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 & tackle 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 test s 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

<table>
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<tr>
<th>SL. NO</th>
<th>CODE NUMBER</th>
<th>DESCRIPTION</th>
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<tr>
<td>1</td>
<td>IS-2189-1988 Reaffirmed in -1998. NFPA</td>
<td>Code of practice for selection, installation and maintenance of automatic fire detection and alarm system (second revision –Amendment-II for IS 2189)</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>
</tr>
<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>
</tr>
<tr>
<td>6</td>
<td>IS-694-1990</td>
<td>PVC insulated cables for working voltages upto and including 1100V (Third revision-Amendment-I)</td>
</tr>
<tr>
<td>7</td>
<td>IS-1554 PART-I-1998</td>
<td>PVC insulated (heavy duty electric cables part-I for working voltages upto &amp; including 1100V (Third Edition-Amendment-I)</td>
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</table>
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:

| Acknowledge | To acknowledge the alarm |

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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 Adjust</td>
<td>To have higher sensitivity during unoccupied period.</td>
</tr>
<tr>
<td>Device Blink Control</td>
<td>For flashing LED’s on the detector.</td>
</tr>
<tr>
<td>Drift Compensation</td>
<td>For compensating the detector response due to environmental changes.</td>
</tr>
<tr>
<td>Pre-alarm control panel Indication</td>
<td>For early indication of fire in the incipient stage</td>
</tr>
<tr>
<td>NFPA 72 Smoke Detector sensitivity test</td>
<td>For routine check-up of the sensors from the panel</td>
</tr>
<tr>
<td>System Status Report</td>
<td>Documentation of various system parameter</td>
</tr>
<tr>
<td>Alarm Verification, by device with tally or</td>
<td>To eliminate generation of false alarm due to dust cigarette smoke.</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 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 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 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>
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</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 tolls 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 minium 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 energize 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, 1phase. 50Hz AC.

9.3. **CABLES: -**

The cables required for detectors connection shall be multi core, (2core, 3core, 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 (MTS.)</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>
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<td>6.37</td>
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<td>4.095</td>
</tr>
<tr>
<td>12</td>
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<td>6.64</td>
<td>5.81</td>
<td>4.98</td>
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<tr>
<td>15</td>
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</tr>
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<td>20</td>
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<td>3.84</td>
<td>2.88</td>
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<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>GR-1 TIME INSTANT 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 TIME INSTANT 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 TIME INSTANT 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:

\[
\text{60 x volume per minute of air supply to the protected space} \div \text{volume of protected space}
\]

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

| Station No. | Location of Subscriber Station | Type of stations |

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 loudspeaker 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.**

- **Power supply cable**: 3 core, 2.5 sq.mm, ATC, Armoured PVC
- **Signal cable**: 5 pair, 0.5 sq.mm, ATC, Armoured PVC
- **Loudspeaker cable**: 1 pair, 24/0.2 mm, ATC, Armoured PVC

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.

<table>
<thead>
<tr>
<th>Peak output power</th>
<th>6 watts indoor box loudspeakers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 watts outdoor industrial re-entrant horn loudspeaker</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Station No.</th>
<th>Location of Subscriber Station</th>
<th>Type of stations</th>
</tr>
</thead>
</table>

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 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:

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

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 loudspeaker 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 :

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input sensitivity</td>
<td>100 mv</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>100 Hz to 10 KHz</td>
</tr>
<tr>
<td>Signal to noise ratio</td>
<td>Better than 60 db</td>
</tr>
<tr>
<td>Hum and noise level</td>
<td>Better than 65db below rated output power</td>
</tr>
<tr>
<td>Distortion</td>
<td>Less than 3% at 1 KHz and at full output power</td>
</tr>
<tr>
<td>Floating outputs</td>
<td>100V/70V</td>
</tr>
<tr>
<td>Protection</td>
<td>Against open and short circuits and spurious oscillation</td>
</tr>
<tr>
<td>Safety requirement</td>
<td>As per IEC-65/268</td>
</tr>
</tbody>
</table>

05.02 Microphone :

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Unidirectional, dynamic (moving coil)</td>
</tr>
<tr>
<td>Frequency response</td>
<td>100 Hz to 10 KHz</td>
</tr>
<tr>
<td>Impedance</td>
<td>230 - 270 Ohms</td>
</tr>
</tbody>
</table>

05.03 Loudspeaker :

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Horn/Box enclosure</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>100 Hz to 10 KHz</td>
</tr>
<tr>
<td>Input voltage</td>
<td>100V/70V</td>
</tr>
<tr>
<td>Voice coil impedance</td>
<td>8 Ohms, 16 Ohms</td>
</tr>
<tr>
<td>Sensitivity at 1KHz</td>
<td>111 dB+/− 3db per watt at adistanceof 1 metre.</td>
</tr>
</tbody>
</table>
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></td>
<td>Make</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Material of housing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type of camera mounting</td>
<td>C / CS</td>
</tr>
<tr>
<td></td>
<td>Temperature range</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooling water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compressed Air</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>Make</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model no.</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>Braking</td>
<td>Mechanical friction type</td>
<td></td>
</tr>
<tr>
<td>Construction material</td>
<td>Main body – Aluminium casting</td>
<td></td>
</tr>
<tr>
<td>Whether heavy-duty/medium duty/light duty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whether suitable for indoor/outdoor use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated temperature range</td>
<td></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.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video Inputs</td>
<td>as per bill of quantities</td>
</tr>
<tr>
<td>Video outputs</td>
<td>as per bill of quantities</td>
</tr>
<tr>
<td>RS-232 Ports</td>
<td>1 each for PC, printer and alarm signals</td>
</tr>
<tr>
<td>Input voltage level</td>
<td>0.5 V p-p to 2.0 V p-p, Composite Negative Sync</td>
</tr>
<tr>
<td>Gain</td>
<td>Unity (75 ohm terminated)</td>
</tr>
<tr>
<td>Switching</td>
<td>Cross point Matrix</td>
</tr>
<tr>
<td>Features</td>
<td>Full matrix switching, any camera to any monitor</td>
</tr>
<tr>
<td></td>
<td>- Programmable switching sequences.</td>
</tr>
<tr>
<td></td>
<td>- Salvo switching capability</td>
</tr>
<tr>
<td></td>
<td>- P/T/Z control outputs in the form of Biphase/RS-485/RS-422 etc.</td>
</tr>
<tr>
<td></td>
<td>- min 40 character on screen display for time-date, camera number, camera ID, monitor or status information &amp; 16 character alarm titling</td>
</tr>
<tr>
<td></td>
<td>- With the keyboard, following P/T/Z controls shall be available:</td>
</tr>
<tr>
<td></td>
<td>a) Pan, tilt, auto pan and random pan</td>
</tr>
<tr>
<td></td>
<td>b) Zoom, focus and iris control</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>as per locations indicated</td>
</tr>
<tr>
<td>Humidity</td>
<td>0 to 95 % relative, non-condensing.</td>
</tr>
<tr>
<td>EMC</td>
<td>CE / UL certified</td>
</tr>
</tbody>
</table>

