



# NASHPA Gas Processing and LPG Recovery Plant

PROC-FC-CB/NASHPA/PROJ-1247 /2015

PROJECT NO.: NASHPA 1247



DOCUMENT NO.:  
NGP-000-ELE-15.03-0005-13

SPECIFICATION

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## Specification for LV Switchgear / MCC

### REVISION DETAILS

REV	DATE	DESCRIPTION	PRPD	CHKD	REVD	APPD
00	30/11/2016	Approved for Design	Zhang Baopeng	Liang Xinlan	Liu Na	Cheng Xin
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## 1.0 GENERAL

### 1.1 Introduction

OIL & GAS Development Company Ltd. (OGDCL) is operating NASHPA Oil & Gas fields in Khyber Pakhtoonkhuwa of Islamic Republic of Pakistan. OGDCL intends to install LPG Recovery Plant, Compressors & Allied Facilities at these field.

### 1.2 Scope

This specification covers the minimum technical requirement for design, manufacture, supply, inspection, testing and commissioning of LV SWITCHGEAR / MCC to be used in NASHPA Gas Processing and LPG Recovery Plant PROC-FC-CB/NASHPA/PROJ-1247 /2015.

### 1.3 Definitions

Within this document the following definitions apply:

<b>Project</b>	NASHPA Gas Processing and LPG Recovery Plant PROC-FC-CB/NASHPA/PROJ-1247 /2015
<b>Company / Owner</b>	Oil & Gas Development Company Ltd.(OGDCL)
<b>Consultant</b>	Zishan Engineers (Pvt.) Ltd.
<b>Contractor</b>	Hong Kong Huihua Global Technology Limited Wholly owned subsidiary of China OIL HBP Science and Technology Corporation Ltd.
<b>Manufacturer/Supplier/Vendor</b>	Patry(ies), which manufactures and/or supplies material, equipment and service to perform the duties as specified by CONTRACTOR in the scope of supply
<b>Shall</b>	Indicates a mandatory requirement
<b>Should</b>	Indicates a strong recommendation to comply with the requirement of this document

### 1.4 Errors or Omissions

1.4.1 The review and comment by the COMPANY of any CONTRACTOR / SUPPLIER's drawings, procedures or documents shall only indicate acceptance of general requirements and shall not relieve the CONTRACTOR / SUPPLIER of its obligations to comply with the requirements of this specification and other related parts of the Contract Documents.

1.4.2 Any errors or omissions noted by the CONTRACTOR / SUPPLIER in this Specification shall be immediately brought to the attention of the COMPANY.

### 1.5 Deviations



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All deviations to this Specification, other related specifications or attachments shall be brought to the knowledge of the COMPANY as a section in the bid. All deviations made during the procurement, design, manufacturing, testing and inspection shall be with written approval of the COMPANY prior to execution of Work. Such deviations shall be shown in the documentation prepared by the CONTRACTOR / SUPPLIER.

### 1.6 Conflicting Requirement

In the event of any conflict, inconsistency or ambiguity between the CONTRACTOR / SUPPLIER's scope of work, this Specification, National Codes and Standards, referenced in the Project Specification or any other documents, the CONTRACTOR / SUPPLIER shall refer to the COMPANY whose decision shall prevail.

### 1.7 Reporting Procedure

1.7.1 A reporting and documentation system shall be agreed between the CONTRACTOR / SUPPLIER and the COMPANY/ CONSULTANT for the status of procurement, design, manufacturing, inspection, testing and shipment of the equipment/material to be supplied under this specification. CONTRACTOR / SUPPLIER shall provide reports and summaries for production performance and testing operations in conformance with a manufacturing schedule approved by COMPANY.

1.7.2 Daily, weekly, monthly and run summaries of all major aspects of the production process shall be provided as reports to the COMPANY/ CONSULTANT.

#### 1.7.3 Third Party Inspection

In addition to the inspection and witnessing of tests by the inspectors to be appointed by the COMPANY during the manufacturing and shipment of the equipment/material, COMPANY may appoint a third party or its own inspector for witnessing of the inspection and tests to be carried out at CONTRACTOR / SUPPLIER's facility under this specification.

### 1.8 Unit Responsibility

The CONTRACTOR / SUPPLIER shall be responsible for the complete design, manufacture, supply, fabrication, construction, installation/erection, inspection and testing of the LV SWITCHGEAR / MCC, including full compliance with all applicable design codes and standards, including those listed in Section 2.0 of this document and the requirements of the certifying authority, if applicable. The CONTRACTOR / SUPPLIER shall handle and expedite drawings and data, and supervise and coordinate all inspection and testing.

CONTRACTOR / SUPPLIER shall guarantee that all material and parts included in construction of the specified Centrifugal pump shall be new, unused and of the required/ specified grade.

### 1.9 Documentation

1.9.1 Documents, calculation sheets, drawings, etc., to be submitted to the COMPANY shall be in English Language.

1.9.2 Unless otherwise specified, the metric units shall be used in documents and drawings, except that pipe sizes, flange sizes and bolts/nuts shall be indicated in inches.

1.9.3 The form of drawings and documents may be as per the CONTRACTOR / SUPPLIER's Standards. However, the format of the data sheet will be submitted to COMPANY for approval.



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1.9.4 Variations from or additions to this specification shall be called to the attention of the COMPANY and approved in writing by the COMPANY prior to starting fabrication.

