultrasonic welding</td>
</tr>
<tr>
<td>Portions of gas pipelines from BF to DC &amp; DC to GCP</td>
<td>--</td>
<td>1</td>
<td>0.5 Portions of the welded joints found defective by ultrasonic testing</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>TOLERANCE (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COLUMNS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation of column axes at foundation top level with respect to true axes</td>
<td>± 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In longitudinal direction</td>
<td>± 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In lateral direction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation in the level bearing surface of columns at foundation top level with respect to true level</td>
<td>± 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-of-plumbness (verticality of column axis from true vertical axis, as measured at column top)</td>
<td>± H/1000 or ±25 mm whichever is less.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For columns without any special requirements</td>
<td>± H/1200 or ±35 mm max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to and including 30 M height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 30 M height</td>
<td>± H/1000 or ±20 mm whichever is less.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For columns with special requirement like cranes or such similar requirements.</td>
<td>± H/1500 or ±25 mm max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upt o and including 30 M height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 30 M height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviations in straightness in longitudinal and transverse plans of columns at any point along the height.</td>
<td>± H/1000 or ±10 mm whichever is less.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>TOLERANCES (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference in the erected position adjacent pairs of columns along with</td>
<td>± 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cross width of building prior to connecting trusses/beams with respect to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>true distance.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation in any bearing or seating level with respect to true level.</td>
<td>± 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation in difference in bearing levels of a member on adjacent pair of</td>
<td>± 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>columns both across and along the building.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:
Tolerance specified under 3(a) & 3(b) should be read in conjunction with 4 & 5. 'H' above is the column height in mm.

contnd..

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>TOLERANCES (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRUSSES</td>
<td></td>
</tr>
<tr>
<td>Shift, at the centre of span of top chord member with respect to the</td>
<td>± 1/250 of height of</td>
</tr>
<tr>
<td>vertical plan passing through the centre of bottom chord.</td>
<td>truss at centre of span</td>
</tr>
<tr>
<td>or ± 15 mm whichever is less.</td>
<td>or</td>
</tr>
<tr>
<td>Lateral shift of top chord of truss at the centre of span from the vertical</td>
<td>± 1/1500 of height of</td>
</tr>
<tr>
<td>plan passing through the centre of supports of the truss.</td>
<td>truss at centre of span</td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>TOLERANCES (mm)</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Lateral shift in location of truss from its true vertical position.</td>
<td>±10 mm whichever is less.</td>
</tr>
<tr>
<td>Lateral shift in location of purlins from its true positions.</td>
<td>±5</td>
</tr>
<tr>
<td>Deviation in difference of bearing levels of trusses or beam from the true difference.</td>
<td>L/1200 or ±20 mm whichever is less (L = span)</td>
</tr>
</tbody>
</table>

**DESCRIPTION**

**TOLERANCES (mm)**

**CRANE GIRDERS & RAILS**

| Shift in the centre line of crane rail with respect to centre line of web of crane girder. | ± (web thickness + 2)/2 |
| Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point. | ±5 |
| Deviations in crane track gauge with respect to true crane gauge. For track gauge up to and including 15 M. For track gauge more than 15 M. | ±5 (5 + 0.25(S-15)) subject to a max. of 10 mm, where S in |
Deviations in crane rail level at any point from true level.  

Deviation in levels between crane track rails (across the bay) at:
- Support of crane girder
- Mid span of crane girders

<table>
<thead>
<tr>
<th>Deviation</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference in levels between crane track rails</td>
<td>±10</td>
</tr>
<tr>
<td>Relative shift of crane rail surfaces at a joint in plan and elevations</td>
<td>±15 ±20</td>
</tr>
<tr>
<td>Relative shift in location of crane stops (end buggers) along the crane track gauge</td>
<td>2 mm subject to grinding of surfaces for smooth transitions</td>
</tr>
</tbody>
</table>

### CHIMNEYS & TOWERS

Out of plumbness (vertically from the true vertical axis).  

<table>
<thead>
<tr>
<th>Deviation</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out of plumbness of chimney or tower</td>
<td>1/1000 of the height of chimney or tower in mm</td>
</tr>
</tbody>
</table>

### BUNKERS

Deviation in length of bunker from the true length.  

