



ADNOC GROUP PROJECTS AND ENGINEERING

AIR INSULATED HIGH VOLTAGE SWITCHGEAR AND CONTROLGEAR SPECIFICATION

Specification

APPROVED BY:

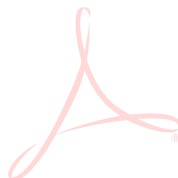
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INTER-RELATIONSHIPS AND STAKEHOLDERS

- a) The following are inter-relationships for implementation of this Specification:
- i. ADNOC Upstream and ADNOC Downstream Directorates and
 - ii. ADNOC Onshore, ADNOC Offshore, ADNOC Sour Gas, ADNOG Gas Processing, ADNOC LNG, ADNOC Refining, ADNOC Fertilisers, Borouge, Al Dhafra Petroleum, Al Yasat
- b) The following are stakeholders for the purpose of this Specification:
- ADNOC PT&CS Directorate.
- c) This Specification has been approved by the ADNOC PT&CS is to be implemented by each ADNOC Group company included above subject to and in accordance with their Delegation of Authority and other governance-related processes in order to ensure compliance
- d) Each ADNOC Group company must establish/nominate a Technical Authority responsible for compliance with this Specification.

DEFINED TERMS / ABBREVIATIONS / REFERENCES

“**ADNOC**” means Abu Dhabi National Oil Company.

“**ADNOC Group**” means ADNOC together with each company in which ADNOC, directly or indirectly, controls fifty percent (50%) or more of the share capital.

“**Approving Authority**” means the decision-making body or employee with the required authority to approve Policies & Procedures or any changes to it.

“**Business Line Directorates**” or “**BLD**” means a directorate of ADNOC which is responsible for one or more Group Companies reporting to, or operating within the same line of business as, such directorate.

“**Business Support Directorates and Functions**” or “**Non- BLD**” means all the ADNOC functions and the remaining directorates, which are not ADNOC Business Line Directorates.

“**CEO**” means chief executive officer.

“**Group Company**” means any company within the ADNOC Group other than ADNOC.

“**Specification**” means this Air Insulated High Voltage Switchgear and Controlgear Specification.

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General

1 PURPOSE

- a) The purpose of this specification is to specify the requirements of the design, performance, materials, manufacturing, inspection, testing, documentation and preparation for shipment of 'factory built assemblies' of air insulated switchgear rated for above 1 kV to 52 kV.
- b) Throughout the text of this specification switchgear shall mean 'switchgear and controlgear'.

2 SCOPE

- a) This specification applies to 'factory-built assembly' metal-enclosed air insulated switchgear and controlgear for ac voltages above 1 kV and up to and including 52 kV.
- b) The standard voltages used by ADNOC for air insulated switchgear are 3.3 kV, 6.6 kV and 11 kV (including 11kV for RMU units).
- c) For project and site specific additional requirements, refer to supplementary requirements stated in respective project's Purchase Requisition documentation.

3 DEFINED TERMS / ABBREVIATIONS

3.1 DEFINED TERMS

COMPANY shall mean 'Abu Dhabi National Oil Company or any of its group companies. It may also include an agent or consultant authorized to act for, and on behalf of the COMPANY'

CONTRACTOR shall mean the company contracted to carry out engineering work on behalf of ADNOC

VENDOR shall mean the manufacturer or supplier of the equipment.

The term (PSR) where used, shall indicate a process safety requirement.

The word 'Shall' indicates a requirement.

The word 'Should' indicates a recommendation.

3.2 ABBREVIATIONS

Abbreviations	
AC	Alternating Current
AIS	Air Insulated Switchgear
CT	Current Transformer
DC	Direct Current
DCS	Distributed Control System (Process Controls)
ECMS	Electrical Control and Monitoring System
EHV	Extra High Voltage
EMC	Electromagnetic compatibility
GRP	Glass Reinforced Plastic
HMI	Human Machine Interface
HRC	High Rupturing Capacity
HV	High Voltage (above 1kV)
IAC	Internal Arc Classification
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineers
IOC	International Oil Companies
IOGP	International Association of Oil and Gas Producers
IPC	Institute for Interconnecting and Packaging Electronic Circuits
IRP	Interposing Relay Panel
IS	Intrinsically Safe
ISO	International Organization for Standardization

ITP	Inspection and Test Plan
kV	Kilo Volts
kVA	Kilo Volt Amperes (Apparent Power)
kW	Kilo Watt
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LSC	Loss of Service Continuity
LV	Low Voltage ($\leq 1000V$)
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
PCB	Printed Circuit Board
PE	Protective Earth
PRP	Parallel Redundancy Protocol
PSR	Process Safety Requirement
RCCB	Residual Current Circuit Breaker
RMU	Ring Main Unit
SIL	Safety Integrity Level
SLD	Single Line Diagram
TCS	Trip Circuit Supervision
TFTP	Trivial File Transfer Protocol
VT	Voltage Transformer

References

See reference documents

4 NORMATIVE REFERENCES

4.1 INTERNATIONAL CODES AND STANDARDS

The following documents are referred to in this Standard and some or all of their content is therefore deemed to constitute requirements of this Standard as set out below.

IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements.
IEC 60204-11	Safety of machinery - Electrical equipment of machines. Requirements for equipment for voltages above 1000V AC or 1500V DC and not exceeding 36kV.
IEC 60255	Measuring relays and protection equipment - All Parts
IEC 60332	Tests on electric and optical fibre cables under fire conditions.
IEC 60364	Low voltage electrical installation.
IEC 60364-4-41	Low Voltage Electrical Installations. Protection for Safety – Protection against electric shock.
IEC 60445	Basic and safety principles for man-machine interface, marking and identification. Identification of equipment terminals, conductor terminations and conductors.
IEC 60529	Degrees of protection provided by enclosures (IP Code).
IEC 60617-DB	Graphical symbols for diagrams.
IEC 60870	Tele-control Equipment and System.
IEC 61034-2	Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements.
IEC 61439	Low voltage switchgear and controlgear assemblies.
IEC 61511-1	Functional safety – safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements.
IEC 61850	Communication networks and systems for power utility automation - All Parts.
IEC 61869	Instrument Transformers - All Parts.

IEC 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems.
IEC 62271-1	High voltage switchgear and controlgear – Part 1: Common specification for alternating current switchgear and controlgear.
IEC 62271-3	High voltage switchgear and controlgear – Part 3: Digital interfaces based on IEC 61850
IEC 62271-37-013	IEEE/IEC Standard for high-voltage switchgear and controlgear. Alternating current generator circuit breakers.
IEC 62271-100	High voltage switchgear and controlgear – Part 100: Alternating current circuit breakers
IEC 62271-103	High voltage switchgear and controlgear – Part 103. Switches for rated voltages above 1kV up to and including 52kV
IEC 62271-106	High voltage switchgear and controlgear – Part 106. Alternating current contactors, contactor-based controllers and motor starters
IEC 62271-200	High voltage switchgear and controlgear – Part 200: AC metal enclosed switchgear and controlgear for rated voltages above 1kV and up to 52kV.
IEC 62271-206	High voltage switchgear and controlgear – Part 206: Voltage presence indicating system for rated voltage above 1kV and up to and including 52kV.
IEC 62351	power systems management and associated information exchange.
IEC 62402	Obsolescence management.
IEC 62439	Industrial communication networks – High availability automation networks.
IEC 62443	Industrial communication networks – Network and system security (DRAFT)
IEC TS 62271-304	High-voltage switchgear and controlgear - Part 304: Classification of indoor enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV related to the use in special service conditions with respect to condensation and pollution.
IEC TR 61000-3-6	Electromagnetic compatibility (EMC) - Part 3-6: Limits - Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems.
IEC TR 62061-1	Guide to the application of ISO 13849-1 and IEC 62061.
ANSI C-37.2	Electrical power system device function numbers.



Where switchgear is defined on datasheets for service on an offshore installation, the equipment shall also conform to requirements for such equipment, as defined in the following standards:

IEC 60092-101 Electrical installations in ships - Part 101: Definitions and general requirements.

IEC 61892-3 Mobile and fixed offshore units - Electrical installations - Part 3: Equipment.

SECTION A

5 REFERENCE DOCUMENTS

5.1 ADNOC DOCUMENTS

AGES-SP-02-008	Electrical control and monitoring system specification.
LATER	ADNOC tagging and numbering procedure
LATER	ADNOC painting, preservation and shipment specification

5.2 STANDARD DRAWINGS

To be advised

5.3 OTHER REFERENCES (OTHER CODES/IOC STANDARDS) ETC.

IOGP Specification: S-620 Supplementary Specification to IEC 62271-200 High-voltage switchgear and controlgear

6 DOCUMENTS PRECEDENCE

The specifications and codes referred to in this specification shall, unless stated otherwise, be the latest approved issue at the time of Purchase Order placement.