1.9.5 Information for installation, operating, maintenance or inspection purposes shall be submitted to COMPANY.

## 2.0 CODES AND STANDARDS

2.1 Reference is made in this specification to the following documents. The latest issues, amendments and supplements to these documents shall apply unless otherwise indicated.

- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- American National Standards Institute, Inc. (ANSI)
- Underwriters' Laboratories (UL)
- Insulated Cable Engineers association (ICEA)

2.2 All electrical equipment within the system shall meet to IEC codes and standards and shall carry a label of an IEC approved certifying authority. The labeling shall include the total assembly (when available) in addition to individual components.

Documentation of such compliance shall be provided; likewise any item that does not comply with this requirement shall be documented.

If any equipment is not available with this labeling, written documentation shall be provided that the equipment conforms to all applicable IEC codes and standards.

Code	Document Title
IEC 60044	Instrument Transformer
IEC 60073	Direct acting indicating analogue electrical – measuring instruments and their accessories
IEC 60129	Alternating current disconnectors (isolators) and earthing switches
IEC 60146	Semiconductor Converters
IEC 60185	Current transformers
IEC 60186	Voltage transformers
IEC 60255	Electrical relays
IEC 60258	Direct acting recording electrical measuring instruments and their accessories
IEC 60269	Low-voltage fuses



IEC 60417	Graphical symbols for use on equipment
IEC 60439	Low voltage switchgear and control gear assemblies
IEC 60445	Identification of equipment terminals and of terminations of certain designated conductors, including general rules of an alphanumeric system
IEC 60521	Class 0.5, 1 and 2 alternating-current watt-hour meters
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60617	Graphical symbols for diagrams
IEC 60641	Enclosed Low Voltage Switchgear and Control gear Assemblies-Guide to testing under conditions of arcing due to internal faults
IEC 60688	Electrical measuring transducers for converting AC electrical quantities to analogue or digital signals
IEC 60715	Dimensions of low voltage switchgear and control gear
IEC 60898	Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations
IEC 60947	Low-voltage switchgear and control gear
IEC 60950	Safety of information technology equipment, including electrical business equipment
IEC 60989	Separating transformers, auto transformers, variable transformers and reactors
BS 5486	Low-voltage switchgear and controlgear assemblies
OSHAS 18001	Occupational Health and Safety Management System
ISO 9000	Quality management and quality assurance standards
ISO 9001	Quality systems – model for quality assurance in design/ development, production, installation and servicing
ISO 9004	Quality management and quality system elements
ISO 14001	Environmental Management Systems

**2.3** The recommendations listed in 2.2 are supplemented by this specification, which states only requirements in addition to the requirements stated in these recommendations.

**2.4** All electrical equipment within the system shall be to IEC codes and standards and shall carry a label of an IEC approved certifying authority. The labeling shall include the total assembly (when available) in addition to individual components.



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Documentation of such compliance shall be provided; likewise any item that does not comply with this requirement shall be documented.

If any equipment is not available with this labeling, written documentation shall be provided that the equipment conforms to all applicable IEC codes and standards.

- 2.5** Contractor / Supplier shall be knowledgeable of the requirements of the above listed codes and standards. Any changes or alterations to the equipment to meet the above listed codes and standards shall be at the expense of Contractor /Supplier.
- 2.6** In the event of conflict between the Technical Requirements, codes and standards, the most stringent shall govern.

### 3.0 ENVIRONMENTAL DESIGN CRITERIA

#### 3.1 General

The equipment shall in all respects, be suitable for operation in service conditions typical of gas handling facilities.

#### 3.2 Environmental Data

The NASHPA site conditions are summarized as under:

Altitude reference (Elevation)	2700 ft (823m)
Ambient temperature (max.)	115 °F (46.1 °C)
Ambient temperature (min.)	35 °F (1.7 °C)
Relative Humidity (min – max)	10% – 70 %
Maximum wind velocity	100 miles/hr (27.8m/s)
Seismic zone((Earthquake Forces)	Zone 2B
Ground acceleration	0.2 g
Average Monthly rainfall	0 to 50 mm

### 4.0 ELECTRICAL SYSTEM

- 4.1 The equipment shall be supplied in accordance with the single line diagram(s) and/or data sheet(s) referenced in the material requisition.
- 4.2 All equipment shall be rated for continuous operation unless otherwise specified. The rating (voltage, current, frequency, fault current, etc.) shall be as stated on the single line diagram/data sheets. Short time current rating shall be certified by a recognized testing authority.
- 4.3 Switchgear shall be suitable for operation, without deleterious effect, with variations of  $\pm 10\%$  voltage and  $\pm 2\%$  frequency.
- 4.4 Transient voltage depressions down to 80 percent of rated voltage shall not affect the performance of the equipment.