<table>
<thead>
<tr>
<th>Deviation</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviation in length of bunker from the true length</td>
<td>±1/1000 of length in mm</td>
</tr>
<tr>
<td>Deviation in width of bunker from the true width</td>
<td>±1/1000 of width in mm</td>
</tr>
<tr>
<td>Deviation in height of bunker from the true height</td>
<td>±1/1000 of height in mm</td>
</tr>
<tr>
<td>Section</td>
<td>Specification</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BF SHELL</td>
<td>Ellipticity (the maximum difference in diameter in diameter) of courses.</td>
</tr>
<tr>
<td></td>
<td>0.002 of the theoretical diameter of the courses.</td>
</tr>
<tr>
<td>STOVE SHELL</td>
<td>The dome centre shift with respect to the bottom centre.</td>
</tr>
<tr>
<td></td>
<td>± 20</td>
</tr>
<tr>
<td>Ellipticity</td>
<td>0.002 of the nominal diameter</td>
</tr>
<tr>
<td>TOP STRUCTURES</td>
<td>Shift of frame centre from the designed position.</td>
</tr>
<tr>
<td></td>
<td>± 20 mm</td>
</tr>
<tr>
<td>Non horizontality of girders</td>
<td>3 mm per 1 m of girder length.</td>
</tr>
<tr>
<td>DOWN COMERS</td>
<td>Erection and sag of down comers</td>
</tr>
<tr>
<td></td>
<td>0.0015 L but not more than 80 mm. (L is the length of pipeline)</td>
</tr>
<tr>
<td>GAS PIPELINE SUPPORTS</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Deviations of support axes</td>
<td>from the vertical plane.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>GAS &amp; AIR</td>
<td>Distortion of flange /surfaces (except for the furnace top one ) with respect</td>
</tr>
<tr>
<td></td>
<td>to the branch pipe/ pipe socket axis.</td>
</tr>
<tr>
<td>DUST CATCHER</td>
<td>Ellipticity</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>BUSTLE PIPE</td>
<td>The deviations of the bottom level ( of the shell ) of the ring pipe ( measured</td>
</tr>
<tr>
<td></td>
<td>along the axis of air tuyere ) from the designed one.</td>
</tr>
<tr>
<td></td>
<td>Ellipticity</td>
</tr>
</tbody>
</table>
Note:

The tolerances given at Sections 11 and 12 above, are meant as general guidelines, mainly for technological structures, and for those not covered in IS Codes. Tolerances for fabrication and erection in general, shall be as per stipulations of IS : 7215-1974, and IS : 12843 -1989. In case of a conflict between the guidelines given in IS Codes and this Specification, those specified herein shall prevail.

ANNEXURE-A

Permissible deviations in pitch and gauge of holes for bolts of normal accuracy (high strength bolts included)

<table>
<thead>
<tr>
<th>Description</th>
<th>Hole diameter (mm)</th>
<th>Permissible deviations in spacing (mm)</th>
<th>Permissible deviations in each group of holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Steel</td>
<td>Low Alloyed Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>a) Deviation in the hole diameter</td>
<td>Upto 17.0</td>
<td>+1</td>
<td>No limits</td>
</tr>
<tr>
<td>Above 17.0</td>
<td>+1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Ovality (difference between the biggest and the smallest diameter)</td>
<td>Upto 17.0; Above 17.0;</td>
<td>+1</td>
<td>No limits</td>
</tr>
<tr>
<td>+1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Curves, exceeding 1mm and</td>
<td>__</td>
<td>__</td>
<td>Not permissible</td>
</tr>
</tbody>
</table>
cracks on
the hole
edges
d) (i) Non-coincidence of holes in separate details of the assembled unit, upto 1mm
(ii) Above 1 mm upto 1.5 mm
(e) Slope of axis

<table>
<thead>
<tr>
<th></th>
<th>Upto 50%</th>
<th>Upto 50%</th>
<th>Upto 10%</th>
<th>Upto 10%</th>
<th>No</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Limits</td>
<td>Limits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>thickness of unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GENERAL SPECIFICATION
FOR
QUALITY SYSTEM, INSPECTION &
TEST OF PLANT / EQUIPMENT AT
MANUFACTURER’S PREMISES
(GS – 05)

