6.4.2 Human machine interface shall include engineering and operator function. Engineering and operator workstations shall be separate.

6.4.3 HMI shall be of industrial grade suitable for continuous operation at design ambient temperature with restricted natural ventilation.

6.4.4 HMI shall be of latest version of industrial grade PC and the same shall be provided with 21" color monitor (TFT flat screen) with non glare glass filters to minimize glare from external lighting.

6.4.5 Operator workstation shall have user friendly software for interactive display of substation data in multiwindow feature. Software shall have capability to display substation single line diagrams, display of electrical system parameters, reports, alarm annunciation, daily and monthly data logging, continuous polling, relay monitoring, relay supervision, fault disturbance record of each relay, graphic representation and trending of data etc. The offered system shall comply with requirements of IEC for basic and safety requirements for Human-machine interface.

6.4.6 Engineering workstation shall have software for engineering, detailed self diagnostic for maintenance, trouble shooting and changing parameters. Further, it shall also have facility to program and configure numerical relays, data concentrator and other intelligent devices. In addition engineering work station shall have all the facilities as provided for operator workstation.

6.4.7 The HMI system shall be provided with color laser jet A3 printer for generating hardcopy of alarm, event and logging report. The printing shall be on demand, unless otherwise agreed.

6.4.8 If specified, separate laptop shall be provided. The laptop shall include all functionalities as specified for HMI system and the same shall be provided with required licensed software, hardware, accessories and material. System configuration shall be latest proven model and upgradable.

6.4.9 HMI system shall be provided with all associated furniture for PC, printer etc.

6.5 Time Synchronization

6.5.1 All internal clocks of numerical relay, data concentrator, SOE modules, HMI etc. shall always work in synchronism such that there is one and only one system-wide time. GPS shall be considered to synchronize with an external satellite clock. The time synchronization accuracy shall be ± 1.0 msec or better.

6.5.2 The GPS system shall consist of GPS antenna, lightning arrestor, GPS receiver/server and associated cables.

6.5.3 The time synchronization shall be carried out either through communication over substation relay LAN or by considering dedicated time synchronization channel. In case of synchronization through relay LAN, the communication protocol shall support to carry time synchronization message to the relays/data concentrator/HMI and maintain the desired accuracy. In case of time synchronization through dedicated time synchronization channel, relays, data concentrator and HMI shall be provided with IRIG- B port and the same shall be directly hooked up to GPS receiver.

6.5.4 In Ethernet based communication network, GPS receiver shall be directly hooked up to Ethernet LAN and all internal clocks of HMI and numerical relays shall be updated using SNTP protocol.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 During assembly, EIL / Owner or his authorized representative shall be permitted to assess the progress of work as well as to ascertain that quality raw material is used for the same. All assistance as required during inspection shall be given to inspector.

7.2 For testing requirements refer Inspection & Test Plan No. 6-81-1055.

8.0 PACKING AND DESPATCH

The equipment shall be properly packed for transportation by ship/rail or trailer. All equipments shall be wrapped in polyethylene sheets before being placed in wooden crates/ cases with fillers to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'centre of gravity', 'weight', 'Owner's particulars', 'PO nos.' etc. shall be clearly marked on the package together with other details as per purchase order.