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## 5.0 STRUCTURAL & MECHANICAL REQUIREMENTS

- 5.1 The equipment rated for operation at 400/230V AC, 50 Hz shall be of multicubicle, factory built assembly type complying with BS 5486 / IEC 60439 form 4 or equal.
- 5.2 The equipment shall be metal clad, free standing, floor mounting, flush fronted and arranged to form a single structure with a common bus bar assembly to which additional sections may be readily added.
- 5.3 The minimum IEC protection coding for the enclosure shall be IP 31 to IEC 60529 or equal and shall be vermin proof.
- 5.4 The equipment shall be of angle iron frame work fabricated, welded and grinded, and covered with 2 mm thick sheet steel. The sheets shall be cleaned to bear shining, derusted degreased provided with two base coats of anti-rust paint, finished inside and outside with powder coated paints.
- 5.5 The equipment shall be complete with eyebolts/lifting angles etc. to facilities installation. The Supplier shall supply appropriate base frames for the equipment installation together with the necessary holding down bolts, nuts and washers etc.
- 5.6 The structure, including doors and panels, shall be capable of withstanding the internal pressures created by faults within the structure (equal to the maximum fault current rating) without danger to the operating personal.
- 5.7 Structures shall be self ventilating.
- 5.8 Interlocks, bus bars shutters, covers, etc. shall be provided to prevent incorrect or unsafe operation, and to prevent access to live parts.
- 5.9 Isolation between compartment/cubicle, bus and cable spaces shall provide the following:
- 5.9.1 Permit cables to be pulled safely into the equipment and extended to the compartments/cubicles, with the equipment energized. It is preferred that no uninsulated live parts be located in the cable pulling spaces. It is acceptable guarded cable terminals are located there, provided temporary insulation can be installed during cable pulling.
- 5.9.2 Arc propagation barrier between compartments.
- 5.9.3 Permit personnel to work safely within an empty compartment/cubicle, or one from which the device assembly has been removed, with the bus bar energized.
- 5.10 Similar parts and components shall be interchangeable wherever practical.
- 5.11 Incoming and bus-section units shall be housed in separate cubicles (tier formation shall not be used).
- 5.12 Outgoing feeder circuit breakers may be arranged in tier formation, limited to a maximum of 2 feet high.
- 5.13 Each motor starter, feeder switch and fuse unit, etc. shall be housed in a separate compartment within the equipment.
- 5.14 The equipment shall be designed to permit rearrangement of compartment sizes after installation at site.



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5.15 Self tapping screws shall not be used in the main construction of the equipment. Where removable cover plates are fitted, the anchor nuts or similar shall be fitted to the underside of the plate. Threaded holes are acceptable provided at least four threads are engaged.

5.16 Isolating mechanisms and unit withdrawal facilities shall be suitable for operation by a single operator.

5.17 All equipment shall be treated for operation in tropical conditions.

5.18 There shall be no exposed bare copper. All copper must either be covered with insulation or tinned.

5.19 All materials used shall be of the "self extinguishing" type.

5.20 Cable entry inside the equipment shall be from bottom only.

5.21 All exterior hardware (handles, hinges, nuts, bolts etc.) shall be of stainless steel unless otherwise specified. Ventilation openings shall be filtered or screened to prevent the entrance of dust/rodents etc.

## 6.0 CIRCUIT BREAKERS

6.1 MDB shall have all incoming and outgoing circuit breakers as withdrawable. For MCC also, Incoming circuit breakers shall be withdrawable and of the air break type while starters shall also be withdrawable. Solenoid operated closing and shut trip mechanisms shall be provided with manual operation facilities.

6.2 Circuit breaker duty, rating and number of poles shall be as stated on the single line diagram/data sheets.

6.3 Circuit breakers of similar rating shall be interchangeable.

6.4 Circuit breakers shall be supplied with manual operating devices.

6.5 Tripping, closing, control and indication supplies shall be as shown on the single line diagram and/or the data sheets.

6.6 Circuit breaker operating mechanisms shall be as stated on the switchgear single line diagram/data sheets/interlocking block diagrams.

6.7 Test facilities shall be provided to permit operation of the circuit breaker whilst in the test/isolated position.

6.8 Circuit breakers shall be fully type tested and carry certification from a recognized testing authority.

6.9 Circuit breakers shall be provided with trip circuit supervision to monitor trip circuit continuity and trip circuit supply. Alarm and indication facilities shall be provided.

6.10 Circuit breakers shall be provided with four normally open and four normally closed spare auxiliary contacts wired out to terminals.

6.11 Circuit breakers shall be mechanically interlocked to prevent:

6.11.1 The breaker being inserted into the service position unless it is open.

6.11.2 The breaker being withdrawn from the service position unless it is open.

6.11.3 The breaker being closed unless it is fully in the service or withdrawn/test position.

6.11.4 Remote operation whilst in the withdrawn/test position.



6.11.5 The breaker being inserted into the service position while shutters are padlocked.

6.12 Circuit breakers shall be fitted with busbar and cable circuit shutters. Shutters shall be:

6.12.1 Fitted with padlocking facilities.

6.12.2 Coloured red for busbar and yellow for circuit in addition to being labeled.

6.12.3 of metal construction and effectively earthed to the main housing.

6.12.4 of the positively driven type, gravity drop shutters are not acceptable.

6.12.5 capable of being individually operated by hand.

6.13 Where indicated on the Single line Diagram / data sheets a secondary selective system with automatic transfer is required on switchgear/motor control centre with two incoming circuit breakers and a bus section circuit breaker.

## 7.0 MOTOR STARTERS

7.1 All motor below 37 KW shall be Direct on Line starting.

7.2 All motors between 37 KW and 100 KW shall have Star-Delta Starter.

7.3 Motors above 100 KW shall have soft starter/VFD.



7.4 All motor starters, feeders and heaters shall be protected with Earth Fault Relay (EFR)

7.5 All starters shall be arranged for remote control in addition to any controls specified at the equipment.

7.6 Motor starters shall be of the withdrawable type, with starter components mounted on a withdrawable chassis.

7.7 Motor starters shall include, but not be limited to, the following:

7.7.1 Isolator – fault make and capable of breaking motor locked rotor current, mechanically interlocked with door / withdrawable mechanism, padlockable in the 'off' positions and fitted with additional auxiliary contacts (for isolating internal/external controls, etc.) as specified.