MECON LIMITED
RANCHI – 834002
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</tr>
<tr>
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<td>STAMPING AND ISSUE OF INSPECTION DOCUMENTS</td>
<td>5</td>
</tr>
<tr>
<td>11.</td>
<td>GENERAL CLAUSES</td>
<td>5</td>
</tr>
</tbody>
</table>

**ENCLOSURES:**

- i) Form No. 11.20.(DQM)F-09 Rev-0 - QAP for Structural & Mechanical Equipment
- ii) Form No. 11.20.(DQM)F-10 Rev-0 - QAP for Electrical Equipment
- iii) Form No. 11.20.(DQM)F-11 Rev-0 - QAP for Refractory Materials
- iv) Form No. 11.20.(DQM)F-5/2 Rev-0 - Inspection Call Proforma
- v) LIST OF MECON OFFICES and Contact Address Details
GENERAL SPECIFICATION ON QUALITY SYSTEM, INSPECTION & TEST OF PLANT & EQUIPMENT AT MANUFACTURER'S PREMISES

1.0 GENERAL

1.1 Inspection & testing of plant & equipment shall be carried out by Consultant/ Purchaser at the works of successful tenderer during manufacturing and/or on final product to ensure conformity of the same with the acceptable criteria of technical specifications, approved drawings, manufacturing drawings and applicable national / international standards.

2.0 QUALITY SYSTEM REQUIREMENTS

The successful tenderer must recognise the importance of quality and follow defined quality programme in all stages of manufacturing and quality control activities of the product. Contractor must define and implement the tasks and controls that will provide needed assurance, in case manufacturing of product is sub-contracted either partly or fully and/or for the procured components of the product. All bought-out equipment or component shall be procured from vendors which are duly approved by the project authority.

Consultant/ Purchaser reserve the right to verify the quality programme of tenderer & its vendors/sub-vendors to assure the effectiveness of the programme to meet the intended and specified quality of the product.

3.0 QUALITY ASSURANCE PLAN (QAP)

3.1 The successful tenderer shall furnish Quality Assurance Plan (QAP) for respective equipment after completion of detailed engineering and finalisation of billing schedule / equipment identification number for Consultant's approval at least one month prior to start of manufacturing.

3.2 QAP shall be prepared & furnished by Contractor in Form Nos. 11.20(DQM) F-09,10,11 (specimen copy enclosed) / detailed manufacturing QAP for structural & mechanical equipment, electrical equipment and refractory materials respectively, QAPs must be submitted in four (4) sets duly signed and stamped by tenderer for MECON approval.

3.3 The successful tenderer shall indicate procurement source and furnish to Consultant, during the submission of QAP, copies of P.O., Sub-P.O., T.S., approved GA drawings/ data sheets & detailed manufacturing drawings, as backup reference materials for scrutiny & final approval by Consultant. The submission & subsequent approval of QAPs shall be ensured to be restricted to one round only.

3.4 Inspection and test requirements shall be decided with due consideration of factors like safety, duty cycle, operating conditions, equipment life, environmental conditions, place of installation and statutory regulations, as applicable, for a particular equipment. Any, additional type or special tests or routine tests if found necessary to establish the intended quality after detailed engineering then the same shall have to be incorporated in the QAP without any commercial implication.

3.5 Detailed QAP shall be prepared by the successful tenderer in consultation with their Sub-contractors / Manufacturers to avoid any complicacy later.
4.0 **CALIBRATION OF MEASURING EQUIPMENT**

4.1 All the measuring equipment used for inspection & testing shall be calibrated and appropriate accuracy class of measuring equipment shall be used. Calibration standards used for calibration of measuring equipment shall be traceable to national standards of National Physical Laboratory (NPL), New Delhi with unbroken chains of comparison.

4.2 Valid calibration certificate for all measuring equipment used during inspection and testing at manufacturer's works, with traceability to national standards of NPL/ NABL accredited laboratories shall be furnished prior to undertaking inspection by Consultant/ Purchaser.