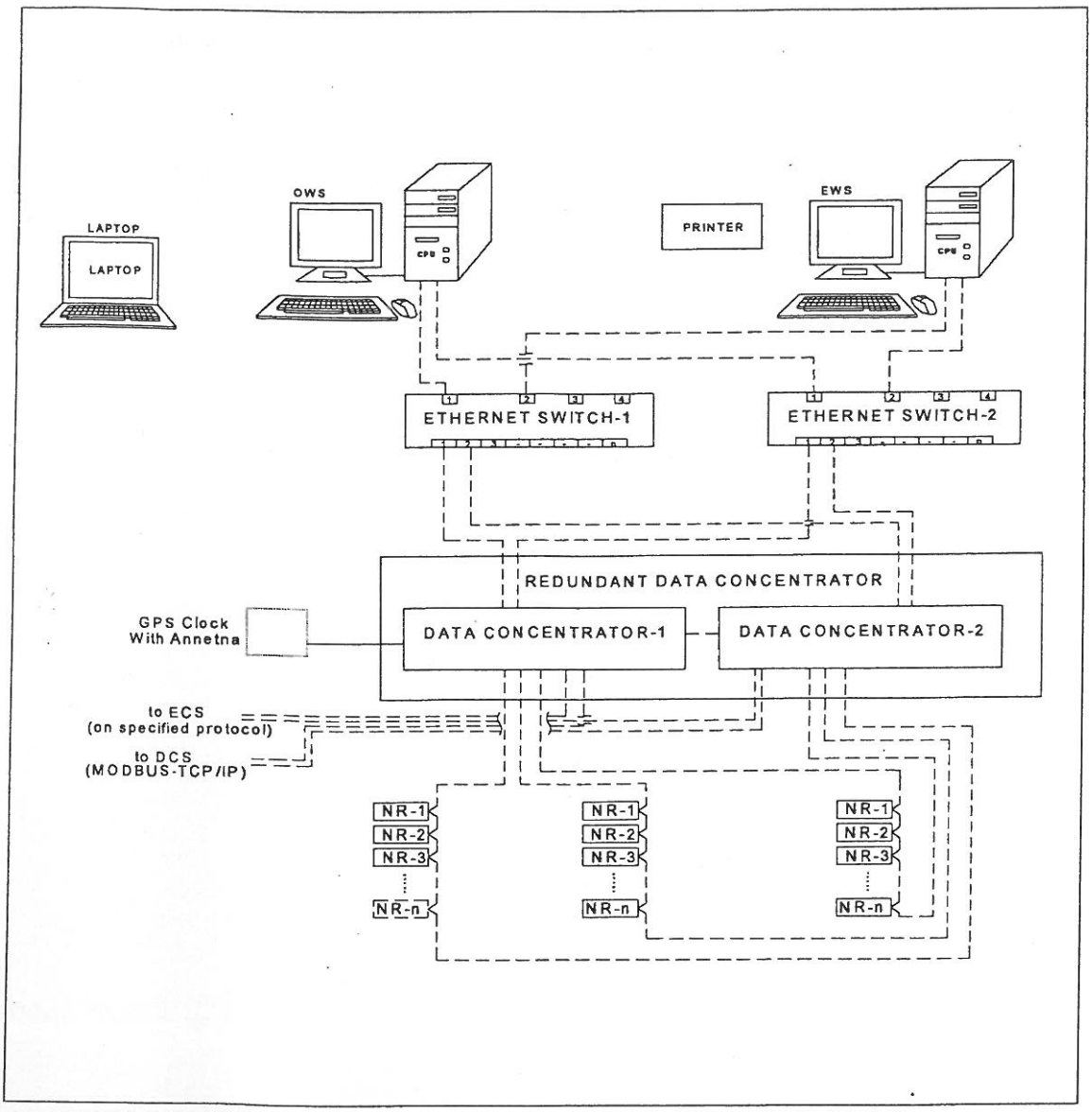

FIGURE 1: TYPICAL ARCHITECTURE FOR SERIAL COMMUNICATION

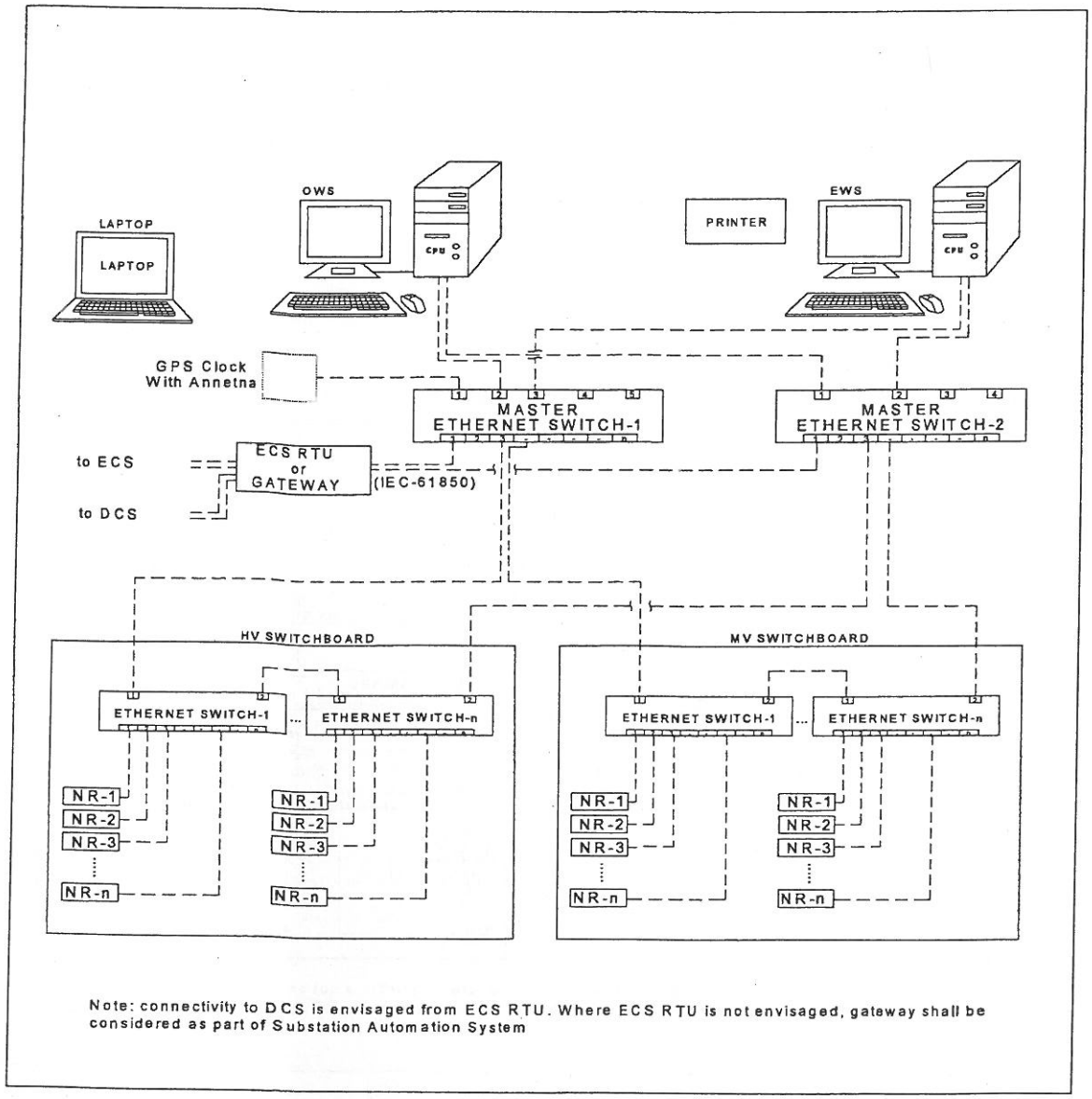

FIGURE 2: TYPICAL ARCHITECTURE FOR IEC-61850 COMMUNICATION

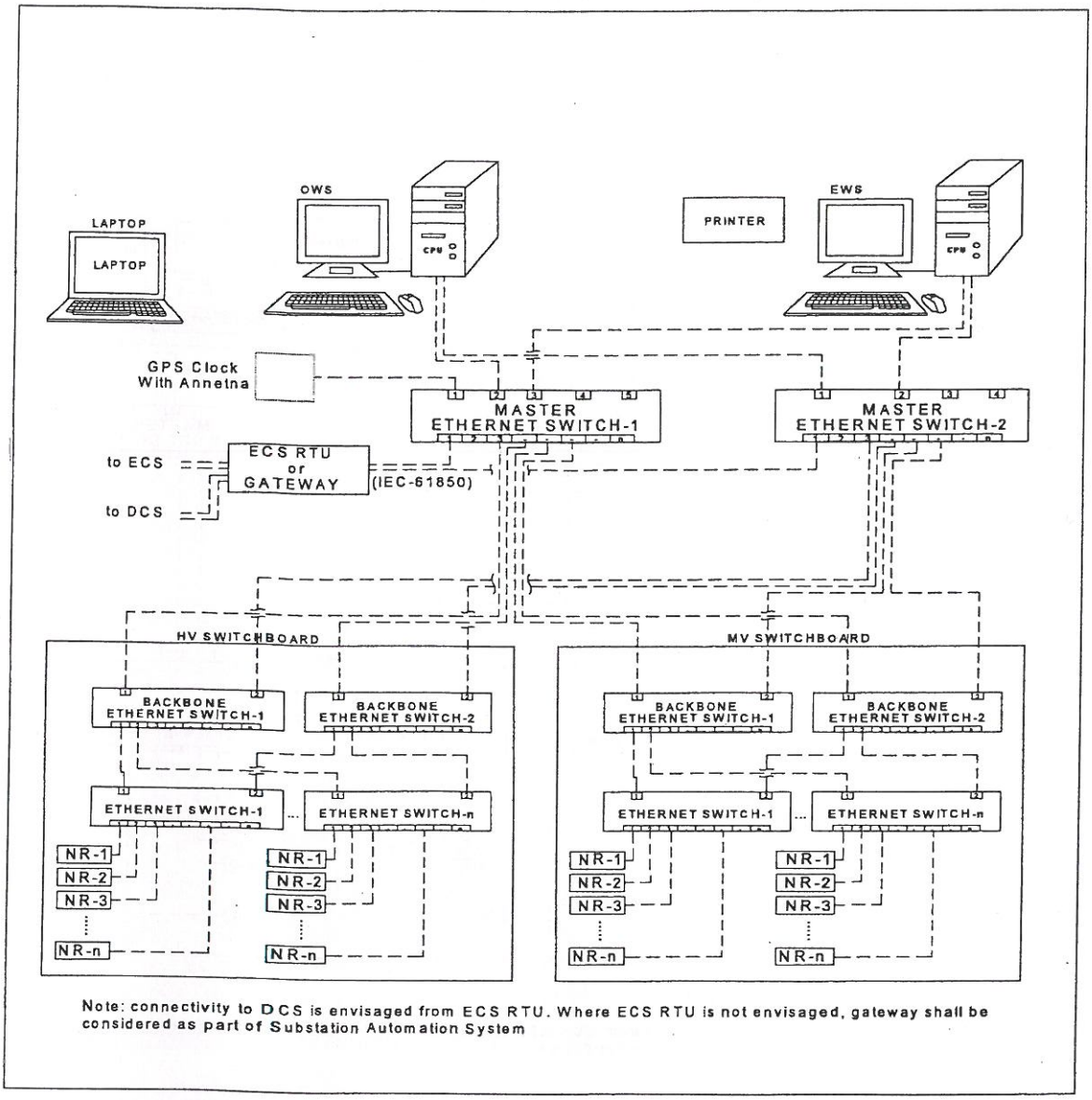

FIGURE 3: TYPICAL ARCHITECTURE FOR IEC-61850 COMMUNICATION.

1.0 SCOPE

1.1 The intent of this specification is to define the functional and design requirements for an Integrated Fire Alarm System for industrial plants and buildings. This specification covers the requirements for selection, design and engineering, manufacture, testing at vendor's works, supply and installation, testing at site and commissioning unless otherwise stated.

1.2 The Integrated Fire Alarm System shall be conventional or micro processor based analogue addressable system comprising BGUs, detectors; conventional or microprocessor based Fire Alarm panels and associated equipment detailed hereunder and in Project data sheets/ drawings.

2.0 CODES AND STANDARDS

2.1 The fire alarm system and the components used shall conform to the latest edition of the following Codes/Standards, other relevant Indian Standards and International Standards as applicable.

IS-5	Colours for ready Mixed Paint & Enamels.
IS – 513	Specification for cold rolled low carbon steel sheets and strips
IS – 1646	Code of practice for fire safety of buildings (general): Electrical Installations
IS – 2175	Specification for heat sensitive fire detectors for use in automatic fire alarm system
IS – 2189	Code of practice for selection; installation and maintenance of automatic fire detection and alarm system.
IS – 3034	Code of practice for fire safety of Industrial buildings: Electrical generating and distributing stations.
IS – 5469	Code of practice for the use of semi-conductor junction devices (Applicable parts)
IS – 12459	Code of practice for fire safety in cable runs
IS/IEC 60079-0	General requirements for electrical apparatus for explosive gas atmosphere
IS/IEC 60079-11	Specification for Intrinsically safe electrical apparatus and circuits
IS/IEC 61241-14	Electrical apparatus with protection of enclosure for use in the presence of combustible dust
NFPA 72	National Fire Alarm code
LPC	Loss prevention council recommendations.
BS – 5839	Specifications for manual call points. Part – 2
BS-EN 50081-1/2	EMC (Electromagnetic compatibility test)
BS-EN 50082-1/2	EMC (Electromagnetic compatibility test)

2.2 Standards of country of origin shall be applicable if these standards are equivalent or more stringent than the applicable Indian Standards in case of imported equipment.

2.3 Equipment shall also conform to the provisions of CEA regulations and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/BS/VDE/IEEE/NEMA/UL/FM/VdS or equivalent agency shall be applicable.

2.5 In case of any contradiction between various referred standards/specifications/data sheet and statutory regulations, the most stringent requirement shall govern and decision of owner in this regard shall be final.

3.0 GENERAL REQUIREMENTS

3.1 Offered equipment shall be brand new with established state of the art technology and having proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply. The spares shall be available ex-stock with the vendor.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user to place order for spares and services.

3.4 Vendor shall be responsible for design & engineering and manufacturing of the complete system and equipment to fully meet the intent and requirements of this specification and attached data sheets.

3.5 All equipment and accessories required for completeness of the system, whether specifically mentioned or not but considered essential for satisfactory performance, shall be included by the vendor as part of the offered system.

3.6 The system integrator shall coordinate with the manufacturers of various bought-out items associated with the system as required, and shall freely and readily supply all technical information as and when asked for.

3.7 All equipment required to be located in hazardous areas shall have test certificates issued by recognized independent test house such as CIMFR, ERTL, BASEEFA, UL, FM or equivalent. Indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. Equipment (indigenous & imported) shall also have valid statutory approvals e.g. PESO, DGMS as applicable for the specified location. Indigenous flameproof equipment shall also have valid BIS license and marking as required by statutory authority.

4.0 DEFINITIONS

4.1 CFAP

It is the main or central fire alarm panel located in fire station or in disaster management control room, which receives inputs from automatic and manual Fire alarm devices and supplies power to detection and notification devices along with sub-systems where applicable. CFAP provides interface with telephone exchange, plant's public address system etc. and has features, such as provision to activate plant-wide sirens. CFAP is supported by mimic/ graphical display for geographical depiction of alarms either on panel or HMI.

4.2 DGFAP

It is a Microprocessor based fire alarm panel, designed for use with addressable fire alarm system. It has alpha- numeric LCD displays along with LED displays for fire/ fault conditions. It also includes loop cards (for field devices), I/O (input/ output) cards for interface with other equipment e.g. exit signs and hooters. It functions as fire alarm panel located centrally to population of fire detectors distributed over an area for optimizing and limiting the loop lengths.

4.3 ZFAP

It is a fire alarm panel for conventional fire alarm system. This is functionality similar to what is provided for DGFAP. This has LEDs for fire/ fault annunciations.

4.4 Repeater Panel

It is similar to distributed fire alarm panels (DGFAP/ ZFAP) but will not have Zone card/ Loop card for field devices. These are provided at manned locations and are configured to acquire information about the fire/ fault of selected zones from DGFAP/ ZFAP and annunciate.

4.5 Integrated Fire Alarm System

It signifies a comprehensive fire alarm system comprising all the distributed fire alarm panels (DGFAP, ZFAP, repeater panels etc) having integration with CFAP for fire/ fault monitoring of total plant/ buildings. It provides audio/ visual alarm building/plant-wide having provisions for connectivity with telephone exchange and public address system. It shall provide interfaces with fire protection system and other systems like pressurization systems, air conditioning, clean agent system, water spray system, Fire & Gas detection system etc. via potential free contacts.

4.6 System Architecture

System architecture is line diagram defining the connectivity of DGFAPs, repeater and CFAP. This also specifies various system requirements such as redundancy, communication protocol, communication hardware, cable requirement, work station and programming tools.

4.7 Data High Way

This term is meant to define the communication path between DGFAPs, CFAP and other network components in microprocessor based fire alarm system. Physical media for Data highway can be FO cable or twisted pair copper conductor, screened cable.

4.8 Field Devices

Devices such as detectors, BGUs, exit signs, hooters, siren etc. are termed as field devices.

4.9 Hazardous Area

An area in which an explosive gas/ dust atmosphere is present, or likely to be present in quantities such as to require special protection for the construction, installation and use of electrical apparatus.

4.10 Signal Loop (Signaling Circuit)/Signaling Line Circuit

A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple system input signals or output signals, or both are carried.

4.11 Notification Appliance Circuit

A circuit or path directly connected to notification appliances (eg. Bell, horn, speaker, strobe, printer etc.)

4.12 Zone

A defined area within protected premises. A zone may define an area from which a signal can be received, an area to which a signal can be sent or an area in which a form of control can be executed.

5.0 SYSTEM AND SITE CONDITIONS

All equipment shall be designed to operate with power supply and site conditions as specified below:

5.1 Site Conditions

The offered equipment shall be capable of operating continuously and maintaining its guaranteed performance at the site ambient conditions indicated in data sheet.

Unless specified otherwise, fire alarm panels along with associated hardware shall be suitable for installation and operation in a closed building/ room with restricted ventilation. Unless otherwise defined, a design ambient temperature of 40°C and an altitude not exceeding 1000M above mean sea level shall be considered for all equipment. For battery sizing, minimum ambient temperature shall be considered as 10°C.

5.2 Input Power Supply

5.2.1 Primary power supply will be provided by Owner at 240V, 50Hz, SPN at one point to each Fire Alarm Panel. Suitable power distribution to various signaling and notification devices shall be included in the vendor's scope. For microprocessor based system, 240V, 50Hz, SPN power supply to remotely located Repeater panel and sub-system, if any, shall be provided by the Owner on the basis of actual system configuration and requirements. For conventional Fire Alarm system, power supply to ZFAP, repeater panel and remotely located strobe etc. shall be planned and provided by the vendor.

5.2.2 For siren, power supply shall be made available by Owner preferably at 110/230V AC supply.

5.2.3 Unless otherwise specified, secondary power supply for fire alarm panels shall be through battery provided by the vendor. This shall have sufficient capacity to operate the fire alarm system under quiescent load (system operating in a non-alarm condition) i.e. to operate a local central station or proprietary Fire alarm system for a minimum of 24 hours. At the end of that period, this shall be capable of operating all alarm notification devices used for evacuation and to direct aid to the location of emergency for 5 minutes.

The secondary power supply for in-building fire emergency voice/alarm communication service shall be capable of operating the system under quiescent load for a minimum of 24 hours and then be capable of operating the system during a fire and other emergency conditions for 15 minutes at maximum connected load.

The secondary power supply capacity required shall include all power supply loads that are not automatically disconnected upon the transfer to secondary power supply.

Battery sizing shall consider the maximum quantity of detector/equipment that can be connected in the loops, as well as 5 hooters and 5 exit signs per loop in DGFAP. Battery sizing calculations shall be reviewed during detailed engineering and there shall be no cost/time implication for providing adequately sized batteries and chargers of approved rating during the order execution. Separate battery charger shall be provided incase battery charger part of the DGFAP cannot cater to the boost charging requirement of battery.

An overall ageing factor of 0.8 and a temperature correction factor corresponding to minimum temperature of 10°C shall be considered for battery sizing.The battery calculations shall include a 10 percent safety margin to the calculated amp-hour rating.

Operation on secondary power shall not affect the required performance of a fire alarm system or supervising station facility. The system shall produce the same alarm, supervisory and trouble signals and indications.

The switch-over from primary source to secondary source, in the event of mains failure, shall be automatic. Battery shall be Ni-Cd/VRLA/ SMF type as specified in the datasheet. Suitable adequately rated battery charger shall be supplied as a part of secondary power source. Quick charging of the battery from fully discharged state shall be attainable in 10-14 hours except VRLA batteries, which shall follow the charging cycle according to supplier's recommendations.

6.0 FIRE ALARM SYSTEM DESCRIPTION

6.1 General

Fire alarm system, under this specification, is envisaged to provide fire monitoring in industrial plants and buildings. The system shall be designed to detect incipient fires, smoky fires and flaming fires and generate audio/ visual alarm on detection of smoke or fire.