**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 additional 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>Video Standard</th>
<th>PAL, 625 line, 50 Hz</th>
</tr>
</thead>
<tbody>
<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. Automatic looping termination</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 15 days storing capacity</td>
</tr>
<tr>
<td>Recording modes</td>
<td>Selectable from 0.1 IPS to real time recording, 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>
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&quot;</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 incase 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.
<table>
<thead>
<tr>
<th>Shield material</th>
<th>Copper braided.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacket material</td>
<td>FRLS PVC BLUE.</td>
</tr>
<tr>
<td>Armour</td>
<td>1.4 mm GI wire round.</td>
</tr>
<tr>
<td>Outer jacket thickness</td>
<td>1.2 mm FRLS</td>
</tr>
<tr>
<td>Outer jacket</td>
<td>FRLS PVC BLUE</td>
</tr>
<tr>
<td>Nominal impedance.</td>
<td>75 ohms</td>
</tr>
</tbody>
</table>

**03.14.02. POWER SUPPLY CABLE:**

The specifications shall be as under:

<table>
<thead>
<tr>
<th>No of cores</th>
<th>min 3 (three)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductor size</td>
<td>min 2.5 sq mm, 7/0.68 multi strand with standard annealed electrolytic copper conductor.</td>
</tr>
<tr>
<td>Primary insulation</td>
<td>PVC insulated of 85º C PVC as IS-5831Type C</td>
</tr>
<tr>
<td>Thickness of PVC insulation</td>
<td>0.8 mm</td>
</tr>
<tr>
<td>Color code</td>
<td>Red, Black and Green</td>
</tr>
<tr>
<td>Inner and Outer Jacket</td>
<td>Extruded Flame retardant and 90º C PVC to IS 5831- Type ST2</td>
</tr>
<tr>
<td>Armoring</td>
<td>Galvanised Steel Wire / flat as per IS-1554 part-I</td>
</tr>
</tbody>
</table>

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.**

<table>
<thead>
<tr>
<th>No of pairs</th>
<th>as required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductor size</td>
<td>2.5 sq mm standard annealed electrolytic copper conductor.</td>
</tr>
<tr>
<td>Primary insulation</td>
<td>Low density polyethylene (LDPE)/ PE as per IS 6474</td>
</tr>
<tr>
<td>Thickness of insulation</td>
<td>0.5 mm</td>
</tr>
<tr>
<td>Pair shielding</td>
<td>Aluminium backed by mylar/ polyester</td>
</tr>
<tr>
<td>Drain wire</td>
<td>0.5 sq mm multistrand bare tinned</td>
</tr>
</tbody>
</table>
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 carryout 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 it’s 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.
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
<table>
<thead>
<tr>
<th>CLAUSE NO.</th>
<th>DESCRIPTION</th>
<th>PAGE NO(S).</th>
</tr>
</thead>
<tbody>
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<td>1</td>
</tr>
<tr>
<td>02.</td>
<td>ENVIRONMENTAL SPECIFICATION</td>
<td>2</td>
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<td>03.</td>
<td>BASIC DESIGN CONSIDERATION</td>
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<td>GAS ANALYSIS SYSTEM</td>
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<td>05.</td>
<td>LIQUID ANALYSIS SYSTEM</td>
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<td>CALORIFIC ANALYSER</td>
<td>26</td>
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<td>08.</td>
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<tr>
<td>09.</td>
<td>CONTROL PANELS &amp; CABINETS</td>
<td>27-29</td>
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<tr>
<td>10.</td>
<td>ELECTRICAL SYSTEMS</td>
<td>29-31</td>
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<tr>
<td>11.</td>
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<td>12.</td>
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<td>13.</td>
<td>CABLE LAYING</td>
<td>33-34</td>
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<td>14.</td>
<td>IMPULSE PIPE LAYING</td>
<td>35</td>
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<td>GUIDELINES FOR SELECTION OF ERECTION MATERIALS</td>
<td>36-38</td>
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<td>INSTALLATION OF INSTRUMENTS</td>
<td>38</td>
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<td>19.</td>
<td>TESTING &amp; COMMISSIONING</td>
<td>39-40</td>
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<td>20.</td>
<td>QUALITY ASSURANCE PLAN</td>
<td>40-41</td>
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<tr>
<td>21.</td>
<td>DCS BASED AUTOMATION SYSTEM</td>
<td>42-65</td>
</tr>
</tbody>
</table>
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>
<tr>
<td>Relative humidity</td>
<td>0 – 95%</td>
</tr>
</tbody>
</table>

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/ Profinet 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) x 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.
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>Diameter Range</th>
<th>Minimum Thickness</th>
</tr>
</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 pilot tubes with multi-holes (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. Reylond’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 earthpit shall be provided exclusively for earthing of electro-magnetic flowmeters. Preparation of such earthpits 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 240 VAC, 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.

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 up to 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.

2. 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 analyzer & sample conditioning equipment etc.

8. Condensation monitors, complete sampling system shall be designed & supplied by the analyzer manufacturers only. All components & fittings of the analyzer & 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 stellifed 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.
16. Repeatability of the analysers shall be within ±1%.
17. Purging facility, inlet filters, etc., shall be provided, wherever there is a possibility of choking of analyser.
18. All solenoid valves, used in analysis system, shall have manual override.
19. 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.
20. Analyser in explosion hazardous area shall be installed in ex-proof enclosures.
21. Suitable exhaust tubing shall be provided for the fluid under analysis, taking care of all safety means.
22. 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).
23. Zero & span gas cylinders shall be provided as per the requirement.
24. 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 enamelled 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**
1.0mm² PVC insulated, stranded Cu-wire: gray colour

**Power supply wiring:**
- For 240/110V, 50 Hz
  1.5 mm² PVC insulated stranded Cu-wire, colour code:
  - Live: red
  - Neutral: black / blue
- For 24V, DC
  - Earth : green
    - 1.5 mm² PVC insulated stranded Cu-wire, colour code:
      - Positive : brown
      - Negative : black / blue
  - Earth : 4.0 mm² 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, 2.5 mm² size terminals shall be used.

9. For power wiring, 4.0 mm² 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  
   Relative humidity  
   Dust content  
   No. of air changes  
   Positive pressure in the room  

   23± 2 °C  
   50 to 60%  
   0.1 mg / m3  
   2 to 3  
   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 hydrotesting.

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/ Proibus 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 along with 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 along with 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, real time 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 (repeaters 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 down stream
  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 annunciating 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.

xxxii. 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.

xxxiii. The recorded process information shall include – measured value; alarm status; set point or desired value; control mode.

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.

xlii. 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.

xliii. 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.

xliv. 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.

xlv. 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.

li. 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.

lii. Each operator workstation shall be capable of storing sufficient number of events of each type and details for the same shall be indicated.

liii. 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.

liv. Facility to configure a report to accept manually entered data for specified fields shall be provided.

lv. 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.

lx1. 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 Window 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.
16. Separate terminal strips shall be provided for 24 V DC, 240 VAC and intrinsically safe terminals.

17. 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.

18. A minimum of 20% spare terminals shall be provided in each terminal block.

19. 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.

20. 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.

21. 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.