7.7.2 Fuses – main fuses shall be the H.B.C. type and have motor protection duty characteristic.

Parallel arrangement of fuses to achieve the required rating is not acceptable.

Control, indication and instrument circuit fuses shall be the H.B.C. cartridge type.

7.7.3 Contactor – suitable for uninterrupted duty, intermittent duty class 1 and utilization category AC3 or AC4 (IEC).

Contactor and protective device shall be coordinated to ensure that contactor fault rating is not exceeded.

7.7.4 Protective devices – affording overload and single phasing protection. Instantaneous earth fault relays shall be provided for motors rated at 15KW and above. The protective device shall be provided with manual reset.



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7.7.5 Selector switches-spring loaded type, switch position clearly and indelibly marked and circuits properly interlocked to avoid any maloperation.

7.7.6 Stayput stop facility with pad lockable in the 'Stop' position.

7.7.7 Overload Reset push-button mounted on front of the starter.

7.7.8 Ammeters and current transformers where applicable. Provision shall be made for remote ammeter indication. All ammeters shall have an adjustable red pointer.

7.9 Test facilities shall be provided to permit operation of the motor starter without energizing the power circuit.

7.10 Space shall be provided in each starter compartment for a future auxiliary (Pilot) relay.

## 8.0 OTHER FEEDERS

8.1 These shall comprise one or more of the following components:-

8.1.1 Isolator – fault make, load break, mechanically interlocked with door/withdrawal mechanism, pad lockable in the 'off' position and fitted with additional auxiliary contacts (for isolating internal/external controls, etc.) as specified.

8.1.2 Fuses – main control, indication, etc. fuses shall be the HBC type.

8.1.3 The contactor and protective device shall be coordinated to ensure that contactor fault rating is not exceeded.

8.1.4 Protective devices shall be provided with manual reset.

8.1.5 Feeders shall be the withdrawable type.



8.1.6 Feeders supplying power shall be protected with Earth Fault Relay (EFR).

## 9.0 BUSBARS

9.1 Busbars and connections shall be manufactured from hard drawn copper of 99.9 percent purity.

9.2 Busbars shall be insulated with a flame retardant material which will not give off any toxic fumes in high temperature conditions. The oxygen index of the insulation material shall be in excess of 25%.

9.3 Busbars shall be of the same cross sectional area throughout the length of the equipment.

9.4 Phase and neutral busbars shall be run in a separate compartment not requiring access for any other purpose.

9.5 The phase sequence shall be specified in alphabetical order, each phase reaching its maximum in time sequence in this order.

Busbars shall be marked as follows, as seen from the front or operating side of a switchboard.

R	S	T
Front	Centre	Back
Top	Centre	Bottom
Left	Centre	Right



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Cable terminals and apparatus which are to be connected directly or indirectly to supply conductors shall be marked U, V, W.

The earth shall be marked with an E.

9.6 Busbars, at bus section switches, shall be arranged to permit safe work on one bus section whilst the other remains energized.

9.7 An earthing busbar shall be provided along the full length of the equipment structure with provision for earth cable connections at each end.

9.8 Busbars and connections shall be adequately sized, braced and supported to withstand the mechanical forces and thermal effects resulting from the switchgear rated short circuit current and carry certification from a recognized testing authority.

9.9 Busbars and other primary connection joints are to be shrouded by means of clip on shrouds or alternatively to be encapsulated.

## 10.0 BUSDUCT

### 10.1 General

The busducts shall be Sandwich type and suitable for 400 V AC system, 3 phase, 50 Hz. Bus ducts will be installed partially outdoors and partially indoors. It shall be capable of operating continuously in a 46.1°C ambient with the outdoor section exposed to direct solar radiation. All components of the bus duct shall be rated for the electrical system characteristics as specified on the CONTRACTOR's data sheet. The bus duct shall be furnished as a complete system to include all necessary straight sections, bends, wall frames, vapour barriers, expansion joints, splice plates, space heaters, termination materials, support materials and fixings and fastenings.

The system is to include all hardware and materials for connection to drilled pads on the bus of the supply and utilization equipment and for joining the bus enclosure to the equipment enclosures.

Bus duct components and materials shall be of the latest field prove design, and in current production. Obsolete components or components scheduled for discontinuation shall not be used.

The bus duct shall be of a type which is fully short-circuit tested and certified by an internationally recognized testing authority for the fault levels as stated on the data sheet.

All conductors shall be fully braced by reinforcing frames or similar measures to withstand the thermal and dynamic stresses associated with the maximum peak rated short circuit current for the bus duct.

The phase rotation of the main distribution system is counter-clockwise. Phase sequence identification is as follows:

- Phase conductors - **Brown, Black, Grey** (L1, L2 & L3 respectively)
- Neutral conductor – Blue
- Earth conductor - **Yellow/Green**



### 10.2 Enclosure



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Bus duct shall consist of sections of non-segregated, hard drawn, high conductivity, round edge rectangular, fully insulated, copper bus bar, completely metal enclosed.

 Bus ducts shall have enclosure protection of IP42 for indoor and **IP65 for outdoor** as a minimum (in accordance with IEC 60529).

All phase conductors shall be tin plated at all contact surfaces.