The system shall consist of automatic fire detectors and break glass units. Automatic fire detectors shall work on the principle of sensing of smoke, heat or infrared / ultraviolet rays. Depending on type of smoke, optical or ionization type detectors shall be used. Detectors shall generally be provided in plant/ buildings. BGUs shall be provided at exit doors of the buildings, exit routes of industrial plants and along service roads surrounding protected areas. Number of detectors and break glass units shall be decided as per guidelines given in applicable codes and standards.

For conventional FA system, Plant/ building shall be divided into fire monitoring zones. In defining zones, care shall be taken to ensure that location of fire can be easily identified. No two buildings shall be combined to form one zone. Detectors and BGUs at these buildings and plants shall be connected to CFAP, ZFAP. These panels shall continuously monitor the state of these devices. On sensing fire condition, an audio/ visual alarm shall be initiated identifying the zone where fire is detected. Panels shall continuously monitor the health of the cabling and in case of short circuit or open circuit fault alarm shall be activated. Fire alarm panels shall also have powered outputs for switching on exit signs and hooters as specified in data sheet/ drawings. Further, panels shall provide required output for interfacing with the Owner's systems such as air conditioning system or pressurization system or fire protection systems.

Alarms, if specified, shall be relayed to repeater panel provided in buildings like control rooms/ administrative buildings to provide zone wise annunciation. In addition facility shall be provided to actuate siren/ hooter.

For integrated fire alarm system where plant-wide large numbers of fire alarm panels are envisaged, these panels shall be integrated to CFAP, which shall be located in fire station, disaster management control room or in administrative control room of the building as per the job requirements. The connectivity shall be achieved using data high way or dedicated cable connection from each fire alarm panel to CFAP. In conventional system Mimic at CFAP shall be provided for fire/ fault annunciation depicting geographical location in addition to the text/ LED on the CFAP. This will be in the form of graphics available at HMI in microprocessor based system. If defined, CFAP shall have provision for automatic and manual actuation of plant-wide siren as per operator's choice. Interface with other systems such as telephone exchange/ plant's public address system shall be provided for communication required for disaster management.

6.2 Conventional / Addressable fire alarm systems

6.2.1 Fire alarm system shall be conventional fire alarm system or addressable microprocessor based fire alarm system as specified in data sheet. Conventional fire alarm system shall have

conventional field devices/ equipment and microprocessor based system shall have addressable type field devices.

Conventional fire alarm system shall generally comprise but not be limited to the following equipment used in conjunction with conventional automatic fire alarm detectors and BGUs as a minimum.

- CFAP with/ without mimic (as per data sheet)
- ZFAPs
- Repeater Fire Alarm Panel
- Sirens and starters/Siren control panels
- Hooters & exit sign in buildings
- Interface with Owner's systems
- Any other hardware as required to render system complete

6.2.2 Microprocessor based fire alarm system shall generally comprise but not be limited to the following equipment used in conjunction with addressable automatic detectors and addressable BGUs as a minimum.

- CFAP consisting of computer based graphic work station and engineering station.
- Multi loop DGFAPs
- Sirens and starters/siren control panels
- Hooters & exit sign
- Interface with Owner's systems
- Data Highway

  [Copper/ FO cable data highway complete with redundant architecture for communication, hardware including communication port, switches, processor and power supply.]
- Any other hardware/ Software required for rendering system complete.

6.2.3 As specified in data sheet, the system shall be provided with siren/s to be located at a suitable location/s in the plant and it shall be actuated manually and automatically as selected by operator from CFAP/ DGFAP located at fire station/ other buildings.

7.0 CONVENTIONAL FIRE ALARM SYSTEM

7.1 Design Features

7.1.1 System shall be modular and facilitate future extension / modification. Panel design and component selections shall be done for future extension up to 10% of specified zones or one zone whichever is maximum in each panel. 10% spare zone cards subject to minimum of 1 shall be provided. The design of common facility and hardware shall be provided for required future extension of zones.

7.1.2 PCBs shall have watchdog feature for self-diagnostic. Each PCB shall have LED for annunciating card failure. Following self-diagnostic features may be considered as minimum.

- Open circuit detection
- Short circuit detection
- Earth fault detection
- Power supply failure e.g. low battery voltage, main incoming supply fail
- System faults (PCB failure)

7.1.3 Logic of operation shall be built on "Fail safe" feature i.e. NC contact of field devices shall be considered as healthy condition and NO as fire condition. 1 NO+ 1 NC contact of output relays shall be wired to terminal block for interface with Owner's other equipment.

7.1.4 It shall be possible to test lamps, hooters, flasher circuit, and carry out functional tests etc through common "Test" push button.

7.1.5 The circuit shall be so designed that silencing of the current alarm by ACCEPT push button shall not prevent annunciation of subsequent fire alarm received from any other location.

7.1.6 Signal-to noise ratio shall be high to avoid spurious actuation due to noise induced in the field wiring because of proximity with power cables. Cables for field devices shall be multicore copper conductor, unscreened, armoured, copper conductor FRLS cable. If required noise filters shall be provided at fire alarm panel.

7.1.7 Detectors and BGUs shall be wired through 1.5 mm^2 multi-core, Copper conductors, PVC insulated, armoured FRLS cable. Limiting distance from fire alarm panel to last detector/BGU shall not be less than 2 km or as specified in data sheet whichever is maximum.

7.1.8 LEDs shall be provided for fire/ fault visual annunciation on the panel front. LED shall also be provided for Power supply healthy, Battery backup ON, Battery/ Charger status.

7.1.9 If zone is protected with clean agent/ CO_2 system, the detectors and BGUs of the zone shall be wired in cross-zones by providing minimum two signaling circuits in a zone. The last device in each circuit shall be provided with end of line resistor of suitable value as per circuit design to facilitate cable open circuit and short circuit detection.

7.1.10 Scheme for FIRE/ FAULT annunciation for CFAP/DGFAP, Zonal Fire Alarm Panel, Repeat Alarm Panel shall be as per the following.

System condition	AUDIO	VISUAL
NORMAL	OFF	OFF
FIRE	ON (tone 1)	Flasher ON, Fire LED Steady ON
Accept	OFF	Flasher steady, Fire LED steady ON
Reset	OFF	Flasher OFF, Fault LED OFF
FAULT	ON (tone 2)	Flasher OFF, Fault LED Steady ON
Accept	OFF	Flasher OFF, Fault LED Steady ON
Reset	OFF	Flasher OFF, Fault LED OFF

7.1.11 Fire alarm panels including repeater panels and CFAP shall be certified/ approved by applicable approving agency of country of origin as required.

7.2 Zonal Fire Alarm Panel

7.2.1 ZFAP shall consist of number of zones as specified in data sheet. Detectors/ BGUs/ heat sensing cables etc shall be connected zone wise in signaling circuits. It shall monitor fire/ fault condition of the zone. ZFAP shall be located indoor in safe area.

7.2.2 ZFAP shall be free-standing, floor mounting vertical panel consisting of audio/visual annunciation with Alarm Accept, Test and Reset Push Buttons, Auto/Manual control of hooters provided in buildings. Provision to actuate siren shall be provided if specified in data sheet. Circuit shall be designed to provide annunciation if any detector in a zone senses fire.

7.2.3 Audio/ Visual indication and annunciation shall be as per clause 7.1.8.

7.2.4 ZFAP shall have required interface hardware where integration with CFAP/ repeater panel is envisaged as per data sheet.

7.2.5 Output contacts (1NO+1NC) shall be provided for interface with Owner's systems as per clause 9.0 of this specification.

7.2.6 Input power supply and battery backup for ZFAP shall be as per data sheet and as per clause 5.2 of this specification.

7.3 Repeat Alarm Panel-Conventional

7.3.1 Repeat fire alarm panel shall be provided for repetition of fire/fault annunciation of CFAP/ZFAP. Depending on the size Repeat Fire Alarm panel may be floor mounting type or wall mounting type. The display shall be similar to CFAP/ZFAP.

7.3.2 Where required, input power supply from Owner shall either be 240V or 110V, 1phase, 50Hz. It shall be possible to select supply either 240V or 110V at site without modifying or adding additional equipment in the panel.

7.4 Central Fire Alarm Panel

7.4.1 CFAP shall receive inputs from automatic and manual fire alarm devices and supply power to detection, notification and communication devices. Fire and fault annunciation for each Zone or group of zones at ZFAP shall be repeated at CFAP.

7.4.2 CFAP shall be in vertical panel construction or desk type construction as per datasheet having controls such as Accept, Test and Reset Push Buttons, Auto/Manual control of siren etc.

7.4.3 Unless otherwise specified in the data sheet, CFAP shall have mimic to display geographical location of fire. Mimic shall form an integral part of the CFAP and shall be located at the top of the panel. When separate mimic panel is specified, it shall either be wall mounting or freestanding floor mounted type. Two LEDs shall be provided for each zone on mimic panel for display of fire alarm. Mimic panel shall be powered by CFAP. Mimic made out of plastic stickers shall not be acceptable.

7.4.4 Input supply and battery backup for CFAP and MIMIC shall be as per data sheet and as per clause 5.2 of this specification.

7.4.5 Battery charger provided in the CFAP/ ZFAP shall be modular mounted on a draw out chassis. Charger module shall be located on the front allowing withdrawal with the help of handle bars for maintenance.

8.0 ANALOGUE ADDRESSABLE FIRE ALARM SYSTEM

8.1 Design Feature

8.1.1 Unless otherwise specified Microprocessor based FA system shall be analog addressable type. The system shall be integrated as per 'system architecture' indicated in data sheets/ drawings.

8.1.2 Fire alarm system shall be designed consistent with state of the art technology. All fire alarm panels including repeater panel shall be networked through data high way. The system supplied shall not pose any limitation for future expansion by way of networking of fire alarm panels, data transfer, parameterization of addressable field devices, graphic displays etc.

8.1.3 The system shall be modular and shall facilitate future extension/ modification. Panel design and component selections shall be done for future extension up to 10% of specified number of loops or one loop whichever is maximum in each panel. The design of common facility and hardware shall be provided for required future extension.

8.1.4 PCBs shall have watchdog feature for self-diagnostic. Each PCB shall have LED for annunciating card failure. Following self-diagnostic features shall be considered as minimum for the system.

i) Open loop detection
ii) Short circuit detection
iii) Earth fault detection
iv) Power supply failure e.g. low battery voltage, main incoming supply fail
v) System faults (PCB failure)

8.1.5 Unless specified otherwise in data sheet, system architecture shall have minimum redundancy indicated below at DGFAP & CFAP, however not limited to the same.

i) Redundant at processor level (communication processor and I/O card processor)
ii) Redundant communication port
iii) Redundant data highway cable. (For data highway ring topology will be preferred)
iv) Redundant microprocessor
v) Redundant work station/ HMI (engineering station+ operator's station)
vi) Redundant power supply card at all fire alarm panels (but with non-redundant battery backup)

8.1.6 Data highway shall be using Fibre optic or twisted pair shielded copper cable as specified in data sheets. Whether specified or not, data highway shall include all necessary hardware such as modem, repeaters, network switches/ hubs etc including power supply system as required to suit the length of data highway.

8.1.7 The communication shall be peer to peer between various DGFAPs, repeater Panels, CFAP and other system components connected on fire alarm system data highway.

8.1.8 Any fault in Analogue detector addressable loop (signaling loop/ circuit), notification appliance circuit and data highway shall not impair communication, i.e. Communication/ flow of analogue signal shall be possible from either end.

8.1.9 The loop cabling for wiring detectors and BGUs shall be class A, fault tolerant type as per NFPA 72.

8.1.10 Fire alarm logic shall be programmable type. The logic for zone protected with clean agent system/ CO_2, shall be programmed to provide output for actuation after ensuring that there is no false alarm using alarm verification feature. Similarly logic to switch ON sounders. Beacon and hooters shall be programmable type. Exit sign shall remain ON all the time.

8.1.11 The logic shall be so programmed that it will ensure silencing of the current alarm by ACCEPT push button & shall not prevent annunciation of subsequent fire alarm received from any other location.

8.1.12 Signal-to noise ratio shall be high to avoid spurious actuation due to noise induced in the field wiring because of proximity with power cables. Unless other wise specified, fire alarm cables laid in buildings shall be twisted pair, screened and unarmoured and shall be laid in conduits while cable laid outdoor in plant shall be twisted pair, screened and armoured. If required noise filters shall be provided at fire alarm panel.