22. 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 re-loaded 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>
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</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 | ✓   | ✓   |
| 21    | Checking of output status on processor failure for DCS & checking of first-out alarm generation. | ✓   | ✓   |

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.
INSPECTION

(CHAPTEER-05)
GENERAL SPECIFICATION
FOR
QUALITY SYSTEM, INSPECTION & TEST OF PLANT / EQUIPMENT AT MANUFACTURER’S PREMISES
(GS – 05)
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<tr>
<td>11</td>
<td>GENERAL CLAUSES</td>
<td>5</td>
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</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
witnessed by ASNT/ISNT Level-II qualified NDT personals

9.6 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.

9.7 The successful tenderer shall not offer equipment for inspection in painted condition unless otherwise agreed in writing by Consultant/ Purchaser.

9.8 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.

10.0 STAMPING AND ISSUE OF INSPECTION DOCUMENTS

10.1 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.

10.2 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.

11.0 GENERAL CLAUSE

11.1 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.

11.2 Purchaser/ Consultant reserve the right to inspect any product at any stage of manufacturing beyond pre-identified stages & hold points of approved QAP.
## Codes for Extent of Inspection, Tests, Test Certificates & Documents:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Visual (Welding etc.)</td>
</tr>
<tr>
<td>2</td>
<td>Dimensional</td>
</tr>
<tr>
<td>3</td>
<td>Fitment &amp; Alignment</td>
</tr>
<tr>
<td>4</td>
<td>Physical Test / Sample</td>
</tr>
<tr>
<td>5</td>
<td>Chemical Test (Sample)</td>
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<td>6</td>
<td>Ultrasonic Test</td>
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<td>7</td>
<td>Magnetic Particle Test (MPT)</td>
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<td>8</td>
<td>Radiography test</td>
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<td>9</td>
<td>Dye Penetration Test</td>
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<td>10</td>
<td>Metallographic Exam.</td>
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<td>11</td>
<td>Welder’s Qualification &amp;</td>
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<td>Weld Procedure Test</td>
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<td>12</td>
<td>Approval of Test &amp; Repair</td>
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<td>Procedure</td>
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<td>13</td>
<td>Heat Treatment</td>
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<td>Pressure Test</td>
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<td>15</td>
<td>Leakage test</td>
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<td>16</td>
<td>Balancing</td>
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<td>17</td>
<td>Vibration Test</td>
</tr>
<tr>
<td>18</td>
<td>Amplitude test</td>
</tr>
</tbody>
</table>

## Instructions for Filling Up:

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.

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

## Quality Assurance Plan

### Equipment Details

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity No./ M</th>
<th>T</th>
<th>Manufacturer’s Name and Address</th>
<th>Expected Schedule of Final Inspn</th>
<th>MFR</th>
<th>CONTR</th>
<th>MECON</th>
<th>MFR</th>
<th>CONTR</th>
<th>MECON</th>
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### Inspection and Tests

- **Raw Material and Inprocess Test Certificates & Acceptance Criteria**
- **SAMPLING PLAN**

### Documents:

- D1: Approved GA drawings
- D2: Information and other reference
- D3: Calibrations
- 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
- D9: Calibration Certificate of all measuring instrument and gauges.
- 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>
<th>Quantity</th>
<th>MFR No.</th>
<th>MFR Name and Address</th>
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<th>MFR Inspn</th>
<th>CONTR Inspn</th>
<th>MECON Inspn</th>
<th>MFR Inspn</th>
<th>CONTR Inspn</th>
<th>MECON Inspn</th>
<th>Test Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria Standards/IS/BS/ASME/ISO/Norms and Documents</th>
<th>REMARKS/</th>
<th>(Q.A.P. NO. TO BE ALLOTTED BY MECON)</th>
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3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.

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CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

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<th>Code</th>
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<tbody>
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<td>Visual</td>
<td>14</td>
<td>Impact Test.</td>
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<td>2</td>
<td>Dimensional</td>
<td>15</td>
<td>Partial Discharge Test.</td>
</tr>
<tr>
<td>3</td>
<td>Fitting &amp; Alignment</td>
<td>16</td>
<td>Heat run test/Temp. rise Test.</td>
</tr>
<tr>
<td>4</td>
<td>Physical Test(Sample)</td>
<td>17</td>
<td>Enclosure protection Test.</td>
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<tr>
<td>5</td>
<td>Chemical Test(Sample)</td>
<td>18</td>
<td>Calibration.</td>
</tr>
<tr>
<td>6</td>
<td>Ultrasonic Test</td>
<td>19</td>
<td>Noise &amp; Vibrations.</td>
</tr>
<tr>
<td>7</td>
<td>Magnetic Particle Test(MPT)</td>
<td>20</td>
<td>Test Certificates for bought out components.</td>
</tr>
<tr>
<td>8</td>
<td>Radiography test</td>
<td>21</td>
<td>Tank pressure Test.</td>
</tr>
<tr>
<td>9</td>
<td>Dye Penetration Test</td>
<td>22</td>
<td>Paint Shade verification.</td>
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<td>24</td>
<td>Operation &amp; functional check.</td>
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<td>26</td>
<td>Flame Proof Test.</td>
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<td>27</td>
<td>Clearance &amp; creepage distance.</td>
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<td></td>
<td>28</td>
<td>Acceptance Tests as per relevant IS/other standard.</td>
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</table>

Rigorous tests to be performed as per relevant IS/other standard.

ABBREVIATIONS USED :

CONTR : CONTRACTOR
MFG : MANUFACTURER

EQUIPMENT DETAILS

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<tr>
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<th>Description (with equipment heading place of use and brief specification)</th>
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<th>Quantity No./M</th>
<th>T</th>
<th>Manufacturer's Name and Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Test Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria</th>
<th>REMARKS/ASME/Norms and Standards/BS/BSI</th>
<th>SAMPLING PLAN</th>
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For CONTRACTOR / SUB-CONTRACTOR

For MECON (Stamp & Signature)
<table>
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<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>Test Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria Standards/IS/BS/ASME/Norms and Documents</th>
<th>REMARKS/</th>
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</tbody>
</table>

( Q . A . P . NO. TO BE ALLOTED BY MECON )

For CONTRACTOR / SUB-CONTRACTOR

for MECON (Stamp & Signature)

(Stamp & Signature)

FORM NO. 11.20 (DOM) F-10, REV-0
## QUALITY ASSURANCE PLAN

### FOR

**REFRACTORY MATERIALS**

### INSTRUCTIONS FOR FILLING UP:

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.