Thermal expansion of the busbars shall not distort or impose any undue mechanical stress on the busbars, connections, insulation supports or enclosure under normal operating current and rated short circuit conditions.

All busbar connections shall be bolted. Bolts shall pass through the busbar conductors, capable of being properly torqued and locked in place, to provide and maintain full and uniform pressure under all operating conditions. Torque requirements shall be furnished by the VENDOR.

The neutral bar shall have the same cross sectional area as the phase bus bars.

Phase transposition pieces shall be provided to ensure the correct phase rotation at the termination points at both ends of the bus duct.

The bus insulators shall be fire retardant, fungus resistant, anti tracking and non-hygroscopic. The VENDOR shall supply insulating boots or sleeves at all joints and terminations. The insulating material shall be rated for continuous operation at 130°C.

The bus supports shall be crack resistant.

Outdoor enclosures shall have a sloped top that prevents collection of water. Joints shall be water tight by design and not dependent on the gasketing material for water tightness.

Enclosures shall have removable covers for access to bus bar joints and other internal devices. Access openings in horizontal sections shall be located on the bottom of the enclosure. Covers for access openings shall have neoprene gaskets and captive fasteners.

Enclosure for bus assemblies shall be made from non-magnetic metal, to limit induced current losses and circulating currents by breaking the magnetic path. Light weight alloy material is preferred.

All housing and flange gasketing shall be closed-cell neoprene rubber, or other non-corrosive material, and shall be completely concealed for protection against deterioration.

Seals will be provided at all termination points.

Bus duct shall have provision for the connection of the equipment to earth. The bus duct enclosure shall be electrically continuous throughout the entire installed bus duct length. Facilities to electrically bond across all bus duct joints shall be included.

The Bus duct shall be sectionalized for ease of handling and erection at site. They shall be designed to simplify installation, testing and repair.

Where the bus duct penetrates the fabric of a building a seal around the bus duct shall be provided.

Where the bus duct penetrates the fabric of a building, a seal and a barrier shall be provided within the bus duct to prevent the spread of fire or passage of smoke through the bus duct.



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All supports, brackets and fixings shall be hot dip galvanized steel.

The use of asbestos or asbestos fibre is not acceptable.

### 10.3 Busbars

The bus bars shall be fabricated of 99 percent pure copper. The contact surfaces at joints shall be silver plated.

The bus bars shall have continuous current rating and a short time current (for 1 second) equal to those of the bus bars of switchgear. Type test Certificates shall be submitted.

Busbar and joints shall be manufactured to remove sharp edges, and to minimize corona. Joints shall be covered with formed insulating boots.

The bus bars shall be supported to withstand the rated short circuit current.

### 10.4 Safety

The bus duct shall be designed to minimize risk of an internal short circuit. The design and construction of the bus duct shall also provide for personnel and operational safety during all operating conditions, inspection and maintenance. Under extreme conditions of major short circuits or mal-operation there shall be no danger to persons in the vicinity of the bus duct. The equipment shall have been tested in accordance with the requirements of latest IEC standards.

The proper coordination of connections between bus duct and terminal equipment shall be the responsibility of the bus duct VENDOR.

The VENDOR shall coordinate with the Company/Consultant for matching and coordination requirements. If required, the VENDOR shall make necessary measurements on the site or at other manufacturer's facilities.

### 10.5 Labels and nameplates

A trifoliate / laminated plastic label showing the bus duct designation (tag) number shall be fixed to each section of the bus duct. Where the bus duct comprises of just one section, a minimum of one label at each end of the bus duct shall be provided.

The bus duct designation number shall be as shown on the SLD.

The designation labels shall have black characters engraved on a white background, the characters having a minimum height of 75 mm.

Warning labels shall be fixed to both sides of the bus duct at intervals of approximately 2 meters along the full length of the installation. The labels shall warn of the electrical danger and prohibit the bus duct for being used as a platform, walkway, etc.

The warning labels shall have black characters, of substantial size, on a yellow background. These labels will be made of a non-corrosive material.

Each bus duct shall be provided with an external rating plate. The rating plate labels shall have black characters engraved on a white background, the characters having a minimum height of 5 mm. The rating plate shall indicate the following:



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- Manufacturers name and type.
- Bus duct designation (tag)
- System voltage, phases, wires and frequency
- Maximum peak and thermal short-circuit ratings with withstand time in seconds.
- Degree of protection
- Bus bar rating.
- Year of manufacture
- Company order number
- Manufacturers order number
- Additional labels shall be provided on each section of bus duct giving its correct orientation to assist installation.
- All external labels shall be secured with stainless steel fasteners; adhesive or self-tapping screws are unacceptable.
- All labels shall be in English language only.

## 11.0 Load Shedding system

Load Shedding System (LSS) shall provide by Switchgear/MCC vendor and LSS should be installed at a separate panel, LSS shall receive the shedding signal from generator system and send them to each LV load with **three steps**.



The shedding panel shall include but not limited below functions: indicator light for shedding status, alarm for shedding failure, auto/manual shedding selector for each step load, and so on .

## 12.0 EARTHING

12.1 All metallic non-current carrying parts of the equipment shall be bonded together and connected to the earth busbar.

12.2 All doors shall be bonded to the main structure by means of a flexible copper connection arranged so that it cannot be trapped as the door is opened or closed.

12.3 Withdrawable parts shall be effectively earthed until they are completely withdrawn, with all power and control connections disconnected.