8.1.13 Unless specified otherwise in data sheet, the minimum number of detectors/ BGUs/ addressable devices in a signal loop shall be 120.

8.1.14 Unless specified otherwise in data sheet, conductor size of loop cable shall be 1.5sqmm copper. The allowable signal loop length shall not be less than 2 km.

8.1.15 DGFAP and repeater panel shall have backlit alphanumeric LCD display to provide addresses and status of each field device. In addition LEDs shall be provided for fire/ fault visual annunciation. LED shall also be provided for Power supply healthy, Battery backup ON, Battery/ Charger status.

8.1.16 Fire station shall be provided with redundant PC(s) with monitors for operator's work station and for engineering station. Any of the two should be possible to configure as engineering station for programming off line. After Programming, the engineering station will be connected to network as online operator's workstation. Programming shall also allow activating Siren from the keyboard in manual mode as per operator's choice.

8.1.17 All field devices such as detectors and BGUs shall be addressable type. If available in vendor's design, hooters and exit signs may also be connected in addressable loop. Fault isolators shall be provided to minimize outage of number of detectors/ BGUs in case of loop cable fault. For hazardous area flame proof equipment shall be used. As far as possible, the use of intrinsically safe field devices in hazardous area should be avoided. If unavoidable, due care shall be taken care in design to avoid signal distortion and thus the mal-operation due to cable capacitance and inductance.

8.1.18 System shall provide adequate EEPROM size to store minimum of 200 events fire/ fault. The event shall be stored in LIFO structure. All events shall be time stamped. DGFAP shall have real time clock for event time stamping.

8.1.19 Software access for either Zone programming or access to plant/ building graphic on monitor shall be password protected. For viewing status of various field devices e.g. fire and fault status password protection shall not be given.

8.1.20 All Fire alarm panels including repeater panels and CFAP shall be certified/ approved by an international approving agency/ approving agency of country of origin as applicable.

8.2 Data Gathering Cum Fire Alarm Panel (DGFAP)

8.2.1 DGFAP shall have basic design features as per clause 8.1 above. Number of signal loops in each DGFAP shall be as defined in the data sheet/ drawings/ MR. Number of loops shall be basic part of main PCB and should not be extended by providing external electronic devices. LCD display and annunciation scheme shall be as per clause 7.1.10.

8.2.2 It shall be possible to change the reference value of detector sensitivity either manually or automatically as required during the operation to avoid false alarms prior to detector maintenance.

8.2.3 DGFAP shall have serial port for communication to data highway. It should be possible to communicate all the information to CFAP/ FA system work station located with fire marshal. The protocol of communication shall preferably be open protocol.

8.2.4 In the event of non-availability of data highway, DGFAP shall work as stand alone intelligent panel monitoring fire in the zones connected to it.

8.2.5 It shall be possible to configure DGFAP to access data of any other DGFAP and display as per the operation requirement to be finalized during engineering/ commissioning.

8.2.6 Where specified in MR/ data sheet, it shall be possible to interface with existing fire alarm system consisting of conventional zone detectors and BGUs with end of line resistor as a part of retrofitting.

8.2.7 DGFAPs shall have output relays to provide interface with Owner's system defined in clause 9.0 as minimum.

8.3 Repeat Alarm Panel

Repeat fire alarm panel shall be provided for repetition of fire/fault annunciation of CFAP/DGFAP. Depending on the size repeat Fire Alarm panel may be floor mounting type or wall mounting type. The display shall be similar to CFAP/ZFAP.

These panels shall be without loop cards and shall be connected to data highway through serial communication. Panels shall have programming facility to inhibit the display of information that is not required in a particular repeater panel.

8.4 CFAP with PC Based Monitoring Station or Work station

8.4.1 Vendor shall supply CFAP similar to DGFAP along with PC based work stations. Application software shall be installed in PC as Graphic User Interface. The graphic shall include geographical display of locations of various plant areas including locations of addressable detectors and BGUs. The navigation between various graphic pages shall be user friendly. Screen shall have defined area to display the latest fire or fault alarm and shall also have facility to pop up the graphic displaying the location of fire event.

Where specifically indicated CFAP shall include network PC based monitoring station based on vendor's system design directly connected to data highway with other peripherals such as network switches/ controller (HUB).

8.4.2 Unless stated otherwise, CFAP shall have all the features and facilities of the DGFAPs. It shall monitor the status of each addressable field device indirectly from the DGFAPs connected on data highway.

8.4.3 Engineering workstation shall be used for programming off-line. After programming, the changed parameters shall be down loaded to other PC to work in synchronism as normal operation. This station shall also have one laser printers connected to PCs working as engineering printer.

8.4.4 The monitoring station/work station shall be equipped to display the overall plot plan showing all MCPs along the unit roads. The display shall have three levels of penetration, which permits zooming on to any process unit/area or any building. Further one may zoom into specific rooms of the building and view the detectors below the false floor, above the false ceiling or in the room cavity. The CFAP shall also display the location of fire/ fault when such an event occurs.

8.4.5 Unless specified otherwise, adequately rated UPS with bypass shall be provided for the workstations and printers of CFAP. Battery backup shall be sized as per criteria given under 5.2. Only normal supply shall be made available at one point by Owner at the location of central fire alarm panel. Where both CFAP and PC based work stations are provided the battery back up time for the UPS shall be 30 min. Battery back-up to CFAP shall be as per clause 5.2.

8.4.6 It shall be possible to actuate plant-wide siren in auto/ manual mode. Unless other wise specified, manual actuation shall be done from keyboard of workstation. Auto actuation shall be through software logic, which shall be finalized with end user during implementation.

Auto/Manual selection shall be provided at operator's work station. The actuation signal under manual mode selection shall be communicated serially to DGFAP to which siren starter is connected. Siren starters shall be hardwired to DGFAP.

8.4.7 The minimum requirements for the PC and other peripherals shall be as stated below:

* Industrial type Latest generation PC
* DVD-RW
* Mouse and keyboard
* 29 Inch coloured LED monitor
* Engineering laser jet coloured printer with 8 PPM

*Application software supporting graphics with no limitation on number of graphics, events, alarms, number of field devices as required for any large plant like refinery, petrochemical complex or large multistory building.

8.4.8 It shall be possible to provide multilevel access of fire alarm system. Read only access shall not require password protection. Access for programming and access for controls from keyboard shall be password protected. The levels of password protection shall be agreed with plant operators at the time of commissioning of system.

8.4.9 **Printer**

Printer options shall include graphic laser printer. Printer used in the system shall provide real time records of the system events and provide system reports on demand, and shall be microprocessor controlled, high speed, read only (RO).

9.0 INTEGRATION WITH VARIOUS PLANT SYSTEMS

9.1 Fire Alarm System shall have required hardware to have interface with following plant systems as specified in data sheet via potential free contacts.

i) Public Alarm Announcement system
ii) Paging and plant communication systems
iii) Plant data network
iv) ISDN telephone exchange
v) Fire suppression system
vi) Clean agent system
vii) Fire & Gas detection system

9.2 Where ZFAP is required to carry out fire suppression functions, it shall be provided with the following interfaces with fire suppression system unless specified otherwise.

i) Automatic signal for release of clean agent/CO_2 release for protected area and RELEASE audio/ Visual alarm for evacuation.
ii) Selector switches for primary or secondary clean agent/CO_2 supply for each protected area.
iii) Manual push button for discharge of clean agent/CO_2 in each protected area. The actual release of clean agent/ CO_2 shall however be delayed by 30sec after the alarm.
iv) Clean agent/CO_2 Discharge inhibit push button for each protected area.
v) Deluge valve activation push buttons, deluge valve test push buttons and deluge valve activated status lamps.
vi) Firewater pumps start push buttons.
vii) Firewater pumps running indications.

viii) Shutdown signals to various air-handling units/Pressurization system relative to the zone of fire.

10.0 PANEL CONSTRUCTION (CFAP, DGFAP, ZFAP, REPEATER)

10.1 All fire alarm Panels shall be free standing, floor mounting type unless specified otherwise and shall be fabricated out of minimum 2mm thick CRCA sheets and doors shall be fabricated out of minimum 1.6mm CRCA sheets. The panel shall be naturally ventilated in IP-41 enclosure protection as minimum.

The colour shade of final paint shall be 536 as per IS: 5, unless otherwise specified.

10.2 Equipment Mounting

10.2.1 All apparatus, display screen, instruments and indicating lamps mounted on the panel front shall be flush mounting type. The external cabling shall not be terminated directly on the base connector of PCBs but shall be terminated on separate terminal block. Further connection to PCBs shall be as per manufacturer's standard. Routine calibration, adjustments, programming and operation shall be accessible from the front of the panel without opening the door. External cabling shall preferably be done from the rear.

10.2.2 Power supply system including VRLA battery bank shall be mounted inside the panel.

10.2.3 Doors shall be provided with pistol grip handle with lock. Lamps shall be provided inside the panel to provide adequate light for maintenance of equipment.

10.2.4 Cable entry shall be from bottom unless otherwise specified in the data sheet. Terminal strip shall be provided for incoming / outgoing cables.

10.3 Wiring and Terminals

10.3.1 Wiring within the panel shall be harnessed in slotted plastic raceways enclosed with cover. Control connections shall be done with 660V grade PVC insulated wires having stranded copper conductors. 1.5mm2 size of wire shall normally be used for circuits with control fuse rating of 10A or less. Control wiring for electronic circuits shall be through ribbon cable or through copper wire minimum of 0.5mm dia. Panels shall be supplied completely pre-wired, such that only field termination shall be required at site before it is energized.

10.3.2 PCBs for identical functions shall be interchangeable. PCBs shall be plug in type having pin/edge connectors. PCBs shall be suitable for use in tropical, humid and dusty environment. These shall be protected with anti fungus treatment.

10.3.3 Cables shall be terminated on terminal blocks. Clamp type terminals shall be of spring-loaded, stacking type, mounted on rails. Terminals shall be sized to accept, as a minimum 2.5mm2 cross section conductors. Not more than one conductor shall be terminated on the outgoing side of each terminal. At least 20 % spare terminals shall be provided in each panel for termination of spare cores of cables.

10.4 Earthing

A common earth bar of minimum 25 mm x 3 mm. copper or equivalent aluminum shall be provided throughout the length of the panel. All non-current carrying metallic parts of the panel-mounted equipment shall be earthed. Flexible jumpers shall connect all doors and movable parts to the earth bus. Two numbers earth lugs shall be provided outside the panel.

10.5 Name Plates / Warning plates

10.5.1 All nameplates for panel shall be engraved out of 3 ply (black-white- black) lamicoid sheets or anodized aluminum. Back-engraved Perspex sheet nameplates will also be acceptable. Engraving shall be done with square groove cutters. Hard paper or self-adhesive plastic tape nameplates shall not be acceptable.

10.5.2 Labels shall be provided for every component on the cards, connecting wires as well as for the terminals in the terminal strip inside the panel. Wiring diagram shall be pasted inside the panel door as required for termination and maintenance.

10.5.3 Special warning plates shall be provided on all removable covers or doors giving access to energized metallic parts above 24 volts.

10.6 Painting

10.6.1 All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The undersurface shall be made free from all imperfections before undertaking the finishing coat.

10.6.2 After preparation of the undersurface, the panel shall be powder coated. The colour shade of final paint shall be as approved by the Owner. The finished panels shall be dried in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, run-off paint etc.

10.6.3 All unpainted steel parts shall be zinc passivated or suitably treated to prevent rust-corrosion. Moving elements shall be greased.

11.0 CABLE AND CABLE ACCESSORIES

11.1 Supply and laying of FA cables shall be as per the requirement specified in the MR/data sheet. Vendor shall provide JBs for detectors, BGUs, exit signs, hooters etc.

11.2 Where supply and installation of field cabling is excluded from vendor's scope, terminations of all cables (supplied by both vendor/ Owner) at both ends shall be in vendor's scope.

11.3 Bidder, as a part of integration and selection of fire alarm equipment, shall furnish detailed specifications for loop/zone cables, data highway cables, cables for hooter/exit signs etc giving details such as type of cables, number of pairs, size of cable, inductance and capacitance data, number of fibres/ connectors etc.