In case of conflict, the order of precedence shall be:

- UAE Statutory Requirements
- ADNOC Codes of Practice
- Equipment Data Sheets and Drawings
- Project Specification and Standard Drawings
- Company Specifications
- National / International Standards

Any conflicts shall be highlighted to the COMPANY/CONTRACTOR and a resolution proposed.

7 SPECIFICATION DEVIATION/CONCESSION CONTROL

Deviations from this specification are only acceptable where the VENDOR has listed in his quotation the requirements he cannot, or does not wish to comply with, and the COMPANY/CONTRACTOR has accepted in writing the deviations before the order is placed.

In the absence of a list of deviations, it will be assumed that the VENDOR complies fully with this specification.

Any technical deviations to the Purchase Order and its attachments including, but not limited to, the data sheets and Narrative Specifications shall be sought by the VENDOR only through Concession Request Format. Concession requests require CONTRACTOR'S and COMPANY'S review and approval, prior to the proposed technical changes being implemented. Technical changes implemented prior to COMPANY approval are subject to rejection.

8 DESIGN CONSIDERATIONS

8.1 DESIGN LIFE

- a) The switchgear shall have a minimum design life of 25 years when operating at rated conditions and maintained according to the VENDOR's recommendations.
- b) The switchgear shall be capable of continuous operation at full load for a minimum of 50,000 hours without the need for routine maintenance involving de-energisation of the switchgear.

8.2 OBSOLESCENCE

The manufacturer shall submit a statement along with the bid, in accordance with IEC 62402, on any planned or predicted obsolescence of equipment or components over this design life and advise what provisions are made to allow ease of future upgrading of any switchgear purchased.

8.3 DESIGN PARAMETERS

Refer to data sheet

8.4 ENVIRONMENTAL AND SITE DATA

- a) Unless otherwise specified on the data sheet the service conditions of the switchgear shall be as below.
- b) Equipment shall be installed indoors in an air-conditioned environment.
- c) The switchgear shall be rated for normal service conditions as per IEC 62271-1. The maximum air ambient temperature specified in IEC 62271-1 is 40°C. The max 24-hour average ambient temperature shall be 35°C.
- d) The environmental conditions with respect to condensation and pollution shall be Class 0 as per the IEC TS 62271-304.

8.5 AREA CLASSIFICATION

The equipment will be located indoors in a non-hazardous area in respect of hydrocarbon hazards.

SECTION B

9 TECHNICAL REQUIREMENTS

9.1 BASE STANDARDS:

The HV switchgear shall comply with

IEC 62271-1

IEC 62271-200

Associated standards referenced in the above standards

9.2 ADDITIONS AND AMENDMENTS TO CLAUSES RELATING TO IEC 62271-200:

IEC Clause 4.0 Ratings

1. The equipment ratings as defined in IEC 62271-1 shall be as specified in the data sheet.
2. Ratings detailed on data sheets are intended for equipment operating at rated output. Ratings shall be specified on the basis of the equipment and components housed in the enclosures with natural ventilation under the service conditions specified. Forced ventilation shall not be used unless otherwise agreed with the COMPANY.
3. All components shall have the user defined ratings after applying any de-rating factors for the specified service conditions.
4. When a switchgear assembly is close to a generator, it shall be capable of breaking a short-circuit current with a higher percentage DC component than the value given in figure 9 of IEC 62271-100. The required DC component shall be specified in the data sheet.
5. The main bus bar shall be fully rated along its entire length and shall not be lower in rating than the incoming and bus sectionalizing devices.
6. Supply System Variations: The switchgear and control gear shall be capable of continuous operation at its rating and within the limits of temperature rise under continuous deviation of the nominal values of the system voltage and frequency with specified variations as given in the data sheet.
7. Unless otherwise stated in the data sheet the supply voltage harmonic content shall not exceed 6.5% in accordance with IEC TR 61000-3-6: 2008, Table 2
8. Insulation Coordination. The rated insulation levels shall be the higher values selected from Table 1 of IEC 62271-1, for:
 - a) 11kV systems – 75kV
 - b) 6.6kV systems – 60kV
 - c) 3.3kV systems – 40kV
9. Unless otherwise specified, the following auxiliary power supplies shall be used:

- a) Close and trip supplies and spring charger motors: 110V DC (unearthed).
- b) Control, protection, monitoring and inter-trip: 110V DC (unearthed).
- c) Space heaters, panel lighting, and small power: 240V / 220V AC (earthed).