12.4 The cable gland plates shall be bonded to the earthing busbar.

## 13.0 INTERNAL WIRING

13.1 Internal wiring shall be PVC insulated 600/1000V grade, stranded copper conductors, minimum size 2.5 sq.mm. For miniaturized relays or intrinsic safe relays, 600/1000 V grade, 1.5 sq.mm cable will be acceptable.

13.2 Internal wiring within the switchgear shall be securely held in position (either loomed or run in conduit / trunking). If wiring corridors, conduits and flexible conduits are used, they shall be adequately sized to accommodate future additions (6 conductors minimum) by others.

13.3 Bus wires for closing, tripping, control, indication, heaters, etc. shall be run within the equipment.



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13.4 Wiring identification shall be by non-editable numbered and / or lettered ferrules /slip-on labels of insulating material and located adjacent to the terminals.

13.5 Wiring connections to door mounted equipment shall be loomed, wrapped in flexible PVC conduit and be firmly clamped at both ends to prevent movement at terminations.

13.6 All wiring for external connections shall be brought out to individual terminals on a readily assessable terminal block. Sufficient spare ways shall be allowed for future usage.

13.7 Wires shall be terminated using compression type lugs or crimp sleeves.

13.8 Plug and socket connections shall be of robust construction and include a location pin or similar device to prevent the interconnection being made incorrectly.

## 14.0 CABLE TERMINATIONS

### 14.1 Cable Terminations

14.1.1 Cable terminating facilities and terminals shall be suitable for the specified cable type, gland and conductor size.

14.1.2 The Supplier shall provide cable terminating facilities with un-drilled gland plate of sufficient dimensions to terminate the specified cables. Cable entry shall be from the bottom of the equipment.

14.1.3 Positioning of cable terminations shall avoid obstruction of other cable terminations, removable covers etc. and provide for easy access for terminating cables. There shall be a minimum space of 50mm allowed for the termination of cable conductors.

14.1.4 Cable supports shall be provided (where practicable) by the Supplier to avoid under strain on the cable termination.

14.1.5 Termination of single core cables shall be through an insulating or non magnetic gland plate.

14.1.6 All terminal blocks shall be shrouded or provided with transparent covers. Clamp type terminals shall be provided; the pinch screw type is not acceptable.

14.1.7 The number of conductor connected to each terminal shall not exceed two.

14.1.8 All terminal blocks shall be mounted in a single deck arrangement. The double deck arrangement is not acceptable.

14.1.9 Spare terminal blocks (approve. 10%) shall be provided with each group of terminals.

14.1.10 All group or individual terminals and wires shall be segregated and clearly marked and labeled with non-perishable and easily changeable markers or labels. The labels shall be positively fixed as to prevent the loss of labels.

14.1.11 All terminal blocks shall be numbered with fixed or slip-on type markers.

14.1.12 All interconnecting cables will have positively fixed, non-destructible slip-on cable labels at both ends.



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14.1.13 All labeling and marking shall be in correct technical English which shall have been approved by the Company.

## 15.0 AUXILIARY SUPPLIES

15.1 Auxiliary supplies (closing, tripping, control, indication, etc.) shall be in accordance with the single line diagrams / data sheets.

15.2 Circuit breaker closing, tripping, control and indication power shall be supplied from A.C. supply units. The Contractor/Supplier shall specify his load requirements. The supplies shall be monitored by means of relays connected to the most remote point of the wiring.

15.3 Switchgear control power buses shall be arranged such that a separate one is provided for each of the following:

### 15.3.1 Closing supply (Electrical Release Coil)

The 230 volt A.C. supply for each incoming circuit breakers will be derived from a separate source.

### 15.3.2 Tripping Supply

The 230 volt A.C. supply for each incoming circuit breakers will be derived from a separate source.

### 15.3.3 Motor Starters – Control Circuit Supplies

The control circuit supply for each starter shall be 230 Volt.

15.4 All auxiliary supplies except tripping shall be individually fused / protected within each circuit breaker housing.

15.5 Anti-condensation heater supplies for the equipment shall be fed from a single source for each bus bar section.

## 16.0 INSTRUMENT TRANSFORMERS

16.1 Voltage and current transformers of appropriate ratio, output, class and accuracy for protection and metering shall be provided.

16.2 The Contractor/Supplier shall provide details of ratio, output, class and accuracy for all instrument transformers in his supply.

16.3 The secondary windings of instrument transformers shall be earthed at one point through a removable link, with provision for attaching test links.

16.4 Current transformers shall be rated to withstand the thermal and magnetic stresses resulting from through fault current which, in the case of circuit breaker feeders, shall be equal to the switchgear fault rating.

16.5 Where current balance protection is specified the Contractor/Supplier shall provide calculations together with current transformer magnetization curves to prove the through fault stability of the protection up to the switchgear fault rating.



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16.6 Bridging terminals for current transformers shall be provided at the outgoing terminals where external connections are required.

16.7 Voltage transformers primary and secondary windings shall be protected by fuses/MCBs.

16.8 Instrument transformer nameplates shall be fixed in a position so that details can easily be read when the transformers are fitted in the cubicle.

## 17.0 METERING, PROTECTION, CONTROL & INDICATION

17.1 Metering, protection and control shall be provided in the equipment.

17.2 All meters shall be of the industrial type, enclosed in dust and damp-proof casings, square dial, similar throughout in size and type and of suitable standard size.