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<tbody>
<tr>
<td>1</td>
<td>Visual</td>
<td>D1. Laboratory test report</td>
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<tr>
<td>2</td>
<td>Dimensions and geometry</td>
<td>D2. Dimensional drgs. showing plan, elevation, side view &amp; cross sectional view duly approved.</td>
</tr>
<tr>
<td>4</td>
<td>Apparent porosity</td>
<td>D4. Calibration Certificate of all measuring instruments and gauges.</td>
</tr>
<tr>
<td>5</td>
<td>True specific gravity</td>
<td></td>
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### ABBREVIATIONS USED:

- **CONTR**: CONTRACTOR
- **MFR**: MANUFACTURER

### EQUIPMENT DETAILS

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### REMARKS/SAMPLING PLAN

- **MECON** (Stamp & Signature)

- **CONTRACTOR / SUB-CONTRACTOR** (Stamp & Signature)

- **Q.A.P. NO. TO BE ALLOTTED BY MECON**

---

For CONTRACTOR / SUB-CONTRACTOR (Stamp & Signature)
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**Sl. No.**

- 1

**MECON**

- No.:  
- No. MTR:  
- Name and Address:  
- Expected Schedule of Final Inspection:  
- Raw Material and Inprocess Test Certificates & Acceptance Criteria:  
- Final Inspection / Test by MECON:  
- Test Certificates & documents to be submitted to MECON:  
- Acceptance Criteria Standards/IS/BS/ASME/Norms and Documents:  

**REMARKS:***
## INSPCTION CALL PROFORMA

**Inspection Call No.**

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<th>Place of Inspection with address, Fax &amp; Ph. No.</th>
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### List of items offered for inspection:

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**A = Approved, AAN = Approved as Noted, INF = Information Category**

### List of documents & Test Certificates enclosed in four (4) sets.

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for Contractor/Sub-Contractor
## List of Major Inspecting Offices of MECON

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<tr>
<th>SL. NO.</th>
<th>DETAILED ADDRESS</th>
<th>AREA OF OPERATION</th>
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<tr>
<td>1.</td>
<td><strong>BANGALORE</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D.G.M. Inspection Section MECON Ltd., 89, South End Road, Basavanagudi, Bangalore-560 004 (Karnataka)</td>
<td>Karnataka, A.P. &amp; Kerala</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>Fax: 080-6576352</td>
<td></td>
</tr>
<tr>
<td></td>
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<td><strong>Bhilai</strong></td>
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</tr>
<tr>
<td></td>
<td>Dy. General Manager MECON Ltd., Ispat Bhawan, Ist floor, Bilai-490 001 (M.P.)</td>
<td>Bhilai, Nagpur, Raipur, Bilaspur, Bhopal, Satna &amp; Khatni</td>
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<tr>
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### List of Major Inspecting Offices of MECON

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<tr>
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<tr>
<td>4.</td>
<td><strong>CHENNAI</strong>&lt;br&gt;DGM I/C&lt;br&gt;MECON Ltd.,&lt;br&gt;J-5, Plot No. 3552,&lt;br&gt;6th Avenue, Annanagar East,&lt;br&gt;Chennai- 600 102&lt;br&gt;Gram : MECONIND&lt;br&gt;Fax : 044-26261474&lt;br&gt;Phone : 044-26261911,26269743&lt;br&gt;E-mail : <a href="mailto:chennai@mecon.co.in">chennai@mecon.co.in</a></td>
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<tr>
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<td><strong>KOLKATA (Controlled through Ranchi)</strong>&lt;br&gt;DGM&lt;br&gt;Inspection Section&lt;br&gt;MECON Ltd.,&lt;br&gt;50, Chwringhee Road,&lt;br&gt;Kolkata- 700 071 (W.B.)&lt;br&gt;Gram : MECONCAL&lt;br&gt;Fax : 033-22824441&lt;br&gt;Phone : 033-22822381 to 83,22822284,22822857&lt;br&gt;E-mail : <a href="mailto:kolkata@mecon.co.in">kolkata@mecon.co.in</a>&lt;br&gt;<a href="mailto:mec-cal@datatone.in">mec-cal@datatone.in</a></td>
<td>Kolkata, Howrah, Bhubaneswar,&lt;br&gt;Cuttack &amp; Baripada</td>
</tr>
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<td><strong>Mumbai</strong>&lt;br&gt;DGM (I/C)&lt;br&gt;Inspection Section,&lt;br&gt;MECON Ltd.,&lt;br&gt;3rd Floor, Tower No. 7,&lt;br&gt;International Infotech Park,&lt;br&gt;Vashi Railway Station Complex,&lt;br&gt;Vashi, Navi Mumbai-400 703&lt;br&gt;Fax : 022-27812275&lt;br&gt;Phone : 022-27812155 to 58, 27812276&lt;br&gt;E-mail : <a href="mailto:mecon@bom5.vsnl.net.in">mecon@bom5.vsnl.net.in</a>&lt;br&gt;<a href="mailto:mumbai@mecon.co.in">mumbai@mecon.co.in</a></td>
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<td>8.</td>
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<td>Mr. P. Dutta, DGM (I/C) QA &amp; Inspection Section MECON Ltd., Ranchi-834 002 (Jharkhand)</td>
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PAINTING

(CHAPTER-09)
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01 GENERAL

01.01 This specification covers the materials, tools, facilities and quality requirement for surface preparation and painting of steel structures, equipment, piping, ducts, chutes, wood work etc.

01.02 This is only a general guideline of the painting scheme to be followed by the Tenderer. However, in case a specific painting procedure is stipulated in any tendering specification, then this general guideline shall be superceded. Any special case which may arise from time to time shall be dealt with individually on the merit of each case.

01.03 The term “painting” referred herein covers rust preventive, fungus/insects preventive and decorative coating along with surface protection of the following area but not limited to the areas indicated below.

i) Structural steel works
ii) Mechanical equipment
iii) Electrical equipment
iv) Instrumentation and control equipment.
v) Pipe work
vi) Oxygen plant, etc.

01.04 Surfaces made of asbestos, aluminum, brass, bronze, galvanized steel, stainless steel, cast iron and other corrosion resistant alloys and rubber/synthetic polymer/fiber reinforcement plastic and buried pipe work are not required to be painted unless specified except for aesthetic purposes or for identification bands, wherever relevant.

01.05 The complete paint system for any item includes the following basic activities:

i) Proper surface preparation
ii) Application of primer coats
iii) Application of intermediate coats
iv) Application of finished coats

All the above coats shall be of quality paint products and of approved make. The scope of work shall also include supply of all paint materials as per specification described herein.

01.06 If the contractor desires to adopt alternative paint system for any specific item for an improvement or equivalent to the system specified here-in or as per recommendations of paint manufacturer, may do so subject to purchaser’s approval in advance.

02 SURFACE PREPARATION

02.01 Surface preparation required for paint application, shall be such as to clean the surface thoroughly of any material which will be conducive to premature failure of the paint substrates.
02.02 All surfaces shall be cleaned of loose substances, and foreign materials, such as dirt, rust, scale, oil, grease, welding flux, etc. in order that the prime coat is rigidly anchored to the virgin metal surface. The surface preparation shall confirm to pictorial representation of surface quality grade of Swedish Standards Institution SIS – 055900 or equivalent standards such as SSPC – VIS – 1.67 or DIN 55928(Part 4) or BS 4232 or IS 1477 – 1971 (Part I).

02.03 The acceptable surface preparation quality / grade are described under each paint system. The procedures include solvent cleaning, hand tool cleaning, power tool cleaning, blast cleaning, wood surface cleaning, flame cleaning and pickling. This will ensure surface quality as required by the specific primer paint. For ready reference surface preparation quality grade to be adopted in respect of SIS 055900 and DIN 55928 (part-4) is given in Annexure-01.