IEC Clause 4.101 Ratings of the Internal Arc Classification (IAC)

1. Switchgear enclosures shall comply with IEC 62271-200 Annex AA with regard to their mechanical strength in the event of an internal arc.
2. The switchgear shall be IAC classified as AFLR unless otherwise stated in the data sheet.
3. Switchgear accessibility type shall be Type A i.e. authorised personnel only.
4. The switchgear shall be designed to withstand the stated maximum arcing fault current for a duration of 1.0 seconds, unless otherwise stated in the data sheet.

IEC Clause 5.0 Design and Construction

1. Removable parts and components of the same type, rating and construction shall be mechanically and electrically interchangeable. A mechanical mismatching system shall be provided to prevent the entry of units, which are not identical.
2. All components requiring periodic maintenance shall be easily accessible.
3. Cable installation work on functional units and replacement on spare panels shall be safely possible without de-energising adjacent units.
4. Unless stated otherwise stated on the data sheet, the switchgear shall be designed as a single bus bar system. Where a double bus bar system is specified, each bus system shall be fully segregated with functional units independently connectable to each bus bar. Where bus couplers and sectionalisers are detailed on the data sheet, these shall be capable of electrical connection of buses via an interlocking system.
5. The incoming and bus-sectionalising breaker cubicles shall be located at the centre of the switchgear unless otherwise stated on the data sheet or SLD.
6. The switchgear shall be designed to facilitate future extension at either end of the line-up with minimum disturbance to installed equipment and without a shutdown of the complete switchgear. Bus bars shall be pre-drilled for future extension.
7. The design shall include facilities for HV testing of one bus section while the other section is in operation.
8. HV and LV Power Cable Terminations:
 - a) The type and size of the cables will be advised by the COMPANY or CONTRACTOR as defined in the circuit schedule.
 - b) The switchgear supplier shall size the terminals and shall determine the size of terminating compartment.
 - c) Separate compartment for high and low voltage shall be provided.

- d) When terminating to bar conductors the bar conductors shall be pre-drilled by the switchgear supplier.
 - e) Pre-drilled gland plates shall be supplied as stated in the data sheet. Gland plates for single core cables shall be of non-ferrous material.
 - f) Where three phase cables are to be terminated the dimension of the cable compartment shall enable adequate clearances for crossing of cable cores.
9. All cables entering the enclosure shall be bottom entry unless otherwise stated on the data sheet.
10. Back-to-back (double front) layout of switchgear is not acceptable.

IEC Clause 5.3 Earthing of switchgear and controlgear

- 1. An earthing bus bar shall be provided along the full length of the switchgear structure.
- 2. Earthing bolts of at least 10 mm shall be provided at both ends of the earthing bus bar for direct connection to the station earthing grid.
- 3. Earthing bus bar shall have a minimum cross sectional area as specified on the data sheet or shall be sized in accordance with clause 5.3.105 of IEC 62271-200.
- 4. Earthing bus bar shall be made of hard drawn copper.

IEC Clause 5.3.101 Earthing of the High Voltage Conductive Parts

- 1. Circuit earthing switches shall be provided on each incomer and outgoing feeder.
- 2. Earthing switches shall be rated, as a minimum unless stated otherwise in the data sheet.
 - a) Short-circuit making capacity Class E1
 - b) Mechanical endurance classification M0.
- 3. Bus bar earthing switch shall be provided either on each supply incomer, or via dedicated bus bar earthing compartment through a bus bar earthing truck.
- 4. Mechanical interlocking in addition to fail-safe electrical interlocking as per single line diagram and data sheet shall be provided such that:
 - a) Power cannot be switched on a live circuit or bus.
 - b) Earth switch cannot be closed on to a live circuit or bus.
- 5. Key exchange interlocking shall be provided for bus bar earthing such that:
 - a) The bus bar earth switch cannot be closed unless all incoming and outgoing supplies to that section of the bus are isolated and bus section breaker(s) is isolated.

- b) None of the incoming power supply can be switched 'on' unless the bus bar earth switch is open.
6. Earthing devices shall be arranged for local, manual operation only.
7. 'Circuit earthed' and 'bus bar earthed' Indication signals shall be provided.
8. Padlocking facilities for locking the earthing device in the open and closed position shall be provided

IEC Clause 5.4 Auxiliary and Control Equipment (General)

1. Unless otherwise specified in datasheets, Voltage tolerances shall be as specified in the IEC 62271-1
2. Each tripping and closing supply to the switchgear assembly shall have the following arrangements:
 - a) Dual redundant feeders with auto transfer system for AC auxiliary power. Auto transfer will be prevented if the feeder is tripped due to a fault downstream of the supply MCB.
 - b) Dual redundant feeders via blocking diodes for DC auxiliary power.
3. Each feeder shall normally feed one section of the switchgear. A switching facility with auto changeover shall be provided at the switchgear such that any one feeder can feed the entire switchgear.
4. Each functional unit shall be provided with separate two pole MCB for control and auxiliary circuits.
5. Failure of trip circuit shall prevent closing of the circuit breaker. Failure of a power supply shall initiate an alarm.
6. Padlocking or key operated lock shall be provided for each MCB for locking it on open position.
7. Switching device operation counter shall be included.