Calibration certificate shall also indicate reference no. of calibration standards calibrated by NPL/NABL accredited laboratories and copies of such calibration certificates of calibration standards shall be included in the compiled dossiers of inspection/test results.

5.0 **TEST CERTIFICATES AND DOCUMENTS**

5.1 For each of the items being manufactured as per approved QAP, following test certificates and documents, as applicable for each of the equipment, in requisite copies including original, duly endorsed by the Manufacturer/successful tenderer with appropriate linkage to project, purchase order and acceptance criteria etc shall be submitted to Consultant/ Purchaser.


ii) WPS, PQR & WPQ documents as per applicable code.

iii) Details of stagewise inspection & rectification records for fabricated items, castings, forgings and machined articles.

iv) Control dimension chart with records of alignment, squareness etc.

v) Manufacturer's material and performance/relevant test certificates for all bought-out items.

vi) Details of heat-treatment and stress relieving charts as per specification.

vii) Non-Destructive Test reports as per respective code.

viii) Static/dynamic balancing certificate for rotating components/machines.

ix) Hardness test certificate.

x) Pressure/Leakage Test Certificates.

xi) Performance Test Certificates for all characteristics.

xii) Routine / type / calibration / acceptance / special test (Type Tests etc) certificates for electrical items.
xiii) Surface preparation and painting certificates.

xiv) Certificates from competent authority for the items coming under statutory regulations.

5.2 Where physical and chemical test certificates of material are not available, the successful tenderer/Sub-contractor shall arrange to have specimens and test samples of the materials, tested in his own laboratory at his cost and submit the copies of test results in requisite numbers to Consultant/Purchaser for review. Number of test samples against each heat/cast/lot or batch of materials, as applicable shall be as per relevant Indian or International Standards.

5.3 Where facilities for testing do not exist in the successful tenderer/Sub-contractor's laboratories or in case of any dispute, samples and test pieces shall be drawn by the successful tenderer/Sub-contractor in presence of Consultant/ Purchaser and sealed sample shall be sent to any Govt. approved /NABL accredited laboratory for necessary tests at former's own cost.

5.4 The Consultant/ Purchaser shall have the right to be present and witness all tests being carried out by the successful tenderer/Sub- contractor at their own laboratory or approved laboratories. Also, the Inspection Agency shall reserve the right to call for confirmatory test on samples, at his discretion.

6.0 INTERNAL INSPECTION BY SUCCESSFUL TENDERER/MANUFACTURER

6.1 Inspection and tests shall be carried out by Contractor/ Manufacturer in accordance with approved drawings, T.S., P.O., and approved QAP. They shall maintain records of each inspection and test carried out and signed documents shall be submitted to Purchaser/Consultant for verification.

6.2 The successful tenderer shall carry out their internal inspection & obtain clearance from statutory bodies e.g. IBR, CCE, TAC, Weights & Measures, safety, IE rules etc. prior to offering any equipment for Purchaser/Consultant's inspection in accordance with approved QAP.

6.3 The successful tenderer/ Manufacturers shall identify all the inspected equipment/component/raw materials & shall maintain the record of status of inspection viz. inspected & found acceptable, require rectification/rework, rejected etc.

6.4 The successful tenderer shall establish and maintain procedures to ensure that the product that does not conform to specified requirements, is prevented from inadvertent use or installation. The description of non-conformity that has been accepted subsequently by Consultant/ Purchaser by concession and/or of repairs, shall be recorded.

Repaired and reworked product shall be offered for re-inspection to Consultant/ Purchaser alongwith records of corrective action taken.

7.0 MANUFACTURING AND INSPECTION SCHEDULE

All contractors shall submit the schedule for manufacturing and inspection indicating equipment / components, sub-assembly/assembly. Date of approval of drawings / data sheets. Address of manufacturer with contact person and scheduled date of inspection. Such reports shall be submitted to respective Consultant Inspecting Offices with a copy
to Inspection Co-ordinating Office once in a month. These monthly reports shall state the planning for next three months. Submission of first reports must commence one month prior to commencement of manufacturing activities of the product.