11.4 Data Highway Cables

11.4.1 Unless specified otherwise, vendor shall supply Copper cable/ FO type data highway cable to suit system design and equipment specification. Copper cables, if supplied, shall be of adequate size, twisted pair, PVC insulated, overall screened, PVC inner sheathed, armoured, FRLS type PVC outer sheathed as the minimum requirement. Fibre Optic cables, if supplied, shall be armoured, overall FRLS PVC outer sheathed and shall be as per ITU-T recommendation as a minimum.

11.4.2 Vendor shall supply and install all hardware and cabling accessories as per data high way design including modems, repeaters etc as part of the Fire Alarm system. Modems/ repeaters shall be powered by the supply provided for DGFAPs / CFAP.

11.5 Cable Glands / Accessories

11.5.1 All cable glands/ lugs/ connectors as required for the equipment shall be included in vendor's scope and shall be supplied along with the system, irrespective of whether installation is to be performed by vendor or not.

11.5.2 All the cable glands for outdoor application shall be weatherproof, nickel-plated brass and double compression type, whereas those for indoor application shall be single compression type.

11.5.3 Cable glands for hazardous area equipments shall be flameproof, weatherproof and nickel-plated brass double compression type.

12.0 AUTOMATIC FIRE DETECTORS AND ACCESSORIES

12.1 General Specifications

12.1.1 Detectors for conventional fire alarm system shall be conventional type. End of line resistor shall be provided at the last detector in the zone. Detectors for microprocessor based Analogue addressable FA system shall be addressable type. Detectors shall be plug-in type and shall have twist lock action fitting. Multi-colour LEDs provided on the detectors shall indicate Normal and Alarm state. Essential features of detectors are indicated as below.

12.1.2 Detectors shall be supplied with mounting bases. Mounting base shall be identical for all type of detectors except special application detectors such as linear beam detectors etc. for installation as well as cable connection. Detector housing (body and cover) shall be made up of damage resistant, fire resistant polycarbonate and shall be suitable for either surface or recess mounting. Detector base shall be mounted on Junction boxes having terminals for cable termination. Where installation is included in vendor's scope, all necessary installation materials shall also be included in vendor's scope.

12.1.3 Detectors shall be suitable for storage at ambient condition specified in data sheet.

12.1.4 All detectors shall be on the approved list of LPC, UL / FM/ equivalent international approving agency as applicable.

12.1.5 All detectors shall be suitable for operation at DC power supply extended from fire alarm panel.

12.1.6 The addressable detectors shall be continuously monitored to measure changes in their sensitivity due to the environment (dirt, dust, temperature, humidity etc.). These detectors shall give an advance indication to the panel regarding the need for maintenance. The analogueue reading sent by the detectors shall be sensed and if there is a rapid increase, an alarm shall be generated. However, if there is a gradual increase in the analogueue reading, a maintenance alert shall be generated by the fire alarm panel. It shall be possible to generate maintenance reports from the fire alarm panel. For the addressable detectors two-wire operation shall be possible.

12.1.7 All addressable detectors shall have selectable settings for pre-alarm and alarm and preferably have the facility to set the sensitivity and address from the fire alarm panel.

12.1.8 Break glass units for microprocessor based fire alarm system shall be addressable type. Each device shall have its own address module.

12.1.9 All addressable detectors shall be suitable for installation using fault tolerant wiring (class-A, style - 6 wiring as per NFPA72). T- Tapping shall not be permitted in the case of such wiring.

12.1.10 All detectors must have insect screen to prevent insect entry and cause false alarm.

12.1.11 All field devices shall be from the latest generation in the manufacturer's range of products. Commonly used field devices are listed below. The specification given shall be considered as minimum requirements.

12.2 Heat Detectors

12.2.1 Heat detectors shall use negative temperature coefficient thermisters for sensing and for reference. The detector shall be designed to give a response that depends on both absolute temperature and rate of rise in temperature.

12.2.2 The rate of rise element shall be carefully calibrated to ignore any normal fluctuation in temperature, but to respond quickly when the temperature rise is 9°C or more per minute.

12.2.3 The fixed temperature feature should be entirely independent of the rate of rise element. The operating temperature of fixed temperature element should be factory set at 57° C ± 5° C.

12.2.4 The detector shall be self-restoring type ensuring repeated use and easy maintenance.

12.3 Multi Sensor (Detector)

12.3.1 Multi sensor shall have combined & individual features of smoke detector and thermal sensor (heat detector). Smoke activity shall be monitored by photoelectric sensing technology in a single detector / base assembly. Heat detection shall be fixed with selectable rate of rise settings. Multi sensor detectors shall be able to generate multiple alarm signals from any of the sensors (smoke or heat) employed in design independently or in combination. Detectors shall be analogueue addressable.

12.3.2 The detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion like wood, paper, ammonia processing paper, cloth, PVC, bakelite, nylon, foam, acrylic, thermocol, Photo film, nylon, polyester, painted sheets, Teflon, leather etc.

12.3.3 The sensitivity of the detector shall not vary with change in ambient temperature, humidity, pressure or permissible voltage variation. Its performance shall not be affected by an air current of 5 m/sec. It shall have an inbuilt arrangement such that puffs of smoke or hot air pockets do not inadvertently trigger the alarm. The detector shall be protected against dust accumulation/ ingress. It shall have insect resistant screen to prevent nuisance alarms.

12.3.4 In recess above ceiling designed to handle return air for HVAC, it shall be ensured that detectors are compatible to air velocity. Where air velocity is expected to be too high for the detectors to function normally, smoke guard/ baffle shall be used as per requirement.

12.4 UV Flame Detector

12.4.1 UV flame detectors shall work on the principle of a vacuum photodiode tube to detect the UV radiation that is produced by a flame.

12.4.2 UV flame detectors shall respond to ultraviolet rays of a flame. The detector shall not be actuated by artificial lights, sunlight incident through a windowpane or welding arc. False

alarm check circuit shall be incorporated to prevent false alarm due to intermittent flash or lightning.

12.5 IR Detectors

12.5.1 IR detectors shall work on the principle of a single wavelength infrared flame detector using one of several different photocell types to detect the infrared emissions in a single wave length band that are produced by a flame.

12.5.2 IR detectors shall react to the infrared rays of a flame. It should be sensitive enough to detect smoky fires in which flame is hardly recognizable. The detector should not react to extremely glaring artificial light or direct sunlight. The detector shall be completely solid-state type.

12.5.3 Where specified combination UV-IR detector shall be used.

12.6 Linear Beam Detector

12.6.1 Linear beam detector shall work on the principle of obscuration of infrared light beam by particles of smoke. The sensitivity shall be such as to enable operation at 30% to 50% obscuration.

12.6.2 Linear beam detector shall consist of transmitter and receiver. Linear beam detector shall be suitable for application in high roofed locations (10 m & above) such as warehouses, pressurization room, transformer room (if required) etc. The detector shall, preferably, be powered from the loop signal itself. However, if external power supply is required the same shall be explicitly stated by the vendor, which shall be covered under common power supply for the fire alarm panel and devices connected with it.

12.7 Heat Sensing Cables

Heat sensing cable shall be analogueue type. It shall consist of four copper conductors, each covered with a colour coded, negative temperature co-efficient material. The cores shall be twisted together and protected by an outer sheath of high temperature, flame retardant PVC insulation. External mechanical protection shall be provided over the sensor cables. Vendor shall provide control unit for each 100 m length of the sensor cable.

12.8 Break Glass Unit (BGU)

12.8.1 Manual break glass unit shall be fabricated out of 14-gauge cold rolled sheet steel. Alternately the break glass unit may be made of die cast aluminum alloy such as LM6. It shall have IP-55 enclosure and weatherproof construction suitable for outdoor installation. The break glass unit shall have a minimum dimension of 100x100x80mm.

12.8.2 The box shall be fabricated in such a way it can be mounted flush to the wall or on the surface without any modification. Two nos. 19 mm knockouts shall be provided at the bottom of the box to facilitate cable / conduit entry. The glass shall cover at least 30cm² area and shall have a thickness not exceeding 2mm.

12.8.3 The box shall have a push button element kept in pressed condition by a glass sheet fitted in the front of the box.

12.8.4 The enclosure shall be painted with fire red colour (shade 536 of IS-5) epoxy painting and an inscription " Break Glass in case of Fire", shall be painted in white letters or riveted on the enclosure by a steel nameplate. A suitable nickel-plated brass hammer, duly chained to the box with stainless steel chain shall be provided with each box for breaking the glass. Each box shall have a distinct identification number boldly painted on it.

12.8.5 One No. blanking plug shall be provided for 5% of the total quantity of MCPs. MCPs for outdoor installation shall be complete with FRP canopy.

12.8.6 Hazardous area Break Glass Units shall meet the requirement of clause 13.0 of this specification.

12.9 Response Indicator

12.9.1 If specified in the data sheet, response indicators shall be provided suitable for wall/ ceiling mounting. Response indicator shall be provided where the detector is located either above false ceiling or below false floor or where detectors are not directly visible. The response indicators shall be connected to the detectors directly and shall be complete with terminal blocks suitable to accept cables with up to 1.5mm² copper conductor. In the normal state of detector, the LED shall flicker, but in the event the detector goes into alarm condition, the LED shall glow steadily. LEDs shall be red in colour with 5mm dia. as a minimum.

12.9.2 Use of Response indicators in addressable system is not envisaged unless otherwise specified in data sheet.

12.10 Exit Signs

12.10.1 Exit signs shall be fabricated out of 1.6mm thick cold rolled sheet steel. This shall be suitable for wall mounting or suspension from ceiling. Exit signs suspended from the ceiling shall have text/ direction printed on both the side of exit sign.

12.10.2 Fire exit shall be displayed by means of 5mm dia LEDs or backlit text. It shall be powered from the fire alarm panel. Exit sign shall operate on DC power supply.

12.10.3 The exit sign shall be either in red letters on white background or white letters on green background.

12.10.4 Where specified in data sheet, self-luminous exit sign shall be provided.

12.11 Hooters

12.11.1 The unit shall consist of solid-state circuitry on a printed circuit board, a loudspeaker and a flashing lamp housed in a weatherproof dust tight, wall mounting type enclosure. The hooter shall, at least, have 102 db (A) output measured at 1-meter distance. The unit shall be powered from the fire alarm panel and operate on DC power. In the event of fire, the hooter shall raise pulsating audio alarm and the lamp shall start flashing.

12.12 Flashing Lights (Beacon)

12.12.1 The unit shall consist of solid-state circuitry on a printed circuit board and a red-capped incandescent lamp and audio unit housed in a dust tight, wall/ ceiling mounting type enclosure. It shall derive power from the DGFAP/ ZFAP and shall operate on DC supply.

12.12.2 Flashing lights shall be installed in the enclosed areas where clean agent/ CO_2 is to be released. In the event a signal for clean agent/CO_2 release is given, the lamp shall start

blinking with a warning sound enabling operating personnel to evacuate the area. The audio unit (hooter) shall have 102 db (A) output measured at 1-meter distance.

12.13 Clean Agent / CO_2 Release and Inhibit Switches

12.13.1 This unit is required to be provided at the exit of the protected buildings/ rooms. If specified, this unit is integrated with DGFAP/ ZFAP. This shall consist of pull type release and inhibit switches clean agent / CO_2. The unit shall be fabricated out of 2mm thick cold rolled sheet steel suitable for wall mounting. Switches shall be pulled to release or inhibit clean agent / CO_2.

Release switches shall have inscription:
"PULL TO RELEASE CLEAN AGENT / CO_2"
And inhibit switches shall have inscription:
"PULL TO INHIBIT CLEAN AGENT / CO_2".

12.14 Zener Barrier

12.14.1 Preferably flameproof (Ex 'd') equipment that does not require the use of Zener barrier shall be used. When necessary, intrinsically safe (Ex 'i') detectors and BGUs, Zener barriers shall be provided. These shall be located in unclassified/ non-hazardous areas.

12.14.2 Normally not more than 10 detectors shall be connected to one zener barrier. However vendor shall indicate maximum number of detectors/ BGUs that can be connected to one Zener barrier without compromising on working of loop/ zone. Vendor shall also indicate the maximum loop length from zener barrier considering 1.5 mm^2 copper conductor screened cable.