IEC Clause 5.4 Auxiliary and Control Equipment (Accessibility)

1. Indicating instruments shall be in accordance with the IEC standards and have an accuracy class 2.5. They should be of the square pattern type 96 x 96 mm and mounted at a suitable height for easy reading from the front. Readings shall be in actual value(s).

2. Protection and Metering devices in Switchgear shall be installed at a height not exceeding a maximum 1.8m from substation floor level.

IEC Clause 5.4 Auxiliary and Control Equipment

(Components Installed in Enclosures)

Requirements for auxiliary and control circuit components

1. Switchgear compartments shall have natural ventilation. Circuit breaker arrangements requiring forced cooling will not be acceptable.
2. The utilisation categories and minimum characteristics of relays shall be:
 - a) AC15 for AC applications
 - b) DC13 for DC applications
 - c) Minimum rated operational current of the relay: 5A @ 240VAC; 1A @ 110VDC
 - d) Service cycles: 120 cycles/hour (each relay)
 - e) Mechanical duration class: 1 (one million operation cycles)
 - f) Each relay shall have two sets of spare NO/NC change over contacts for future use.

Additional requirements for auxiliary and control equipment are given in Annexure 1 of this specification.

IEC Clause 5.4 Auxiliary and Control Equipment

Cables and Wiring

1. Cabling and wiring shall comply with Section 14 of IEC 60204-11.
2. All wiring for external connections shall be brought out to individual terminals on a terminal block.
3. The terminal blocks shall be grouped by function and operating voltage, separated from other groups using barrier plates or earthed terminals.
4. Functional grouping, voltage levels and discrete terminals shall be identified by labels.
5. Terminals remaining live when a functional unit is isolated shall be provided with a warning label.
6. Terminals associated with external sources of supply shall be provided with a warning label.
7. Terminals associated with inductive CT circuits shall be provided with shorting links.
8. Links used for earthing of control supplies and CTs shall be mounted in accessible low-voltage compartments.
9. Equipment containing instrument or instrument circuits requiring special earthing shall be equipped with a separate instrument earth bar isolated from the enclosure.

10. Knife disconnect terminals shall be used where control circuits are required to be opened without disturbing the wiring.

Additional cabling requirements for auxiliary and control equipment are given in Annexure 1 of this specification.

IEC Clause 5.6 Stored Energy Operation

1. Circuit breaker motor-wound spring operating mechanisms shall be provided with means to charge springs manually. The manual charging mechanism shall be such that the manual charging handle will decouple as soon as the springs are fully charged.
2. The supply voltage to the spring charging motor shall be disconnected when the spring charge handle is inserted for manual charging of the spring. Alternatively, the charging handle shall be so designed that it self-disengages should the motor start running.
3. The closing operation shall be possible only when the closing spring is fully charged.
4. The closing spring can only be released when the breaker is fully open.
5. A device shall be employed to block overcharging of the closing spring when manual charging.

IEC Clause 5.10 Nameplates

Labels and Nameplates shall be provided for:

1. Each Functional Unit. The functional unit name plate shall include
 - a) Functional unit compartment location (number);
 - b) Tag number of connected equipment;
 - c) Service description of connected equipment;
 - d) Circuit rating / kW rating.
2. Name plates with same information shall be fixed at both the front and the rear of each functional unit.
3. Circuit designation labels shall be secured with non-corrodible screws or other demountable fixing systems.
4. Identification of the conductors of main and auxiliary circuits: Alphanumeric notation, generally in accordance with IEC 60445 shall be used for identification and marking of phases, conductors and terminals.
5. A durable mimic synoptic diagram displaying the single line arrangement of bus bars and the main switching devices of incomers, bus couplers and feeders shall be provided on the front of the assembly.
6. Main equipment name plate and rating plate shall be stainless steel and engraved.