02.03.01 Solvent Cleaning

The surface shall be cleaned by wiping, immersion, spraying or vapour contacting of a suitable solvent or washing with an emulsion or alkaline solution to remove oil, grease, dirt, old paint, etc. Solvent cleaning shall not remove rust, scales, mill scales or weld flux. Therefore, before application of paint, solvent cleaning shall be followed by other cleaning procedures as stated in subsequent clauses.

02.03.02 Hand Tool Cleaning

The surface shall be cleaned manually by vigorous wire brushing as per grade St-2 quality of Swedish Standard Institution SIS 055900 and DIN 555928. This method effectively removes loosely adherent materials, but would not affect residues of rust or mill scales that are intact and firmly adherent. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation the surface shall have a faint metallic shine. The appearance shall correspond to the prints designated St – 2.

02.03.03 Power Tool Cleaning

The surface shall be cleaned by electric or pneumatic tools, such as brushes, sanding machines, disc abrasive grinder, rotary disc scaler etc. to St – 3 quality. The tools shall be used carefully to prevent excessive roughening of surface and formation of ridges and burrs. This method will remove loosely adherent materials but would not affect residues of rust or mill scales that are firmly adherent and intact.

02.03.04 Blast Cleaning

The surface shall be cleaned by impingement of abrasive materials, such as graded sand at high velocity created by clean and dry compressed air blast as per the grade according to Swedish Standard Institution SIS 055900. This method will remove loosely adherent materials as well as adherent scales and mill scales. Prior to application of blast, heavy deposit of oil and grease are removed by solvent cleaning excessive
surface scales are removed by hand tools or power tool cleaning. The extent of removal of adherent scales is varied, depending on the application and are defined by the surface quality grades Sa1, Sa2, Sa2.5 and Sa3 in the order of increasing cleanliness. The blast cleaning is not recommended for sheet metal work.

02.03.05 **Flame Cleaning**

The surface is cleaned by rapid heating by means of oxyacetylene flame to loosen the adherent scales, followed immediately by wire brushing. This method will remove loosely adherent materials as well as most of the adherent scales and mill scales. In order to minimize or prevent distortion flame cutting shall not be used on members having thickness of 6 mm and lower.

02.03.06 **Pickling**

In this method the surface is cleaned of mill scales, rust or rust scales by chemical reaction or electrolysis or both.

03. **PAINT APPLICATION**

03.01 **Paints**

03.01.01 Paint shall be applied in accordance with paint manufacturer’s recommendations. The work shall generally follow IS 1477 – 1971 (Part II) for jobs carried out in India and SSPC-PA-1 or DIN 55928 or equivalent for jobs carried out outside India.

03.01.02 General compatibility between primer and finishing paints shall be established by the paint manufacturer supplying the paints.

03.01.03 In the event of conflict between this general procedure on painting and the paint manufacturer’s specification, the same shall be immediately brought to the notice of the Purchaser. Generally in cases of such conflicts, manufacturer’s specifications/recommendations shall prevail.

03.01.04 Before buying the paint in bulk, it is recommended to obtain sample of paint and establish “Control Area of Painting”. On Control Area, surface preparation and painting shall be carried out.

03.01.05 If required, samples of paint shall be tested in laboratories to establish quality of paint with respect to:

(i) Viscosity
(ii) Adhesion/Bond of paint in steel surfaces
(iii) Adhesion/Simulated salt spray test.
(iv) Chemical analysis (percentage of solids by weight)
(v) Normal wear resistance as encountered during handling & erection.
(vi) Resistance against exposure to acid fumes, etc.

03.01.06 Whole quantity of paint for a particular system of paint shall be obtained from the same manufacturer.
03.01.07 The main Contractor shall be responsible for supply of paints and this responsibility shall not be passed on to the sub-contractor.

03.01.08 The painting material as delivered to the Contractor, must be in the manufacturer’s original container bearing thereon manufacturer’s name brand and description. Paint/Painting material in containers without labels or with illegible labels shall be rejected, removed from the area and shall not be used.

03.01.09 Thinners wherever used shall be those recommended by the paint manufacturers and shall be obtained in containers with manufacturer’s name and brand name of thinner legibly printed, failing which the thinner is liable to be rejected and shall not be used.

03.01.10 All paint containers shall be clearly labeled to show the paint identification, date of manufacture, batch number, special instruction, shelf life etc. The container shall be opened only at the time of use.

03.01.11 All paints shall be stored in accordance with the requirements of laid down procedure by the paint manufacturer.

03.01.12 All ingredients in a paint container shall be thoroughly mixed to break-up lumps and disperse pigments before use and during application to maintain homogeneity.

03.01.13 The proposed make, quality and shade of the paint shall have the approval of the client.

03.01.14 The colour code of the finishing paint to be followed shall be intimated to the successful Tenderer after finalisation of order. The undercoat shall have different tint to distinguish the same from the finishing coat.

03.01.15 The Contractor shall furnish paint manufacturer’s test report or technical data sheet pertaining to the paint selected. The data sheet shall indicate among other things the relevant standards, if any, composition in weight percent of pigments, vehicles, additives, drying time, viscosity, spreading rate, flash point, method of application, quality of surface preparation required, corrosion resistance properties and colour shades available.

03.01.16 For details of paint materials refer Annexure - 02

03.02 General

03.02.01 Each coat of paint shall be continuous, free of pores and of even film thickness without thin spots.

03.02.02 Each coat of paint shall be sufficiently dry before application of next coat.

03.02.03 Paint shall be applied at manufacturer’s recommended rates. The number of coats shall be such that the minimum dry film thickness specified is achieved. The dry film thickness of painted surfaces shall be checked with ELCOMETER of measuring gauges to ensure application of specified DFT.
03.02.04 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.

03.02.05 The machine finished surfaces shall be coated with white lead and tallow before shipment or before being put out into the open air.

03.02.06 Areas which become inaccessible after assembly shall be painted before assembly (after obtaining painting clearance from the inspecting authority) after requisite surface cleaning as specified.

03.02.07 Paint shall not be applied when the ambient temperature is 5 deg C and below or 45 deg C and above. Also paint shall not be applied in rain, wind, fog or at relative humidity of 80 % and above unless the manufacturer’s recommendations permit. Applications of paint shall be only be spraying or brushing as per IS 486 – 1983 and IS 487 – 1985.

03.02.08 Primer paint shall be applied not later than 2 – 3 hours after preparation of surface, unless specified otherwise.

03.02.09 Edges, corners, crevices, depressions, joints and welds shall receive special attention to ensure that they receive painting coats of the required thickness.

03.02.10 Surfaces which cannot be painted but require protection shall be given a coat of rust inhibitive grease according to IS 958 – 1975 or solvent deposited compound according to IS 1153 – 1975 or IS 1674 – 1960.

03.02.11 Surfaces in contact during shop assembly shall not be painted. Surfaces which will be inaccessible after assembly shall receive minimum two coats of specified primer.

03.02.12 Surfaces to be in contact with wood, brick or other masonry shall be given one shop-coat of the specified primer.