17.3 Incoming supply metering shall include but not limited to:

- Voltmeter and selector switch
- Ammeter and selector switch
- Kilowatt meter
- Kilowatt hour counter.

17.4 Meters and relays shall be flush mounting and fitted on the front of the equipment.

17.5 Meters and relays shall be capable of withstanding without damage the secondary currents associated with the switchgear rated fault current flowing in the primary of current transformers, in the case of circuit breaker feeders, and the maximum available through fault current in the case of fused feeders.

17.6 External zero adjustment shall be possible on all indicating instruments to facilitate adjustment without dismantling the instrument.

17.7 Voltmeters shall be scaled according to voltage and shall be connected to the system through HRC cartridge fuses or MCBs.

17.8 Ammeters shall be fed from appropriate C.T.'s (Secondary having 5A rating at least).

17.9 Ammeters for motor starters shall have compressed scale for starting currents, so scaled that the motor full load is shown within 1/2 & 3/4 of full scale deflection. Other ammeters shall have liner scales.

17.10 All indicating instruments shall be of class 1.5% accuracy.

17.11 All current transformers shall be class 1.5% accuracy, suitably rated for protection and indicating instruments.

17.12 An electrical system protection scheme shall be incorporated into the design of the equipment to ensure reliable and safe operation of the distribution network and to minimize damage to electrical equipment resulting from electrical faults. An electrical fault on one part of the network shall be automatically isolated with the minimize of disturbance to the remainder of the system.

17.13 The equipment shall be incorporated with the following protection device/relays as a minimum for the protection and control of gas engine generator sets, motors, feeders etc.:



Protection Device/Relays

Device Function No. \*

● Checking or interlocking relay(s)	3
● Stopping device	5
● Undervoltage relay(s)	27
● Directional power relay(s)	32
● Negative sequence or reverse phase or phase balance current relay(s)	46
● Instantaneous overcurrent relay(s)	50
● Time-delay overcurrent relay(s)	51
● Overvoltage relay(s)	59
● AC directional overcurrent relay(s)	67
● Permissive control device	69
● Operating mechanism(s)	84
● Lock out relay(s)	86
● Differential protective relay(s)	87
● Tripping or trip free relay(s)	94
● Machine or transformer thermal relay(s)	49
● Incomplete sequence relay(s)	48

\* (From ANSI / IEEE C37.2-1979, IEEE Standard Electrical Power System Device Function Numbers.)

17.14 The following types of protection shall be provided as a minimum:

a) General

The electrical relay protection system shall be designed to perform the following functions:

- Isolate the faulted section quickly.
- Minimize damage to the faulted section.
- Prevent loss of stability of the generation and distribution system.
- Minimize any disturbance to the healthy sections of the plant.
- Protect personnel.

b) Generators

Following protections shall be considered as a minimum for the gas engine driven & emergency diesel engine driven generators:

- Generator phase sequence
- Under / Over voltage relay (27/59)
- Over/Under frequency (81 O/U)
- Directional Power Relay (32)
- Instantaneous / Ac time Over-current (50/51)
- Reverse-phase or Phase-balance Current Relay (46)
- Synchronizing or Synchronism-check Device (25)
- Field Relay (40)
- Machine or Transformer Thermal Relay (49)



- Ground Detector Relay (64)

c) LV Motors

Following protections shall be considered as minimum:



- LV Circuit breaker short circuit protection.
- Earth fault ( All motors).
- Thermal overload protection.
- Phase imbalance protection.

Note: Variable speed drive systems (VSDS) where used, shall be equipped with the protection, control, alarm and metering equipment functions as required for their safe & reliable operation.

d) LV Feeders, Power and Convenience Sockets

Protection shall include:



- Short circuit protection by circuit breaker.
- Earth fault.

17.15 In addition to the “active” protection measures described above, the design shall incorporate the necessary features to protect operatives from the dangers of electric shock. Provision shall also be made for the isolation and safe earthing of all equipment for maintenance purposes, without the necessity for a complete interruption in continuity of supply to the distribution network.

17.16 Protective relays for switchgear shall, wherever possible, be of the draw out type with operation indicator and be fitted with test blocks. Manual reset operable from the front of enclosure, shall also be provided on all relays.

17.17 Voltage free alarm contacts shall be provided for alarms.

17.18 Open, Closed and Trip circuit healthy indicating lamps for the circuit breakers shall be provided.

17.19 Indication on motor starters shall include but not limited to:

- Running Lamp
- Stop Lamp
- Trip Lamp
- Ammeter
- Power 'ON'

17.20 Indication of feeder units shall include but not limited to:

- Contactor 'Closed' lamp (where applicable)
- 'Earth Fault Trip' Lamp (where applicable)
- Ammeter

17.21 Running, stop and trip indications of motor shall be hooked up with DCS system.

17.22 Indication lamps (green-open, red-closed) and mechanical position indicators shall be provided for each circuit breaker. Contacts for remote indication shall be provided.



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17.23 It shall be possible to mechanically trip circuit breakers at the switchgear.

17.24 When the circuit breakers or motor starters are in the test, withdrawn or earth position, operation shall only be possible from the switchgear.

17.25 Static type relays shall be supplied. Operation indication and test facilities shall be included.

## 18.0 ANTI-CONDENSATION HEATERS

18.1 The enclosure shall be equipped with anti-condensation heaters of sufficient capacity to prevent the formation of condensation within the enclosure under the service conditions.

18.2 Each heater shall be supplied from single phase supply and terminated in a weatherproof terminal box fitted with an un-drilled gland plate and warning label.