IEC Clause 5.11 Interlocking Devices

1. Padlocking or key operating facilities shall be provided for the following:
 - a) Circuit breakers in either the disconnected, or earthed positions.
 - b) Circuit breaker mechanical closing push button
 - c) All isolators in the "OFF" position only
 - d) Access to isolation and earth switch operating mechanism
 - e) High voltage compartments doors closed position.
 - f) Selector switches such as local/remote, auto/manual selector switches in all positions.
 - g) Circuit breakers closed in earthed position.
 - h) Power supply switching devices in control circuits, lockable in open position
 - i) It shall not be possible to padlock any switching device in its closed position, except for switches used for earthing.
2. Interlocking requirements between functional units and the external system will be specified in the data sheet and drawings included in the requisition.

IEC Clause 5.12 Position Indication

1. Mechanical indicators connected directly and permanently to the operating shaft are required to positively display the actual switch position. Indirect position indicators are not acceptable.

IEC Clause 5.13 Degrees of Protection by Enclosures

1. The minimum degree of protection for LV compartments shall be IP31 for indoor applications, unless otherwise stated in the data sheet.
2. Components remaining live when LV enclosure doors are opened shall have a minimum IP 20 protection.
3. Degree of protection between adjacent functional units shall be a minimum of IP3X
4. For outdoor installations, the minimum degree of protection shall be as below.
 - a) IP 55: Onshore
 - b) IP56: Offshore locations.
5. Minimum dropped object impact level shall be IK07

IEC Clause 5.17 Fire Hazard (Flammability)

1. Where specified in the data sheets, auxiliary and control circuit insulation shall be low smoke and halogen free. Refer to Annexure 1 for more details.

IEC Clause 5.20 Corrosion

Refer to Section 16 of this specification.

IEC Clause 5.101 Internal Arc Fault

1. Each separated compartment of the switchgear shall be provided with means to safely direct and exhaust gases resulting from an internal arc flash to a safe area.
2. Partitions shall be provided at bus coupler boundaries to prevent an internal arc in one bus section propagating to other bus sections.
3. Where required as per the user diagrams, an internal arc fault detection and protection system to reduce incident energy levels, shall be provided and integrated into the high-voltage switchgear assembly.

IEC Clause 5.102.1 General (Enclosure)

1. The switchgear shall be free standing, floor mounting and of flush fronted construction.
2. Unless otherwise specified in the data sheet the switchgear assembly functional units shall be of withdrawable type.
3. The switchgear shall be of the LSC2B-PM category as defined in IEC 62271-200 publication.
4. A base frame, complete with holding down bolts, nuts and washers, rails, etc., shall be included to provide foundation for the installation of the switchgear assembly.
5. Each cubicle shall consist of at least the following arc proof Medium Voltage interlock controlled, tool-based accessible compartments:
 - a) Circuit Breaker compartment
 - b) Bus bar compartment
 - c) Power cable connection compartment
6. In addition, protection, control and monitoring facilities shall be located in a segregated, dedicated low voltage compartment.
7. The switchgear assembly shall be complete with eyebolts/lifting eyes, etc., to facilitate installation.

8. The floor surface below the installed switchgear shall not be considered as part of the enclosure.

IEC Clause 5.102.2 Covers and Doors (Enclosures)

1. Hinged doors shall not be obstructed, when open, by adjacent equipment or doors of the assembly
2. Doors shall be provided with supplementary equipotential bonding, in accordance with IEC 60364-4-41.
3. For offshore applications, doors shall be provided with restraints to secure the door in the open position.

IEC Clause 5.103 High Voltage Compartments

1. The access to the high voltage compartment from front and rear of the panel for normal operation and maintenance shall be interlocked as below.
 - a) Such that the compartment door cannot be opened unless the equipment inside is de-energised,
 - b) The equipment cannot be energised unless the door is closed.
 - c) The rear door or panel cannot be opened if the breaker is in service position.
 - d) The breaker cannot be put in service position unless the rear door or panel is closed.
2. To allow safe access to one bus section when the other is live, bus bar compartments of the different sections of the switchgear shall have separate doors or covers. No bus bar compartment shall contain more than one bus section. Bus bar risers on different sides of a bus coupler shall be in separate compartments.
3. The LSC category for functional units shall be:
 - a) LSC2B for circuit-breakers.
 - b) A minimum LSC2A for contactor feeders without back-feed.
4. Shutters for bus section circuit breakers shall be labelled with their respective bus bar identification, tags, and reference.
5. Voltage transformer: Shutter shall be provided to automatically seal off the high voltage spout when the voltage transformers are withdrawn.
6. Connection Compartment:
 - a) An air insulated connection compartment having adequate clearance for access, installation, and termination of HV cables shall be provided.