8.0 METHOD OF UNDERTAKING INSPECTION & TESTING BY CONSULTANT/PURCHASER

8.1 Inspection call shall be given only on readiness of the equipment/assembly/sub-assembly & after approval of all relevant drawings and QAP. In case, equipment/assembly/sub-assembly offered for inspection are found not ready, all the cost of visit of Consultant's engineer shall have to be borne by the successful tenderer.

If the equipment/assembly/sub-assembly after inspection found not acceptable, require rework and involve Consultant's re-inspection, all the cost of such re-inspections shall also have to be borne by the successful tenderer.

8.2 Inspection call shall be floated to Consultant, in the enclosed Form No.11.20(DQM)F-05/2.REV-0 duly filled in, with ten days clear margin, enclosing all documents like test Certificates, Internal Inspection Reports, P.O., Sub-P.O., T.S., Approved QAP, approved GA drawings/data sheets and manufacturing drawings. Inspection calls without above documents shall be treated as invalid and shall be ignored. The hard copy of such documents must also accompany a CD (comprising computer readable files) containing the identical documents.

8.3 The successful tenderer shall offer substantial quantities for economical inspection consistent with the size of order.

8.4 On receipt of the Inspection call, pertaining to particular package/equipment/item, QA & Inspection group of Consultant, Ranchi (Overall co-ordinating office for Inspection activities) shall organize inspection visit or will issue Inspection assignment to other Consultant's office (based on nearness to the vendor's manufacturing works/relevant job expertise). For further inspection pertaining to the same package/equipment/item, successful tenderer may forward the subsequent inspection calls to the respective Consultant's offices (as identified per initial assignment), with a copy to QA & Inspection Section, Ranchi.

9.0 OBLIGATIONS OF SUCCESSFUL TENDERER

9.1 The successful tenderer shall provide all facilities and ensure full and free access of the Inspection Engineer of Purchaser/Consultant to their own or their Sub-Contractor's premises at any time, during contract period, to facilitate him to carry out inspection & testing of the product during or after manufacture of the same.

9.2 The successful tenderer shall delegate a Representative/Co-ordinator to deal with Consultant/Purchaser on all inspection matters. Representative of successful tenderer shall be present during all inspection at Sub-Contractor's works.

9.3 The successful tenderer shall comply with instructions of Consultant/Purchaser fully and with promptitude.

9.4 The successful tenderer/Sub-Contractor shall provide all instruments, tools, necessary testing & other inspection facilities to Consultant/Purchaser free of cost for carrying out inspection.

9.5 The cost of testing welds by ultrasonic, radiographic and dye penetration tests etc. in the fabrication workshop shall be borne by the successful tenderer. These tests need to be
The successful tenderer shall ensure that the equipment/assembly/component of the plant and equipment required to be inspected, are not dismantled or dispatched before inspection.

The successful tenderer shall not offer equipment for inspection in painted condition unless otherwise agreed in writing by Consultant/Purchaser.

The successful tenderer shall ensure that the equipment and materials once rejected by the Consultant/Purchaser, are not re-used in the manufacture of the plant and equipment. Where parts rejected during inspection have been rectified as per agreed procedures laid down in advance, such parts shall be segregated for separate inspection and approval, before being used in the work.

**STAMPING AND ISSUE OF INSPECTION DOCUMENTS**

**Inspection Memo**: For rejected items/items, which do not conform to Technical Specification in one or more quality characteristics requiring rectification/rework, Inspection Memo shall be issued indicating therein the details of observation & remarks. All the non-conformities with respect to specification of the product shall be indicated in the Inspection Memo for further quality control by successful tenderer.

**Inspection Certificate**: On satisfactory completion of final inspection & testing, all accepted plant & equipment shall be stamped suitably and Inspection Certificate shall be issued by the Consultant for the accepted items.

**GENERAL CLAUSE**

Inspection & tests carried out by Consultant/Purchaser shall not absolve the responsibility of the successful tenderer/Manufacturer to provide acceptable product as per the terms of contract nor shall it preclude subsequent rejection.