03.03 Site/Field Painting

03.03.01 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, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

03.03.02 If more than 50% of the painted surface of an item requires repair, the entire item shall be mechanically cleaned and new primer coats shall be applied followed by intermediate and finishing coats as per painting specification.

03.03.03 All field welded areas on shop painted items shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer paint is burnt).
Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

03.03.04 The first coat of finish paint at site shall be applied preferable within three months of the shop paint.

03.04 Structural

03.04.01 All fabricated steel structure, fabricated steel pipes, etc. shall have a minimum of two coats of primer paint before dispatch to site.

03.04.02 Parts of steel structures embedded in concrete shall be given a protective coat of Portland cement slurry immediately after fabrication and after surfaces of this part is thoroughly cleaned from grease, rust, mill scales, etc. No paint shall be applied on this part.

03.04.03 All structures shall receive appropriate number of primer and finishing coats in order to achieve overall DFT as per design drawings/specification.

03.05 Hot Surfaces

03.05.01 Total DFT for heat resistant paints should not exceed 100 – 120 microns, otherwise flaking occurs (as per paint manufacturer’s recommendations).

03.05.02 Heat resistant paints should be applied by brush.

03.05.03 Primer coat should not be applied on the surfaces having temperature condition more that 120 deg C.

04 PAINTING SCHEMES

For a complete painting scheme of any item being printed, all types of paints are to be procured from the same manufacturer as approved by the purchaser.

04.01 Legend

SP - Surface preparation quality as per SIS standard
2P1 - Two (2) coats of Primer paint type P1
1I1 - One (1) coats of Intermediate paint type I1
2F1 - Two (2) coats of Finish paint type F1
DFT - Dry Film Thickness in microns developed
CRT- Clean and Retouch

Type of paint products like P1 to P9, I1 to I4 and F1 to F10 have been specified under Annexure-02.

04.02 The painting scheme to be followed for various structure/equipment exposed to different condition is briefly given in Annexure-03 for guidance to the tenderer.
04.03 The colour code for different applications are indicated in Annexure-04. Wherever colour codes are not specified, the same is to be mutually agreed between the Purchaser and Contractor.

05. GUARANTEE

05.01 The Contractor shall guarantee that the physical and chemical properties of the paint materials conform with the specification of paint products.

05.02 The Contractor shall submit internal test reports from paint manufacturers regarding the quality of paint whenever asked by the Purchaser/Consultant.

05.03 Guarantee period shall commence from the date of completion of finishing coat of paint. The guarantee period will be indicated depending on the type of surface preparation and system of painting. To fulfill this obligations the Contractor may obtain from the painting manufacturer, guarantee for the performance of paint/painted surfaces.
# Surface Preparation Grade

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Surface Preparation</th>
<th>Swedish Std SIS 055900</th>
<th>DIN Std. Din 55928 (Part 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blast cleaning to white metal</td>
<td>Sa 3</td>
<td>Sa 3</td>
</tr>
<tr>
<td></td>
<td>Removal of all visible rusts, mill-scales, paint and foreign matters.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Blast cleaning to near white metal:</td>
<td>Sa 2.5</td>
<td>Sa 2.5</td>
</tr>
<tr>
<td></td>
<td>95% of any section of surface area is free from all rusts, mill-scales and visible residues.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Blast cleaning to commercial quality:</td>
<td>Sa 2</td>
<td>Sa 2</td>
</tr>
<tr>
<td></td>
<td>At least 2/3 of any section of the surface area is free from all rusts, mill-scales and visible residues.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Brush-off blast cleaning:</td>
<td>Sa 1</td>
<td>Sa 1</td>
</tr>
<tr>
<td></td>
<td>Removal of all loose mill-scales, rust and foreign matters etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Power tool cleaning:</td>
<td>St 3</td>
<td>St 3</td>
</tr>
<tr>
<td></td>
<td>Very thorough scrapping and wire brushing to remove loose mill-scale, rust and foreign matters to have pronounced metallic shine.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Hand tool cleaning:</td>
<td>St 2</td>
<td>St 2</td>
</tr>
<tr>
<td></td>
<td>Removal by hand brushing of loose mill-scale, loose rust and foreign matters.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PAINT MATERIALS

01. PRIMER PAINTS (P)

Primer paint products shall be applied only on dry and clean surfaces.

01.01 Primer Paint – P1 (Phenolic – Alkyd Based)

A single pack air drying phenolic modified alkyd composition with zinc phosphate as a primer paint conforming generally to IS : 2074.

- Air drying time - About 60 minutes (touch dry)
  - Overnight (hard dry)
- Dry film thickness (DFT)/Coat - 40 microns (min)
- Temperature resistance - Upto 100°C dry heat

01.02 Primer Paint – P2 (Chlororubber Based)

A single pack air drying high build chlorinated rubber based zinc phosphate primer.

- Percent chlororubber - 20 to 22 (% Chlorine above 65% in chlororubber)
- Air drying time - About 15 minutes (touch dry)
  - Overnight (hard dry)
- DFT/Coat - 50 microns (min)
- Temperature resistance - Up to 65°C dry heat

01.03 Primer Paint – P3 (PVC Copolymer Alkyd Based)

- Polyvinyl chloride (PVC) - Alkyd zinc phosphate – redoxide based primer
- Ratio : PVC copolymer + alkyd resin (1:1)
- Pigments : Zinc phosphate & Fillers
- Air drying time - 24 hours
- DFT/Coat - 80 microns
- Temperature resistance - Upto 80°C dry heat
01.04 **Primer Paint – P4 (Epoxy Based)**

A two pack air drying Epoxy polyamide resin based red oxide-zinc phosphate primer.

- Epoxy content (% wt.) - 15 to 18
- Air drying time
  - About 30 minutes (touch dry)
  - Overnight (hard dry)
- DFT/Coat - 30 microns (min)
- Temperature resistance - Upto 120°C dry heat

01.05 **Primer Paint – P5 (Epoxy Based)**

A two pack air drying Epoxy polyamide with zinc dust of at least 92% zinc dust on the dry film

- Epoxy content (% wt.) - 8 to 10
- Air drying time
  - Less than 10 minutes (touch dry)
  - Less than 2 hours (hard dry)
- DFT/Coat - 40 microns (min)
- Temperature resistance - Upto 300°C dry heat

01.06 **Primer Paint – P6 (Poly – Vinyl Butyral Resin Based)**

A two pack air drying polyvinyl butyral resin based wash primer with rust inhibitive pigments.

- Air drying time
  - 5 to 7 minutes (touch dry)
  - 2 hours (hard dry)
- DFT/Coat - 8 microns
- Temperature resistance - Upto 65°C dry heat
- Application for
  - Galvanised iron, aluminium, light alloys etc. on which the adhesion of conventional paints are poor.

01.07 **Primer Paint – P7 (Ethyl Zinc Silicate, EZS Based)**

A two pack heavy duty zinc dust rich silicate primer which protects the surface with just a single coat.