- b) The connection compartment shall be suitable for terminating heat shrink type cables including stress cones.
- c) Single core cables shall be glanded using undrilled non-magnetic gland plates, insulated from the framework.
- d) Cable entry shall be from bottom.
- e) Cable type and size shall be defined on the data sheet.
- f) Where cable test facilities are included on the data sheet, they shall be fully interlocked with the switching device and any upstream device to ensure that testing can be carried out without risk to personnel or equipment.

IEC Clause 5.105 Provisions for dielectric tests on cables

Requirement for cable testing when connected to the switchgear terminals shall be stated in the data sheet.

IEC Clause 6.0 Type Tests

For inspection and testing requirements see Section 14

IEC Clause 7.0 Routine Tests

For inspection and testing requirements see Section 14

IEC Clause 10.1 Conditions during transport, storage and installation

VENDOR's standard packing shall be acceptable unless otherwise stated in the users' Preservation and Export Packing Procedure and/or data sheet.

10 ADDITIONAL SPECIFIC REQUIREMENTS

10.1 GENERAL

In addition to the IEC Standards' requirements, the switchgear shall comply with the following.

10.2 BUS BARS

- a) Bus bars shall be of the same cross sectional area throughout the length of the switchgear
- b) Bus bars shall be made of hard drawn high conductivity copper.
- c) The bus bars including the branch connections shall be fully insulated. The insulation shall be rated to withstand at least the line voltage of the system.
- d) All bolted connections shall be

- i. Silver or tin plated
- ii. Made with high tensile strength bolts
- iii. Secured against loosening.

10.3 SWITCHING DEVICES

10.3.1 General

- a) Unless otherwise specified in the data sheet circuit breakers and contactors shall be vacuum type.
- b) Unless otherwise specified circuit breakers and contactors shall be withdrawable type.
- c) Surge suppressors shall be provided for all vacuum circuit breakers and contactors.

10.3.2 Circuit Breakers

- a) Circuit breakers shall comply with the requirements of IEC 62271-100.
- b) Circuit breakers shall be rated for the fault make and break duties stated in the data sheet and single line diagram.
- c) Circuit breakers shall be designed for use with cable circuits and be rated Class S1, unless defined otherwise in the data sheet.
- d) Circuit breakers designated for use in generator incomer circuits shall conform to IEC/IEEE 62271-37-013 for operation with the circuit parameters defined on the data sheet and accompanying documents.
- e) Circuit breakers shall be rated as below as a minimum unless stated otherwise in the data sheet.
 - i. Basic electrical endurance Class E1
 - ii. Normal mechanical endurance Class M1 for non-motor circuit breakers.
 - iii. Extended mechanical endurance Class M2 for motor feeders.
- f) Circuit breakers shall be withdrawable type with the following positions:
 - i. Inserted (service position)
 - ii. Test position (power contact disconnected, and auxiliary circuit connected).
 - iii. Rack out position (isolated).

10.3.3 Switches and Fuse Switches

- a) Switches shall be of 3-phase, load break, fault make design, rated for the specified load and fault conditions, and shall incorporate three positions, Closed, Open and Earthed.
- b) Switches shall be designed for 'increased operating frequency' in accordance with IEC 62271-103
- c) Unless otherwise specified the operating mechanism shall be manually initiated motor powered, fast acting with speed of operation independent of operator action.
- d) Where indicated on the data sheet, switches shall be fitted with electrical operating mechanisms.
- e) Padlocking facilities shall be provided for locking in the Closed, Open and Earthed positions.

- f) Where fuses are specified, they shall be housed in a separate air insulated, phase segregated compartment.
- g) Fuses shall incorporate a mechanical trip. Fuse blow in any of the phase shall open all three phases of the switch.
- h) Auxiliary boxes shall be interlocked such that they can only be opened when the switch is in the earthed position. In addition, the switch shall be interlocked such that it cannot be moved from the earthed position if the access of the auxiliary compartment is open.
- i) Where switches are supplied directly from upstream remote switchgear, a Key exchange interlocking scheme shall be provided to prevent switching to the earthed position if the upstream device is closed, and to prevent closure of the switch if the upstream device is open.