Purchaser/Consultant reserve the right to inspect any product at any stage of manufacturing beyond pre-identified stages & hold points of approved QAP.
### QUALITY ASSURANCE PLAN

**FOR**

**STRUCTURAL & MECHANICAL**

**EQUIPMENT**

---

**INSTRUCTIONS FOR FILLING UP:**

1. GAP shall be submitted for each of the equipment separately with break-up of assembly/sub-assembly/part/component or for group of equipment having same specification.

2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant & equipment.

3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.

4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

---

**ABBREVIATIONS USED:**

**CONTR:** CONTRACTOR

**MFG:** MANUFACTURER

---

**EQUIPMENT DETAILS**

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<thead>
<tr>
<th>Sl. No.</th>
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<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer’s Name and Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>RAW Material and Inprocess Test Certificates &amp; Documents</th>
<th>Test Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria Standards/BS/ASME/Norms and Documents</th>
<th>REMARKS/SAMPLING PLAN</th>
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**CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS**

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**DOCUMENTS:**

D1. Approved GA drawings
D2. Information and other reference
D3. Relevant catalogues
D4. Bill of Material Item no. / Identification
D5. Matchmark details
D6. Line/Layout diagram
D7. Approved erection procedures
D8. Unpriced sub P.O. with specification and amendments
D10. Ordering Specification
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No.</th>
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<th>Expected Schedule of Final Inspection</th>
<th>Raw Material and Inprocess Stage Inspection</th>
<th>Final Inspection / Test by MFR</th>
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For CONTRACTOR / SUB - CONTRACTOR

for MECON (Stamp & Signature)
## Instructions for Filling up:

1. **QAP** shall be submitted for each of the equipment separately with breakup of assembly/sub-assembly/part/component or for group of equipment having same specification.

2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.

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## Abbreviations USED:

- **CONTR**: CONTRACTOR
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## Quality Assurance Plan for Electrical Equipment

### Equipment Details

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<th>Description (with equipment heading, place of use and brief specification)</th>
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### Inspections and Tests

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</table>

### Test Certificates & Acceptance Criteria

- Test Certificates & documents to be submitted to MECON
- Standards/IS/BS/ASME Norms and Documents

### Documents:

- D1. Approved GA drawings
- D2. Approved single line / schematic diagram
- D3. Catalogues / Approved data sheet
- D4. Approved Bill of Materials
- D5. Unpriced P.O. copy
- D6. Calibration Certificate of all measuring instrument and gauges

---

For CONTRACTOR / SUB-CONTRACTOR

(Stamp & Signature)
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**FORM NO. 11.20 (DQM) F-10, REV-0**

For MECON (Stamp & Signature)
### Instructions for Filling Up:

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### Abbreviations Used:

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### Quality Assurance Plan for Refractory Materials

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<th>Sl. No</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer's Name &amp; Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Raw Material and Inprocess Test Certificates &amp; Acceptance Criteria</th>
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</tbody>
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1. **QAP** shall be submitted for each of the equipment separately with break up of assembly / sub-assembly & part/component or for group of equipment having same specification.

2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.

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**ABBREVIATIONS USED**

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### Equipment Details

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<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No.</th>
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<th>Manufacturer's Name &amp; Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Raw Material and Inprocess Test Certificates &amp; Acceptance Criteria</th>
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<th>Expected Schedule of Final Inspection</th>
<th>Tests Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria Standards/IS/BS/ ASME Norms and Documents</th>
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(Q. A. P. NO. TO BE ALLOTTED BY MECON )

For MECON (Stamp & Signature)
### INSPECTION CALL PROFORMA

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<th>Project</th>
<th>Purchaser</th>
<th>Date：</th>
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<td>Contractor's Order No. &amp; Date</td>
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<td>Place of Inspection with address, Fax &amp; Ph. No.</td>
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<td>Proposed Date of Inspection</td>
<td>Name &amp; Designation of Contact Person with Ph. No.</td>
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#### List of items offered for inspection:

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<th>Item Description</th>
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<th>QAP No. &amp; Status</th>
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<th>Total Ordered</th>
<th>Total Accepted</th>
<th>Offered</th>
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A = Approved, AAN = Approved as Noted, INF = Information Category