- Total solids (3 wt) - 84 +/- 2
- Density (g / cc) - 3.07 +/- 0.05
Air drying time  -  To top coat 16 hours
DFT / coat  -  60 microns
Temperature resistance  -  Upto 450 deg C dry heat

01.08  **Primer Paint – P8 (High Build Coal Tar Epoxy)**

A two pack cold cured H.B. epoxy coal tar coating – no primer is required.

Mixing ratio  -  Base: Hardener (4:1 by vol.)
Air drying time  -  48 hours (hard dry)
                      Full cure 7 days
DFT / Coat  -  100 microns

01.09  **Wood Varnish-P9**

Treated oil based primer pigmented with suitable pigments:

Air drying time  -  16 hours for application of top coat.

Coverage  -  10 to 14 sq. m/litre

02.  **INTERMEDIATE PAINTS (I)**

These paints shall be applied over primer coats as an intermediate layer to provide weather proof seal of primer coats.

02.01  **Intermediate Paint-II (Phenolic alkyd based)**

A single pack high build phenolic based paint with micaceous iron oxide (M10).

Air Drying Time  -  4 to 6 hours (touch dry) -
                      2 days (hard dry)
DFT / Coat  -  75 microns (min)
Temperature resistance  -  Upto 100 deg C dry heat
Compatible with  -  Primer P1

02.02  **Intermediate Paint-I2 (Chlororubber based)**

A single pack air drying high build chloro based paint with MIO.

Air Drying Time  -  15 minutes (touch dry) -
                      24 hours (hard dry)
DFT/Coat  -  70 microns (min)
Temperature resistance  -  Upto 65 deg C dry heat
Compatible with  -  Primer P2, P3 & P4

02.03  **Intermediate Paint-I3 (PVC – Alkyd Based)**

PVC Copolymer  -  Resin 1 : 1
Pigments  -  Micaceous iron oxide (MIO)
DFT/Coat  -  80 microns (min)
02.04 **Intermediate paint-I4**

A two pack air drying high build epoxy resin based paint with MIO.

- **Air drying time**: 
  - 6 to 8 hours (touch dry)  
  - 7 days (full cure)

- **DFT / coat**: 100 microns

- **Temperature resistance**: Up to 180°C dry heat

- **Compatible with**: Primer P4 & P5

03. **FINISH PAINTS (F)**

Finish paint costs shall be applied over primer coats and intermediate coats after proper cleaning and touch up of primed surface.

03.01 **Finish Paint – F1**

A single pack air drying high gloss phenolic alkyd modified synthetic enamel paint suitably pigmented.

- **Air drying time**: 
  - 3 to 4 hours (touch dry)  
  - 24 hours (hard dry)

- **DFT/Coat**: 25 microns (min)

- **Temperature resistance**: Up to 100°C dry heat

- **Compatible with**: Primer P1, Intermediate I1

- **Colour**: Generally all shades

03.02 **Finish Paint – F2**

A single pack air drying polyurethane enamel of high gloss and hard finish suitably pigmented.

- **Air drying time**: 
  - 2 to 2½ hours (touch dry)  
  - 6 hours (hard dry)

- **DFT/Coat**: 30 microns (min)

- **Temperature resistance**: Up to 100°C dry heat

- **Compatible with**: Primer P1 & P8 and Intermediate I1

- **Colour**: Generally all shades
03.03 **Finish Paint – F3**

A two pack air drying bituminous aluminum paint.

- **Air drying time**  
  - 1 to 2 hours (touch dry)  
  - 21 hours (hard dry)

- **DFT/Coat**  
  - 25 microns (min)

- **Temperature resistance**  
  - Upto 100°C dry heat

- **Compatible with**  
  - Primer P1 and Intermediate I1

- **Colour**  
  - Bright metallic

03.04 **Finish Paint – F4**

A ready mixed oil-alkyd based synthetic enamel paint of high gloss and hard wearing properties.

- **Air drying time**  
  - 6 to 8 hours

- **Coverage**  
  - 14 to 16 Sq. m /litre

- **Temperature resistance**  
  - Upto 60°C dry heat

- **Compatible with**  
  - P8

- **Colour**  
  - Generally all shades

03.05 **Finish Paint – F5**

A single pack air drying plasticized chlororubber paint suitably pigmented.

- **Air drying time**  
  - 30 minutes (touch dry)  
  - 24 hours (hard dry)

- **DFT/Coat**  
  - 35 microns (min)

- **Temperature resistance**  
  - Upto 65°C dry heat

- **Compatible with**  
  - Primer P2 & P3,  
  Intermediate I2 & I3

- **Colour**  
  - Nearly all shades except few.
03.06 **Finish Paint – F6**

A PVC – Copolymer alkyd based enamel.

- **Density**: 1.17 ± 0.05
- **Total solids (1 wt)**: 55 ± 2
- **DFT/Coat**: 40 microns
- **Compatible with**: P2 and P3

03.07 **Finish Paint – F7**

A two pack air drying epoxy polyamide enamel suitably pigmented.

- **Air drying time**: 2 to 3 hours (touch dry)
- 7 days (full cure)
- **DFT/Coat**: 40 microns (min)
- **Temperature resistance**: Up to 130°C dry heat
- **Compatible with**: Primer P4 & P5, Intermediate I4
- **Colour**: Generally all shades.

03.08 **Finish Paint – F8**

A single pack synthetic rubber based aluminium paint.

- **Air drying time**: 2 hours (touch dry)
- 24 hours (hard dry)
- **DFT/Coat**: 25 microns (min)
- **Temperature resistance**: Upto 200°C dry heat
- **Compatible with**: No Primer paint except primer P6 is applicable in case of non-ferrous substrate.
- **Colour**: Smooth aluminium.
# PAINTING SCHEME

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>1.0</td>
<td><strong>Steel Structures</strong> <em>(Temp. not exceeding 80°C)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Technological steel structures for plant and equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor</td>
<td>SP – Sa 2.5</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2P1</td>
<td>2F1</td>
</tr>
<tr>
<td></td>
<td>Outdoor</td>
<td>SP – Sa 2.5</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2P1</td>
<td>1I1</td>
</tr>
<tr>
<td>1.2</td>
<td>Fabricated steel structures at site for rung ladders, cat-ladders, gates, rolling shutters, etc. (Springs/rubbing surfaces excluded)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Indoor / Outdoor</td>
<td>SP – St-2 and/or St-3</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2P1</td>
<td>2F1</td>
</tr>
<tr>
<td>1.3</td>
<td>Walkways, stairs, platforms etc. which are of wearing surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Indoor</td>
<td>SP – St-2 and/or St-3</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2P1</td>
<td>2F1</td>
</tr>
<tr>
<td></td>
<td>- Outdoor</td>
<td>SP – St2 and/or St-3</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2P1</td>
<td>1I1</td>
</tr>
<tr>
<td>1.4</td>
<td>Steel doors and windows</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Indoor / outdoor</td>
<td>SP – St-2 and/or St-3</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2P1</td>
<td>1I1</td>
</tr>
</tbody>
</table>

---

## MECHANICAL EQUIPMENT

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td><strong>MECHANICAL EQUIPMENT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Mechanical equipment <em>(Temp. not exceeding 80°C)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1</td>
<td>Static equipment like storage tanks, vessels, bins, bunkers, heat exchangers, coolers,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### General Technical Specification