12.14.3 In case loop length permits, zener barrier shall be located at DGFAP itself, else it shall be located in safe area nearest to the detector/ BGU.

12.14.4 Wherever zener barriers are provided in safe area outside the Zonal panel or DGFAP, these shall be housed in their own enclosure with IP-55 degree of protection as a minimum.

12.15 Fault Isolator

12.15.1 Fault isolator shall be installed, if specified in the data sheet.

12.15.2 Fault isolator shall be designed to provide short circuit protection to an addressable detector loop. It shall be possible to wire the fault isolator at any point in the detector loop.

12.15.3 On occurrence of a fault (short circuit), the isolator shall cut power to all devices installed between the two isolators minimizing the outage of all the detectors in a loop.

12.15.4 The fault isolator shall have the capability to continuously check the faulted side of the loop to determine if the fault still exists. On rectification of the fault, the isolator shall automatically reset itself.

12.15.5 Fault isolator modules shall be housed in a enclosure having IP-55 degree of protection as a minimum. If located in hazardous area, it shall also be tested and approved for use in area classification defined in the data sheet.

12.16 Sirens

12.16.1 Sirens shall be industrial type with minimum 2.5 km unidirectional range (i.e. 5 km diametrical range) against the wind direction.

12.16.2 The decibel level of the siren shall, at least be 132db(A) at 1 meter, to meet the audibility requirement for the above range. Unless otherwise specified, Sirens shall operate preferably at 110/230V AC supply. Sirens shall be housed in weatherproof enclosure. Starter shall be DOL and shall be housed in a separate IP55 enclosure suitable for installation indoor/ outdoor.

12.16.3 The siren shall provided with five tones suitable for various conditions as follows

i) SMALL FIRE: No siren

ii) MAJOR FIRE: A wailing siren for two minutes.

iii) DISASTER: Same type of siren as in case of Major Fire but the same will be sounded for three times at the interval of one minutes i.e.(wailing siren 2min + gap 1 min + wailing siren 2min + gap 1min + wailing siren 2min) total duration of Disaster siren to be eight minutes.

iv) ALL CLEAR (For fire): Straight run siren for two minutes.

v) TEST: Straight run siren for two minutes at frequency atleast once a week.

12.16.4 The siren controller shall be as below

i) The operation of siren shall be in Manual mode with single button operation through Push Buttons – 5 Nos. mounted on the control desk for tone selection.

ii) The siren shall be initiated with a single pulse from the Push Button. The logic shall be such that first Push Button pressed shall be accepted till the completion of cycle of that particular siren tone.

iii) One no Push Button shall be provided for EMG STOP in case the siren tone is required to be stopped mid way.

12.16.5 The operation of the siren shall also be possible in Auto mode. The programming for the same shall be possible from the DGFAP/CFAP.

13.0 FIELD DEVICES FOR HAZARDOUS AREA

13.1 Hazardous area is classified as Zone 1/ Zone 2, gas group IIA/ IIB or IIC, temperature class T3 (200 ^{0}C) as specified in data sheet. The field devices shall be suitable for installation in hazardous area as per specified area classification.

13.2 Field devices such as detectors, BGUs, fault isolators, Beacons, hooters etc for use in hazardous area, if specified in the data sheet, shall have flame proof enclosure conforming to IS/IEC 60079. All equipment for hazardous area installation shall be complete with flame proof weather proof cable glands as specified in clause 11.5.

13.3 Equipment, which cannot have flameproof construction, shall be intrinsically safe in design and shall be used with Zener barriers located in safe area.

13.4 Equipment that are tested / certified by a recognized test laboratory of country of origin shall only be offered. The vendor shall possess valid test certificate issued by a recognized independent test house such as CIMFR/ BASEEFA/ UL/ FM or Equivalent for the offered equipment.

13.5 All equipment (indigenous or imported) shall have valid statutory approval as applicable for the specified hazardous location from PESO or any other applicable statutory authority. All indigenous flameproof equipment shall also have valid BIS license and corresponding marking as required by statutory authority.

13.6 A separate name plate shall also be provided on each equipment to indicate details of testing agency, test certificate number with date, statutory approval number with date, approval agency, BIS license number with date, applicable gas group, temperature class etc. The name-plate shall be riveted/ fixed with screws and not pasted. In case above information are embossed on the enclosure, the same need not be repeated.

14.0 ENGINEERING REQUIREMENTS

Unless specified otherwise, vendor shall design entire fire alarm system including design of system architecture with details of integration, cabling requirement and protocol selection etc. Vendor's scope shall also include basic design and preparation of layouts for fire alarm system for plant/ buildings if specified in the data sheet/ purchase documents.

14.1 Conventional Fire Alarm System

i) For conventional fire alarm system, Owner shall provide typical block diagram. On this basis, vendor shall prepare detailed drawing giving various system component details. The design and engineering shall include sizing and selection of various equipment such as fire alarm panels, batteries, battery chargers, field equipments, siren/ siren starter etc. including preparation of General Arrangement drawings of various equipment.

ii) The layout engineering for buildings shall include the drawings showing location of BGU/ Detector and other field devices, cable schedules, interconnection diagram, equipment installation drawings etc as minimum.

14.2 Addressable Fire Alarm System

i) Vendor shall develop a system architecture based on Owner's requirement showing details of various network elements such as DGFAP, CFAP, Work station, networking hardware, redundancy, protocols, data highway etc. including the maximum permissible loop length and length of data highway.

ii) The design and engineering shall include sizing and selection of various equipment such as fire alarm panels, batteries, battery chargers, field equipment, siren/ siren starter etc. including preparation of General Arrangement drawings of various equipment.

iii) The layout engineering for buildings shall include the drawings showing location of BGU/ Detector and other field devices, cable schedules, interconnection diagram, equipment installation drawings etc. as minimum.

iv) The "Cause & effect" diagram of the system shall be developed by vendor during detail engineering, in consultation with client.

v) The parameterization facilities of various field devices along with the geographic mimic, annunciation, text messages etc shall be available on the fire alarm panel.

15.0 INSPECTION, TESTING AND ACCEPTANCE

15.1 All the equipment shall be tested to the defined specifications as per mutually agreed test plan/ FAT procedure, which shall be submitted and got approved from Owner at least one month before inspection. EIL/ Owner's inspectors shall witness all the tests.

15.2 During manufacture, the equipment shall be subject to inspection as per agreed inspection plan to assess the progress of work and to ascertain that the quality controls are being maintained. Vendor shall provide all necessary assistance and information concerning the supply to EIL/Owner's inspectors.

15.3 Tests shall be carried out at the vendor's works under his care and expense and Owner shall be informed at least 4 weeks in advance regarding this.

15.4 FAT shall include simulation of operational field conditions and test for functional adequacy besides all routine and acceptance tests specified by applicable codes and standards.

15.5 For bought out items, the routine and acceptance tests shall be conducted at the respective equipment manufacturer's works.

15.6 At the time of inspection, vendor shall produce original of all the type test certificates, test and approval certificates for hazardous area equipment from testing and approving authority and any other certificates as required from statutory authority for the review of inspectors.

15.7 Vendor shall submit a SAT procedure for EIL/ Owner's approval. All equipment and systems shall be tested at site as per the approved SAT procedure

15.8 SAT shall be conducted by vendor after the entire fire alarm system is installed and inter connected by cables. These tests shall establish the operational correctness of the system. Vendor shall rectify deficiencies noticed during SAT with no commercial implication to Owner including replacement of system components and supply of new component for making system successfully operational.

16.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The panels shall be wrapped in polythene sheets before being placed in crates to prevent damage to finish. Crates shall have skid bottom for handling. Special notations such as `Fragile', `This side up', `Center of gravity', `Weight' etc., shall be clearly marked on the package together with Tag nos., Purchase order Nos. etc.

The equipment may be stored outdoors for long periods before erection. The packing shall be completely suitable for outdoor storage in areas with heavy rains/ high ambient temperature.

17.0 INSTALLATION AND COMMISSIONING

Where installation of the system is included in the scope of the vendor, vendor shall arrange all necessary manpower and equipment required for the same. Commissioning of the complete system is to be carried out by vendor in all cases irrespective of whether the installation was performed by vendor or not. All tools, test equipment etc. for the successful commissioning of the system shall be arranged by the vendor at his own cost. Only the cabling specifically excluded from vendor's scope shall be installed by others. However, termination at panels for Owner's cables shall be done by the vendor.

1.0 SCOPE

This specification along with the applicable project design data sheet shall form the basis for developing detailed design and engineering for electrical facilities including electrical power system, Electrical equipment, Electrical control system, Plant communication system, Fire detection and alarm system and electrical installation etc.

2.0 CODES AND STANDARDS

The main codes and standards, considered as minimum requirements, as applicable, are as mentioned below. Latest version of these shall be followed:-

IS-1646	:	Code of practice for the fire safety of buildings - Electrical Installations
IS-2189	:	Code of practice for selection: installation and maintenance of automatic fire detection and alarm system
IS-2309	:	Code of practice for the protection of buildings and allied structures against lightning
IS-3034	:	Code of practice for fire safety of industrial buildings - Electrical generating and distributing stations
IS-3043	:	Code of practice for Earthing
IS-3646	:	Code of practice for Interior Illumination
IS-3716	:	Application guide for Insulation Coordination
IS-4051	:	Code of practice for installation and maintenance of electrical equipment in mines
IS-5216	:	Recommendation on safety procedures and practices in electrical work
IS-5571	:	Guide for selection and Installation of electrical equipment for hazardous areas (Other than mines)
IS-5572	:	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installations
IS-6665	:	Code of practice for Industrial Lighting
IS-7689	:	Guide for Control of undesirable static electricity
IS-7752	:	Guide for improvement of power factor in consumer installations
IS-8478	:	Application guide for on load tap changers
IS-9676	:	Reference ambient temperature for electrical equipment
IS-10028	:	Code of practice for selection, installation and maintenance of transformer
IS-10118	:	Code of practice for selection, installation and maintenance for switchgear and control gear
IS-10561	:	Application guide for Power Transformer
IS-12360	:	Voltage bands for electrical installations including preferred voltages and frequencies
IS-13234	:	Guide for short circuit calculations in three phase AC systems
SP-30	:	National Electrical Code (NEC) - BIS Publication
OISD-RP-110	:	Recommended practices on static electricity
OISD STD-113	:	Classification of Area for electrical installation at Hydrocarbon processing and handling facilities
OISD-RP-147	:	Inspection and safe practices during electrical installation
OISD RP-149	:	Design aspects for safety in electrical systems

OISD STD 173	:	Fire Protection System for Electrical Installations
OISD GDN-180	:	Lightning Protection
IS/IEC 60079-0	:	Electrical apparatus for explosive gas atmospheres – General requirements.
IS/IEC 60079-1	:	Explosive Atmospheres: Equipment protection by flameproof enclosures "d"
IS/IEC 60079-2	:	Explosive protection by pressurized enclosures "p"
IS/IEC 60079-5	:	Explosive Atmospheres: Equipment protection by powder filling "q"
IS/IEC 60079-6	:	Explosive Atmospheres: Equipment protection by Oil immersion "o"
IS/IEC 60079-7	:	Explosive Atmospheres: Equipment protection by increased safety "e"
IS/IEC 60079-11	:	Explosive Atmospheres: Equipment protection by intrinsic safety "i"
IS/IEC 60079-15	:	Electrical apparatus for explosive gas atmosphere – Construction, test and marking of type of protection ``n" electrical apparatus
IS/IEC 60079-20	:	Electrical apparatus for explosive gas atmosphere: Data for flammable gases and vapours relating to the use of electrical apparatus.
IS/IEC 61241-0	:	Electrical apparatus for use in the presence of combustible dust: General Requirements
IS/IEC 61241-1	:	Electrical apparatus for use in the presence of combustible dust: Protection by enclosure "tD"
IS/IEC 61241-2-1	:	Electrical apparatus for use in the presence of combustible dust: Test Methods – Methods for determining the minimum ignition temperature
IS/IEC 61241-2-3	:	Electrical apparatus for use in the presence of combustible dust: Test Methods – Methods for determining minimum ignition energy of dust/ air mixtures.
IS/IEC 61241-10	:	Electrical apparatus for use in the presence of combustible dust: Classification of area where combustible dust may be present.
IS/IEC 61241-14	:	Electrical apparatus for use in the presence of combustible dust: Selection and Installation
IS/IEC 61241-18	:	Electrical apparatus for use in the presence of combustible dust: Protection by encapsulation mD

3.0 STATUTORY REQUIREMENTS

The latest version of the following statutory regulations shall be followed for design of electrical system, as applicable for the particular project/ industry.