#### List of documents & Test Certificates enclosed in four (4) sets.

<table>
<thead>
<tr>
<th>Description</th>
<th>Ref No. &amp; Date</th>
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for Contractor/Sub-Contractor
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<tr>
<td></td>
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<td>Phone : 080-6571661-68/6576476</td>
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<td>E-mail : <a href="mailto:bangalore@mecon.co.in">bangalore@mecon.co.in</a></td>
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</tr>
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<td>Phone : 0788-220107/224101/224454</td>
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</tr>
<tr>
<td></td>
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# List of Major Inspecting Offices of MECON

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<th>Area of Operation</th>
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<tbody>
<tr>
<td><strong>4.</strong></td>
<td><strong>CHENNAI</strong></td>
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<td></td>
<td>DGM I/C</td>
<td>Chennai &amp; total Tamil Nadu</td>
</tr>
<tr>
<td></td>
<td>MECON Ltd., J-5, Plot No. 3552, 6th Avenue, Annanagar East, Chennai-600 102</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gram : MECONIND</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fax : 044-26261474</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phone : 044-26261911, 26269743</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail : <a href="mailto:chennai@mecon.co.in">chennai@mecon.co.in</a></td>
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<tr>
<td><strong>5.</strong></td>
<td><strong>KOLKATA (Controlled through Ranchi)</strong></td>
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<tr>
<td></td>
<td>DGM Inspection Section</td>
<td>Kolkata, Howrah, Bhubaneswar, Cuttack &amp; Baripada</td>
</tr>
<tr>
<td></td>
<td>MECON Ltd., 50, Chwringhee Road, Kolkata-700 071 (W.B.)</td>
<td></td>
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<tr>
<td></td>
<td>Gram : MECONCAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fax : 033-22824441</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phone : 033-22822381 to 83, 22822284, 22822857</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail : <a href="mailto:kolkata@mecon.co.in">kolkata@mecon.co.in</a></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:mec-cal@datatone.in">mec-cal@datatone.in</a></td>
</tr>
<tr>
<td><strong>6.</strong></td>
<td><strong>MUMBAI</strong></td>
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<tr>
<td></td>
<td>DGM (I/C) Inspection Section, MECON Ltd., 3rd Floor, Tower No. 7, International Infotech Park, Vashi Railway Station Complex, Vashi, Navi Mumbai-400 703</td>
<td>Maharashtra (except Nagpur), Gujarat &amp; Goa</td>
</tr>
<tr>
<td></td>
<td>Fax : 022-27812275</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phone : 022-27812155 to 58, 27812276</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail : <a href="mailto:mecon@bom5.vsnl.net.in">mecon@bom5.vsnl.net.in</a></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:mumbai@mecon.co.in">mumbai@mecon.co.in</a></td>
</tr>
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</table>
## List of Major Inspecting Offices of MECON

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Detailed Address</th>
<th>Area of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td><strong>NEW DELHI</strong></td>
<td>Delhi, Punjab, Rajasthan</td>
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<tr>
<td></td>
<td>DGM</td>
<td></td>
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<tr>
<td></td>
<td>Inspection Section, MECON Ltd., Scope Minar, 14th &amp; 15th Floor, North Tower, Laxmi Nagar, Delhi-110 092</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fax               : 011-22401203, 22041214</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phone             : 011-22041201/22041315, 22041238</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail            : <a href="mailto:delhi@mecon.co.in">delhi@mecon.co.in</a></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td><strong>RANCHI</strong></td>
<td>Ranchi, Dhanbad, Jamshedpur, Allahabad, Naini and all over India, if need arises for whatever reason.</td>
</tr>
<tr>
<td></td>
<td>Mr. P. Dutta, DGM (I/C) QA &amp; Inspection Section MECON Ltd., Ranchi-834 002 (Jharkhand)</td>
<td></td>
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<tr>
<td></td>
<td>Gram              : MECON</td>
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</tr>
<tr>
<td></td>
<td>Fax               : 0651-2480216/2480002/2262194</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phone             : 0651-2481002/2481216 Extn : 7330 2482183 (P &amp; T) Direct</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail            : <a href="mailto:insp@mecon.co.in">insp@mecon.co.in</a>, <a href="mailto:pdutta@mecon.co.in">pdutta@mecon.co.in</a></td>
<td></td>
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