#### 2.1.2 Rotary/moving equipment and machineries like crushers, mills, vibratory screens, bin activators, blowers, fan, air/gas compressors, pumps, gear boxes, machine housings etc.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DFT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cyclones, scrubbers, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Indoor</td>
<td>SP – Sa 2.5 2P2/2P3</td>
<td>CRT 2F5/2F6</td>
</tr>
<tr>
<td></td>
<td>- Outdoor</td>
<td>SP – Sa 2.5 2P2/2P3+1I2/1I3</td>
<td>CRT 2F5/2F6</td>
</tr>
<tr>
<td></td>
<td>- Outdoor</td>
<td>SP-Sa 2.5 2P3 2P4</td>
<td>CRT 2F6/2F7</td>
</tr>
<tr>
<td></td>
<td>- Outdoor</td>
<td>SP-Sa 2.5 2P3 + 1I2/1I3</td>
<td>CRT 2F6/2F7</td>
</tr>
</tbody>
</table>

#### 3.0 Pipe / Duct work (Overground)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DFT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.1 Non – insulated (temperature up to 80°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Indoor</td>
<td>SP – St2 and 2P1</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td></td>
<td>- Outdoor</td>
<td>SP – St2 and 2P1 + 1I1</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td></td>
<td>3.2 Insulated (hot)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Indoor/Outdoor</td>
<td>SP- St2 and 1P1</td>
<td>Remove paint and insulate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 4.0 Oxygen Plant

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DFT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>outdoors</td>
<td>SP – St2 and CRT</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>4.2</td>
<td>Rotary equipment like air compressors</td>
<td>2P1 + 1I1</td>
<td>2F3</td>
</tr>
<tr>
<td>5.0</td>
<td>Others</td>
<td>Sa 2.5</td>
<td>CRT 2F7</td>
</tr>
<tr>
<td>5.1</td>
<td>Standard mobile equipment like chasis of trucks, dumpers, crawler cranes bulldozers, railway rakes, chasis of slag cars, ladle cars, etc.</td>
<td>As per manufacturer’s standards</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Laboratory equipment like ovens, screens, magnetic stirrers, samplers, etc.</td>
<td>Stove enamelling</td>
<td>CRT</td>
</tr>
<tr>
<td>5.3</td>
<td>Steel structures partly immersed in water</td>
<td>SP – Sa 2.5</td>
<td>CRT</td>
</tr>
</tbody>
</table>

**Notes:**

1. Painting scheme of all fabricated steel structures, fabricated pipe work, building structure, conveyor galleries, pipe trestles etc. is indicated in the Technical Specification of steel structures.

2. Primer Paint

Primer coat shall be suitable for intended temperature applications as per manufacturer’s recommendation. The primer selection shall be generally in line with the specification laid down in Annexure-02.

3. Finish Paint

In case of Aluminium cladding final painting will not be required.
COLOUR CODE

The colour codes are mentioned for all the items including pipe work. Shades of finish coat of paint applied over respective item indicated below are tentative and subject to alteration as per Purchaser’s request or due to compatible paint system adopted. The service for which colour code/bands are not specified are to be mutually agreed for by the Purchaser & the Contractor.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Items Painted</th>
<th>Colour</th>
<th>Colour No. of IS:5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Building frames including bracings, side girts, louvers etc.</td>
<td>Aircraft grey</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>Crane girders</td>
<td>Azure blue</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Crane stops</td>
<td>Post office red</td>
<td>538</td>
</tr>
<tr>
<td></td>
<td>Gutters</td>
<td>Black bituminous aluminium</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Fire escape platforms ladders, etc.</td>
<td>Signal red</td>
<td>537</td>
</tr>
<tr>
<td></td>
<td>General hand railing, top runners</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Rung ladders</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>All members blocking passages for movement</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Trestles, towers and pipe bridges</td>
<td>Dark admiralty grey</td>
<td>632</td>
</tr>
<tr>
<td></td>
<td>Conveyor gallery structures</td>
<td>Aircraft grey</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>Steel chimneys</td>
<td>Aluminium</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Equipment and Machinery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General indoor equipment</td>
<td>Light grey</td>
<td>631</td>
</tr>
<tr>
<td></td>
<td>General outdoor equipment</td>
<td>Dark admiralty</td>
<td>632</td>
</tr>
<tr>
<td></td>
<td>Crane bridges, trolleys, hooks etc. and other mobile equipment</td>
<td>Base: Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stripes: Black (100 mm wide)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Furnaces</td>
<td>Aluminium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tanks</td>
<td>Base: Same as for general equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strips: Same shade as for piping around the tnk at half the tank height</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fire-fighting equipment</td>
<td>Signal red</td>
<td>537</td>
</tr>
</tbody>
</table>

3. **Pipe work**

Colours shall be as given below. The base colour shall be applied throughout entire length except on surfaces of materials such as asbestos, aluminium, brass, bronze, galvanized steel, stainless steel and other corrosion resistant alloys and rubber / synthetic polymers. In such cases identification colour bands of at least 500mm width shall be provided near each branch, valve and at distances not exceeding 10m either as local colour coatings or coloured adhesive type of suitable material or label attached to the pipe work. Additional identification bands superimposed over the base colour shall be provided near each branch, valve and at distance not exceeding 10m. The bands shall be at least 25mm wide except in case of double bands where the first band shall be about 100mm wide. Direction of flow shall be clearly marked on the pipelines at intervals not exceeding 10m and all branches and change of directions.
<table>
<thead>
<tr>
<th>Service</th>
<th>Colour</th>
<th>Colour No. of IS:5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea or river water (untreated)</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band - White</td>
<td>-</td>
</tr>
<tr>
<td>Cooling water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band - White</td>
<td>166</td>
</tr>
<tr>
<td>Boiler feed water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td>Condensate</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Light brown</td>
<td>410</td>
</tr>
<tr>
<td>Drinking water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>First band - French blue</td>
<td>166</td>
</tr>
<tr>
<td></td>
<td>Second band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Industrial water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Light orange</td>
<td>557</td>
</tr>
<tr>
<td>Compressed air</td>
<td>Base – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td>Instrument air</td>
<td>Base – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>Band – Light brown</td>
<td>410</td>
</tr>
<tr>
<td>Drainage</td>
<td>Base – Black</td>
<td>-</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>Base – Light brown</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td>Band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Coke oven/BF gas/other fuel gases</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Argon</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – French blue</td>
<td>166</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – Dark violet</td>
<td>796</td>
</tr>
<tr>
<td>LP Gas (LPG)</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>First band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td></td>
<td>Second band – Traffic green</td>
<td>267</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – Black</td>
<td>-</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – White</td>
<td>-</td>
</tr>
<tr>
<td>Non-acidic slurries</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – White</td>
<td>-</td>
</tr>
<tr>
<td>Fire-fighting system</td>
<td>Base – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Rain water down pipes</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td>Duct work</td>
<td>Base – Aluminium</td>
<td>-</td>
</tr>
</tbody>
</table>

**Note**: For these services, hazard marking as per fig. 4C of IS:2379 shall also be provided.