- Indian Electricity Act.
- Central Electricity Authority Regulations.
- The Factory Act.
- The Petroleum Rules.
- The Mines Act.
- Requirements of other statutory bodies as applicable, e.g. CEA/ State Electrical Inspectorate, PESO, DGMS.

4.0 SYSTEM DESIGN PHILOSOPHY

4.1 General

The electrical system shall be designed to provide:

- Safety to personnel and equipment both during operation and maintenance.
- Reliability of Service.
- Minimal fire risk.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relaying system.
- Electrical supply to equipment and machinery within the design operating limits.
- Adequate provision for future extension and modification.
- Suitability for applicable environmental factors.

4.2 Area Classification and Equipment Selection

4.2.1 All the areas within the battery limits shall be classified for the degree and the extent of hazard from flammable materials. Classification of hazardous areas shall be done in accordance with Petroleum Rules, DGMS regulations (where applicable), IS-5572, IS-61241-10, OISD standards and Process Licensors recommendations.

4.2.2 Following factors shall be considered for proper selection of electrical equipment for use in hazardous area:

- Area classification i.e. Zone.
- Gas classification i.e. Group - The characteristic of the minimum gas or vapour involved in relation to the ignition current or minimum ignition energy and minimum safe gap data.
- Dust classification i.e. Group - The characteristic of the dust involved.
- Temperature classification - The ignition temperature of the gas, vapour or dust involved or the lowest value of the ignition temperature if more than one combustible material is present.
- Environmental conditions in which apparatus is to be installed - The selected electrical apparatus shall be adequately protected against corrosive and solvent agencies, water ingress, thermal and mechanical stresses as determined by the environmental conditions.

4.2.3 All electrical equipment installed in hazardous areas shall be selected as per IS-5571 and IS-61241-14 and shall meet the requirements of relevant IS and Statutory regulations. Ordinary industrial electrical equipment (even though permitted for use in Div.2 area as per NFPA-70) shall not be used in Zone-2 areas. Type of hazardous area protection to be used for individual equipment shall be as specified in the project design data sheet.

4.2.4 Electrical equipments for hazardous areas shall be certified by CIMFR/ ERTL/ Karandikar Lab or equivalent recognised independent test house such as BASEEFA / ATEX/ LCIE / PTB / UL / FM. All equipment (indigenous and imported) shall also have valid statutory approvals i.e. PESO/ DGMS as applicable for use in the specified hazardous area. All indigenous flameproof equipments shall have valid BIS license and marking as required by statutory authorities.

4.3 Power System Design

The distribution system shall be designed in accordance with project specification/ design data taking into account all possible factors affecting the choice of the system to be adopted

such as required continuity of supply, flexibility of operation, operational costs, and reliability of supply from available power sources, total load and the concentration of individual loads.

Special attention is drawn to chapter IX of CEA regulations, which includes requirements for design of electrical system as applicable to Mines and oil fields installation.

4.4 Capacity of Electrical System

All the components of the electrical system shall be sized to suit the maximum load, under the most severe operating conditions. The amount of electrical power consumed by each process unit shall be calculated for its operation at the design capacity. System design shall permit direct on line starting of all motors unless specified otherwise. Sizing factors for normal loads, intermittent loads and standby loads shall be considered as mentioned in project design datasheet.

4.5 System Voltages

System voltages shall be as defined in project design data sheet.

4.6 Voltage Drops

4.6.1 The maximum voltage drops in various sections of the electrical system under steady state conditions at full load shall be within the limits stated in the following table:

Sl. No.	System Element	Maximum Permissible Voltage Drop
a)	Cable between transformer secondary and Switchboards	0.5%
b)	Cable between PCC/PMCC and MCC or auxiliary switchboard i) MCC /Auxiliary Switchboard near PCC/PMCC ii) MCC/Auxiliary Switchboard situated remote from PCC/PMCC	 0.5% Note-3b 2 to 2.5% Note-3a
c)	Cables between HV Switchboard and HV Motor	3%
d)	Cable between PCC/PMCC and motor	5.5%
e)	Cable between MCC (situated near PCC / PMCC) and motors	5%
f)	Cable between MCC (situated remote from PCC / PMCC) and motors	3%
g)	Cable between Auxiliary Switchboard / LDB and Lighting Panel/ Power panel	1 to 1.5% (Note- 2)
h)	Circuit between lighting panels and lighting points	4% (Note- 2)
i)	DC Supply Circuit (Electrical Controls)	5%
j)	DCDB to Control Room	2% (Note -1)
k)	UPS outgoing circuit	5% (Note - 1)

Note-1

Minimum voltage available across any instrument in the field/ control room/ Satellite rack room shall be as per instrumentation design basis. Distribution system for instrumentation supplies shall be designed accordingly. In case of any conflict between electrical project

design data sheet and instrumentation design basis, the latter shall govern regarding instrumentation power supplies.

Note-2

In case of difficulty in achieving specified voltage drops in cables up to lighting panel, 5% drop from Auxiliary switchboard/ LDB up to lighting points may be permitted.

Note-3

a) Higher voltage drop may be permitted between PCC / PMCC and remote mounted MCC/ASB, if overall voltage drop up to motor (from PCC / PMCC) is limited within 5.5%.

b) For large substations 1% drop may be permitted.

4.6.2 The maximum voltage drop at various buses during start-up of large motor and/or motor reacceleration conditions shall be within the limits stated below:

S. No	System Element	Operating Condition	Max. Permissible Voltage Drop
a)	At the busbars of the worst affected Switchboard	Start -up of the large HV motor with other loads on the bus or reacceleration of a group of HV motors (Simultaneous start-up or group reacceleration of HV motors is not envisaged)	15 %
b)	At the busbars of the worst affected MV Switchboard (PCC/PMCC/MCC)	Start up of large MV motor with other loads on the bus, or reacceleration of a group of MV motors.	10 %
c)	Cables between HV Switchboard and motor	Motor start-up or reacceleration	5 % (Note-a)
d)	Cables between MV switchboard (PCC/PMCC/MCC) and motor	Motor start-up or reacceleration	15 % (Note-a)

Notes:

a) Higher voltage drop in motor cables may be permitted, in case the conditions given in Note b), c) and d) are complied.

b) The voltage available at the motor terminals during start-up must be sufficient to ensure positive starting or reacceleration of the motor (even with the motor fully loaded, if required), without causing any damage to the motor.

c) For medium voltage motors, the voltage available at the motor terminals must not be less than 75% of the rated value during start-up or reacceleration.

d) For high voltage motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or reacceleration.

4.7 System Earthing

System earthing for incoming supply and primary/secondary EHV/ HV distribution system shall be as per project design data. The 415V system neutral shall be solidly earthed.

4.8 Short Circuit Capacities

Each short circuit interrupting device shall be designed to have rated short circuit breaking capacity and making capacity equal to or higher than the maximum value of short circuit current (rms) and peak value of short circuit current respectively, calculated at its location. The related switchgear and bus-ducts shall withstand the above maximum available fault current for a minimum period of one second. The minimum size of conductor & metallic screen of high voltage cables and extra high voltage cables shall also be based on the short circuit withstand capacity for a minimum time period as dictated by the protection system and defined in project design data sheet.

4.9 Insulation System

The insulation of electrical facilities shall be designed considering the system voltage, the system neutral earthing and the over voltages resulting due to system fault, switching or lightning surges. Lightning arresters and surge absorbers shall be provided where necessary.

4.10 Protection and Metering Schemes

4.10.1 The protective system shall be selected and coordinated to ensure the following:

a) Protection of equipment against damage, which can occur due to internal or external short circuits or atmospheric discharges.
b) Uninterrupted operation of those parts of the system, which are not affected by the fault.
c) Personnel and plant safety.

4.10.2 Protection relays shall be provided as specified in project design data sheet.

4.10.3 Metering shall be provided to keep a record of power consumption and supervision of all concerned parameters like current, voltage, power, frequency, power factor etc. as specified in project design data sheet.

4.11 DC Power Supply

Independent DC power supply systems shall be provided for the following (unless otherwise specified):

- Plant shutdown system including DC instrumentation (if required, as per instrumentation design basis).
- Electrical switchgear controls including critical lighting.

4.12 Emergency Power Supply

The emergency power supply system, wherever envisaged and required as per project design datasheet, shall feed the following:

- Electrical loads essential for the safe shutdown of the plant.
- Emergency lighting.
- Communication system.
- Fire detection and alarm systems.
- D.C. Supply systems.
- UPS Systems.
- Fire fighting equipment excluding main firewater pump.
- Loads critical for process, plant and personnel safety.

Emergency power supply could be from a different power source or Emergency Generator as per Project design data sheet. Where Emergency Generator is envisaged, emergency power supply shall be made available within a time period of 30 seconds from the instant of failure of normal supply.

The emergency generator shall, generally, not be required to run continuously in parallel with the normal power supply system. However, short time paralleling facility shall be provided for transferring load to normal power supply or other operational needs e.g. periodic testing etc. as required.

4.13 Uninterrupted Power Supply (UPS)

Uninterrupted power supply system shall be provided, (as required) for meeting critical loads that cannot withstand a momentary interruption in voltage (e.g. critical instrumentation, control, HMI for substation automation system, ECS, communication system, LAN system, and process loads, as defined in project design data sheet).

4.14 Power Factor Improvement

Capacitor banks shall be provided, as specified in Project design data sheet, to improve the power factor to meet the minimum stipulated power factor by the power supply authorities. Automatic power factor correction shall be provided, if specified in project design datasheet.

4.15 Plant Communication System

4.15.1 It shall consist of the following:

- Central exchange(s)/ Distributed intelligent nodes.
- Master control station(s) with inbuilt loudspeaker, microphone etc.
- Desk type call stations with inbuilt microphone, loudspeaker for installation in buildings.
- Wall/column mounting type call stations for hazardous/safe areas with external loudspeaker as per Operational requirements.
- Flashing beacon for noisy areas.

4.15.2 Each exchange/ distributed intelligent node shall be designed to have at least 10% spare capacity.

4.16 Fire Detection and Alarm System

4.16.1 The Fire Detection and Alarm System shall be an independent system comprising of individual break glass type manual call points, automatic sensors e.g. smoke/heat detectors, hooters, exit signs, main panel, zonal panel, battery, battery charger and other hardware. The system shall be designed to provide audio-visual indication at the main fire alarm panel to be located in fire station and zonal panels. Repeater panels shall be provided as specified in project design data sheet.

4.16.2 Electrical sirens shall be provided to cover entire plant area.

4.16.3 Each panel and each loop / Zone shall have at least 10% spare capacity.

4.16.4 The fire detection system shall be interfaced with fire suppression system, HVAC system, pressurization system and plant communication system, wherever specified.

4.17 Electrical Surface Heating System

4.17.1 Electrical surface heating system shall be provided for temperature maintenance of process pipes and associated equipments, if required as per process design basis.

4.17.2 The electrical equipments i.e. heat tracers, thermostat/ RTD, PDBs, Junction boxes, connectors, splice boxes, etc. shall be suitable for applicable area classification, though PDBs shall be preferably located in safe area.

4.17.3 In general, system shall be suitable for maintaining the temperature, unless otherwise specified. In case process fluid heating is desired, time duration and other parameters shall be as per process design data.

4.17.4 Skin effect electrical heat tracing system shall be provided for pipelines, if specified in project design data sheet.

4.18 Electrical Control System

4.18.1 Electrical control system shall be provided (as required) to monitor and control electric power generation and distribution network of the plant. ECS shall include distributed RTUs & I/O panels, servers, HMI, printers, fiber optic data highway, network switches etc. Base functionalities and advanced functionalities as specified in project design datasheet shall be provided.

5.0 EQUIPMENT DESIGN PHILOSOPHY

5.1 General

The equipment shall in general conform to EIL standard specifications. Equipments shall be selected and sized as per philosophy given below:

5.2 Transformers

5.2.1 All transformers except lighting transformers & isolation transformers shall generally be three phase, oil immersed, double wound type suitable for outdoor use, unless otherwise specified. Lighting transformers & isolation transformers shall be dry type, unless otherwise specified. The transformers for variable frequency drive system shall be oil immersed or dry type as per project requirement.