18.3 On/ Off switches and thermostats shall also be provided.

## 19.0 LABELS

19.1 Cubicles, compartments and components shall be identified by labels.

19.2 A main label shall be affixed in a prominent position on each switchgear giving the following information:

19.2.1 Manufactures name and type.

19.2.2 Switchboard designation.

19.2.3 System voltage, phase and frequency.

19.2.4 Rated operational voltages.

19.2.5 Rated fault making and breaking current.

19.2.6 Busbar rating

19.2.7 Year of manufacture.

19.2.8 The number of the governing I.E.C. Recommendation.

19.3 Each outgoing unit circuit shall be fitted with internal and external labels giving the following information:

19.3.1 Current and kilowatt rating

19.3.2 Service description and equipment tag number.

19.4 Equipment designation & labels shall have black characters on a white background and be made of a non-corrodible material. Warning labels shall be the same except black characters on a yellow background.

19.5 Labels shall be affixed by means of stainless steel screws.

19.6 A Purchase Order No. label shall be affixed externally.

## 20.0 FINISH

The color and finish shall be in accordance with the recommendation of the Company.



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## 21.0 SPECIAL TOOLS

A complete set of any special tools required for operation, maintenance and testing shall be provided. The Supplier shall provide a list of special tools, individually priced, with his quotation.

## 22.0 INSPECTION & TESTING

22.1 All equipment shall be subject to inspection by the Company or his nominated representative, during the course of manufacture, fabrication, assembly and testing. Inspection shall include verification of the equipment, dimensions, functional test and examination of the documentation.

22.2 The Supplier shall provide test certificates for each type and rating of switchgear for type and routine tests carried out on the switchgear. Tests shall be those listed in the relevant standards (refer to para. 2.0).

22.3 The Company reserves the right to witness the following tests:

22.3.1 Routine tests on all switchgear / components, including power frequency, voltage withstand tests, as specified in the relevant standards (refer to para. 2.0), and:

- Operational (electrical and mechanical) tests on all components.
- Primary and secondary injection tests to prove correct operation of relays.

22.3.2 Type tests where specified.

22.4 The Supplier shall give three weeks notice of test prior to commencement. All relevant certified documentation shall be sent to the Company at least 20 days prior to the test. The test will be witnessed only if the documentation is complete and acceptable to Company. No testing shall commence without written approval of Company.

22.5 The extent of the Company participation in inspection and testing will be identified prior to the placement of an order. The Supplier shall submit an inspection and testing procedure for review and approval by Company prior to start assembling. The inspection and testing procedure shall as a minimum cover:

- Assembling sequence, including inspection and testing.
- Proposed check of system architecture against approved for construction documents.
- Proposed physical inspection of equipment.
- Proposed functional test.
- Proposed check of documentation.

22.6 The Supplier shall submit for Company's review and approval a complete plan for the factory and site acceptance testing. This plan must be complete and provide sufficient detail to indicate the exact nature of each test, time required, expected results and systematic procedure. The plan shall be submitted at least six weeks in advance to the FAT. The objective of the FAT is to verify that the purchased systems, as configured for delivery to site, meets or exceeds the specified designed functional requirements. The FAT shall be a 100% complete system functional test and shall be witnessed by the Company.

22.7 Expenses including airfare, boarding & lodging shall be borne by the Supplier for the agreed number of Company and / Company representatives.

## 23.0 SHIPPING, HANDLING & STORAGE



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- 23.1 The equipment shall be shipped in sections to suit ease of handling for transportation and installation.
- 23.2 Each shipping section shall be provided with supports in the form of suitable steel sections, lifting eyes, etc. to maintain alignment of parts during shipping, handling, hoisting and installation. Location of lifting points shall be clearly marked on shipping containers and on drawings. Each shipping section shall have its weight clearly marked on the container.
- 23.3 Withdrawable circuit breakers shall be shipped separately from their housings.
- 23.4 Preparation for shipment shall protect the auxiliary devices, accessories, etc. against corrosion, dampness, breakage or vibration injury during transportation and handling.
- 23.5 Each shipping container shall be identified with the contents, purchases order number and item number.
- 23.6 Instructions shall be provided for reassembly of sections in the field.

## 24.0 DRAWINGS AND DATA

- 24.1 Drawings and data shall be provided. This data shall include all the protection and overload relay performance curves.
- 24.2 The Supplier shall comply with the following requirements for Installations, Operating and Maintenance Manuals.
- 24.2.1 The front cover, spine and inside page shall state the purchase order number and seller's reference number.
- 24.2.2 The inside front page shall carry an index listing the contents of each section of the manual.
- 24.2.3 Individual sections shall be complete and shall refer to equipment actually supplied.
- 24.2.4 Published data shall be included, including published data for bought in items.
- 24.2.5 Full details of any special equipment shall be clearly set out in separate sections.
- 24.2.6 Details of all protective devices shall be fully documented.
- 24.2.7 A punch list of "do's" and "don'ts" shall be included.
- 24.2.8 Full details for installation and setting up shall be included.
- 24.2.9 Recommended test data shall be stated, covering initial and also regular testing, i.e. values for high voltage, A.C. or D.C. etc. shall be given.
- 24.2.10 Items requiring regular inspection, checking, testing and maintenance shall be listed and the time scale clearly indicated.
- 24.2.11 Important items shall be cross referenced to other parts of the manual as necessary.