5.2.2 100% standby transformers (for power, distribution and lighting) shall be provided in all unit, offsite and utility substations, unless otherwise specified.

5.2.3 In general kVA rating, percentage impedance & X/R ratio of each transformer shall be selected to limit the rated current and short circuit current to values which are within the current rating and interrupting capacity of associated switchgear available.

The kVA rating for power, distribution and lighting transformers shall be decided on the following basis and should be as far as possible a standard value.

a) In systems having redundancy for transformers, with transformers having natural cooling i.e. ONAN/AN, each transformer shall be rated equal to or greater than the 8 hour maximum demand of the load plus 10% margin for future load growth.

b) In systems having redundancy for transformers, with transformers having forced cooling i.e. ONAF, each transformer shall be rated equal to or greater than the 8 hour maximum

demand of the load plus 10% margin for future load growth (within 110% of it's self cooled (ONAN) rating) and shall be fitted with automatic forced air cooling fans.

c) Where redundancy in number of transformers is not provided, rating shall be equal to or greater than 8 hour maximum demand plus 10% margin for future load growth. Fan cooled rating, where provided, shall be reserved as spare capacity for further future load growth.

5.3 Switchgear

5.3.1 All switchgear and associated equipment fed from generators and transformers shall have rating at least equal to the rating of respective generators and transformers feeding it, under any circuit configuration. Generator incomer shall be rated w.r.t. maximum power output of the generator set over entire operating temperature range. Transformer incomer shall be rated at least equal to forced cooled rating of transformer or 110% of ONAN rating as applicable.

5.3.2 Bus tie circuit breakers shall have rating higher of the following:

a) Largest incoming circuit breaker.
b) Maximum running load on either side of bus section.

The tie breaker rating shall not be less than the bus-bar current rating, unless otherwise specified.

5.3.3 All other switchgears not directly fed from generator and transformers shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 10% future load growth. Incomers of these switchgears shall be designed to cater to the complete load including 10% margin for future load growth.

5.3.4 Spare outgoing feeders shall be provided in all switchgear. At least one number of each type of outgoing feeder or 10% of each type of outgoing feeder, whichever is more, shall be provided as spare in the HV and MV switchboards, except for capacitor feeder in HV switchboard.

5.3.5 Circuit breakers/contactors controlling motor feeders shall have a rating of at least 125% of the maximum continuous rating of the connected motors.

5.3.6 Separate feeders shall be provided in the switchboard for each load/motor. However, as an exception maximum two numbers welding receptacles or flood light masts may be connected to one power feeder.

5.3.7 All circuit breakers shall be of single break type having one pole per phase. Circuit breakers for MV generator incomer shall be with four poles.

5.3.8 Rated short circuit breaking capacities and making capacities for all breakers and MCCBs shall be equal to or higher than the maximum specified value of the short circuit current and peak specified value of short circuit current respectively at the point of installation. MCCBs with backup fuses shall not be acceptable.

5.3.9 Air circuit breakers (ACB) shall be provided in MV switchboards for all feeders rated above 400 A and switch fuse/MCCB/ACB shall be considered for feeder rated up to 400A. However in the feeders feeding power to small rated MCCs/ASBs, switch-fuse feeders shall not be used.

5.3.10 Circuit breakers/Switch fuse units for capacitors shall, have a current rating of at least 135% of the capacitor rated current. Circuit breakers capability to interrupt applicable capacitive current shall be specifically verified.

5.3.11 The switchboard components viz. circuit breakers, main horizontal and vertical bus-bars, bus-bar joints, bus-bar supports etc. shall be designed to withstand the maximum specified short circuit current for a minimum time of 1 second, unless otherwise specified.

5.3.12 For motors rated above 5.5 kW, CT shall be provided in the switchgear for ammeter on the local control station/local control panel.

5.3.13 The maximum rating of bus-bars for MCCs/ASBs/LDBs should preferably be limited to 1000 Amps. Heavy duty type load break switches/ACB/MCCB rated for maximum specified short circuit current and duration shall be used for incomer and bus coupler and these shall have suitable interlocks.

5.3.14 Gas Insulated Switchgear (GIS) shall be provided for EHV system and HV system if specified in project design datasheet. Preferably GIS shall not be considered for voltages below 33 kV.

5.4 Bus Duct

The rating of bus ducts connected to breakers shall have same continuous and short circuit rating as that of breakers. Similarly bus ducts connecting two bus sections shall have same continuous and short circuit rating as that of main bus bars.

5.5 Neutral Grounding Resistor

The NGRs shall be rated to withstand the fault current for 10 seconds.

5.6 Batteries

Batteries shall be of adequate capacity to meet the back-up requirements as envisaged in the duty cycle. While sizing the battery, temperature correction factor and ageing factor shall be considered in addition to the maintenance factor. Batteries shall be complete with battery racks and accessories.

5.7 DC Power Supply System

5.7.1 DC power supply system shall include battery bank, charger-cum-rectifier, DC distribution board and cell booster.

5.7.2 The battery charger/rectifier shall feed the load and keep the batteries under fully charged condition. Provision shall also be made for necessary boost charging/initial charging of battery.

5.7.3 The DC system shall have at least 10% spare capacity for future load growth.

5.7.4 Each battery charger and DCDB shall be sized to cater to selected battery capacity.

5.7.5 Each DCDB shall have at least 10% spare feeders with one no of each rating for future use.

5.7.6 Power switch outside battery room shall be provided for local isolation of battery during maintenance.

5.8 Uninterrupted Power Supply System

5.8.1 UPS system shall include battery bank, rectifier transformer, rectifier-cum-charger, inverter, set of filter circuit, static switches, bypass transformer, facility for manual transfer between inverter supply and bypass line, facility for bypassing inverter and static switch for maintenance, AC Distribution board, cell booster and other associated accessories.

5.8.2 Each branch circuit of the UPS distribution system shall have a fused disconnect switch. The fuse shall be fast clearing semiconductor type and the fuse rating shall be co-coordinated with the rating of the UPS system. Normally the largest branch circuit load shall not exceed 25% of the UPS system rating.

5.8.3 UPS system shall be sized to have at least 10% spare capacity for future load growth.

5.8.4 Each UPS ACDB shall have at least 10% spare feeders for future use by owner.

5.8.5 Power switch outside battery room shall be provided for local isolation of battery during maintenance.

5.9 Motors

5.9.1 In general, three phase squirrel cage induction motors designed for direct on line starting shall be used. Motors shall be totally enclosed, fan cooled type and suitable for continuous use. Synchronous motors and motors with variable frequency operation shall be designed for special application.

5.9.2 All motors shall be continuous maximum rated with possible exception of crane and hoist motors, soot blowers, turbine/engine starting motors etc. which may be rated for the envisaged duty cycle.

5.9.3 DOL start high voltage motors shall be suitable for starting under specified load conditions with 80% of the rated voltage at the terminals and DOL start medium voltage motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the terminals. If required, large size motor starting shall be through soft starter/ dedicated transformer as per project design datasheet. Voltage available at the motor terminals which are started through dedicated transformer shall be decided considering the speed torque characteristics of the driven equipment and ensuring the voltage dip at the source bus does not exceed the permissible limits as per project design datasheet.

5.10 HV Capacitor Banks

5.10.1 The capacitor banks shall be supplied with series reactor and RVT (residual voltage transformer). All the capacitor bank equipment shall be suitable for outdoor location unless otherwise specified.

5.10.2 The capacitor bank in conjunction with series reactor shall provide minimum net kVAR at rated nominal voltage. The insulation system shall be designed to withstand continuous over voltage of 110%.

5.11 Emergency Generator

5.11.1 The emergency generator set shall be designed to start automatically on power failure and feed the selected loads. It shall be capable of taking care of the load variations (e.g. the starting of the largest rated motor with specified base load). However, DG sizing shall not

include boost charging loads for UPS and DC system batteries (but shall only include float charging and service loads).

5.11.2 The regulation of generator voltage shall be automatic and necessary instruments for metering viz., Ammeter, Voltmeter, frequency meter, kWH meter, power factor meter, hour run counter etc. shall be included in control panel. Warning of abnormal conditions shall be incorporated prior to automatic trip to prevent unnecessary shutdown.

5.11.3 The unit shall be complete with necessary engine starting equipment, associated control panel and shall be suitable for remote starting. Emergency Generator shall have auto-starting arrangement but only with manual switching off feature. 'Fail to start' annunciation shall be provided, in case the engine fails to start.

5.11.4 The load shall be automatically switched on to the generator only after the requisite voltage build-up.

5.11.5 The Emergency generator set shall have at least 10% spare capacity for meeting future requirements.

5.12 Annunciation Panel

5.12.1 Audio-visual annunciation panels shall be provided, where specified in design data, to monitor the switchgear and other electrical equipments. In case hardwired panel is not envisaged, audio visual annunciations shall be provided as pert of the HMI system.

5.12.2 Detailed annunciation schedule shall be based on but not limited to the following:

a) EHV & HV Switchgear
- Breaker-wise fault trip alarm
- Auto-changeover completed
- Auto-changeover failure
- Trip circuit status for each breaker
- Differential and restricted earth fault relay operation alarm
- Transformer trouble alarm
- DC supply failure alarm (Bus wise)
- PT secondary MCB trip alarm for all line and bus PTs
- Bus wire supervision alarm
- Alarms for SF6 gas system

b) MV Switchgear
- Incomer/Bus coupler fault trip alarm
- Auto-changeover completed
- Auto-changeover failure
- Bus-wise group fault trip alarm for outgoing feeder breakers
- D.C. supply failure alarm (Bus-wise)
- PT secondary MCB trip alarm for all line and bus PTs

c) Operating status/fault conditions for UPS system.

d) Operating status/fault conditions for DC supply system.

e) Operating status/fault condition for DG sets.

f) Fault alarm for VFD panels

5.12.3 Annunciation panel shall be complete with acknowledge, test and reset pushbuttons. 10% spare windows for future use shall be provided in the panel. Generally, annunciation panel shall be fed from the UPS system/ DC system.

5.13 Cables and Wires

5.13.1 EHV cables shall be single core, dry cured XLPE insulated, armoured, extruded FRLS PVC outer sheathed with conductive graphite coating and aluminum/copper conductor, as per project design datasheet and shall be provided with conductor screening, insulation screening and moisture barrier.

5.13.2 HV cables shall be dry cured XLPE insulated, armoured, extruded FRLS PVC outer sheathed with aluminum/copper conductor, as per project design datasheet. All cables rated 3.3 kV and above shall be provided with both conductor screening and insulation screening.

5.13.3 MV power cables shall be PVC insulated, armoured/ unarmoured, extruded FRLS PVC outer sheathed with aluminum/copper conductor, as per project design datasheet.

5.13.4 The control cables shall be twisted pair, copper conductor, PVC insulated, armoured, extruded FRLS PVC outer sheathed and overall shielded. Control cables without twisted pair and shielding shall be provided for specialized applications i.e. for CT secondary current, differential protection, restricted earth fault protection, etc.

5.13.5 The power cables shall be sized based on the maximum continuous load current, the voltage drop, system voltage, system earthing and short circuit withstand criteria as applicable. The derating due to design ambient air temperature, ground temperature, depth of laying, grouping and proximity of cables with each other, thermal resistivity of soil, etc. shall be taken into account.

5.13.6 Cables connected in parallel shall be of the same type, cross-section and terminations.

5.13.7 As an exception within substation areas, unarmoured cables may be used, if specifically agreed upon.

5.13.8 All power and control cables shall be in continuous lengths without any splices or intermediate joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Unless otherwise agreed, cable joints in hazardous areas shall not be permitted.

5.13.9 All incoming cables to switchgear/UPS/DC system/DBs and other equipment shall be sized for maximum anticipated load including 10% future growth. Cable for capacitor banks shall be sized for 135 % of the rated capacitor current.

5.13.10 The incoming cable for heat tracing power distribution panel shall be with four cores, the neutral conductor being of same size as the phase conductors.

5.13.11 All control cables shall have minimum 10% spare pairs/ cores.

5.14 Control Station

5.14.1 Each motor shall be provided with a control station/control panel in the field, unless otherwise agreed upon. Emergency stop push control station for air cooler motors at grade level, for