10.3.4 Contactors

- a) Contactors and motor starter circuits shall comply with IEC 62271-106.
- b) Contactors shall be rated for an utilisation category of AC-3 and shall be rated for both continuous and intermittent duty of Class 12, a minimum intermittent duty.
- c) The minimum short-circuit breaking capacity shall be 5kA at rated voltage.
- d) Unless otherwise specified on the data sheet or SLD, contactors shall be mechanically latched type with an electrical trip coil and manual release.
- e) The minimum no-load operating cycle mechanical endurance shall be in excess of 100,000 operations for latched contactors and 300,000 operations for non-latched contactors.
- f) The classification of acceptable damage shall be Type C considering the largest fuse that can be accommodated.

10.4 INSTRUMENT TRANSFORMERS:

10.4.1 Voltage Transformers

- a) Voltage transformers shall be encapsulated cast resin type.
- b) Voltage transformers shall be withdrawable type and protected by HRC fuses at the primary and MCB at the secondary.
- c) The MCBs shall be with auxiliary contact for trip indication.
- d) Broken delta connection shall have adequate surge suppression protection, if required, in conformance with the application.
- e) Voltage transformers shall be provided in accordance with the data sheet and single line diagram. Voltage transformers shall comply with IEC 61869-1:2007 and IEC 61869-3:2011.
- f) Unless otherwise specified on the data sheet, voltage transformers shall have minimum accuracy as:
 - i. Measurement: class 1.0
 - ii. Protection: class 3P
- g) The secondary rated voltage shall be 110 V.
- h) VENDOR shall be responsible for the selection of the VT burden and shall provide calculations to justify the selection. VT's shall have a burden rating with a spare capacity of at least 25%.

- i) Secondary circuits shall be suitably supervised by a four pole MCCB's of adequate characteristics and shall be equipped with remote alarm contacts to be connected to the ECMS.
- j) One side of the low voltage winding of single phase voltage transformers and the star-point of three phase voltage transformers shall be earthed via an earthing link.
- k) Voltage transformer nameplates shall be fixed in a position so that details can easily be read when fitted in the cubicle.
- l) The use of low power VTs with alternative configurations to those described above shall be acceptable in place of conventional VTs subject to COMPANY approval. In this case, the VTs shall comply with IEC 61869-6/7/9/11/13.

10.4.2 Current Transformers

- a) Current transformers shall be of the toroidal ring type or of the core balance type (as applicable); and shall comply with IEC 61869-2:2012.
- b) Current transformers shall be provided in accordance with the single line diagram and data sheet.
- c) The selection of appropriate class of protection CT shall remain the responsibility of the VENDOR. The VENDOR shall size the CT to ensure correct operation of the protection equipment and provide a spare capacity of at least 25% and shall provide calculations to justify the selection.
- d) The short-time current rating of CTs shall be, as a minimum, equal to that of the let-through current of the main circuit protective device.
- e) Unless otherwise stated, the minimum accuracy classes shall be:
 - i. Measurement:
 - Class 1 for incoming feeders
 - Class 3 for outgoing feeders
 - For tariff metering higher accuracy class as given in the data sheet or SLD shall be used.
 - ii. Differential: Class PX (a minimum margin of 50% shall be provide in knee-point voltage)
 - iii. Other Protections: Class 5P20
- f) The secondary current rating of the CTs shall be 1A.
- g) Secondary windings of each CT shall be earthed at one point only.
- h) Shorting terminals for current transformers shall be provided for all terminals.
- i) Where current balance protection is specified, VENDOR shall provide calculations together with current transformer magnetization curves to prove the through fault stability of the protection up to the switchgear fault rating.
- j) Current transformer nameplates shall be fixed in a position so that details can easily be read when fitted in the cubicle.
- k) Maximum possible DC component and auto-reclosing shall be considered for CT dimensioning.
- l) The use of low power or electronic CTs with alternative configurations to those described above shall be acceptable, subject to COMPANY approval, in place of conventional CTs. In this case, the CTs shall comply with IEC 61869-6/8/9/10/13.

10.4.3 Alternative Instrument Transformer Designs

Where offered, electronic or low power VTs and CTs, complying with stated IECs, will be considered by COMPANY and use of these shall be subject to COMPANY approval. VENDOR shall ensure that all electronic instrument transformers are fully compatible with the electronic device(s) or systems to which they are connected. Any interfacing device required to provide this compatibility shall be included.

Complete details of the proposed installation shall be included in tender documents to allow consideration of the use of these devices. Provision shall be made for a low energy analogue device within the transformer connection to allow for routine testing of relay set points. Supplier shall include within the tender for supply of a test device to enable such testing.

10.5 PROTECTION AND CONTROL SYSTEM

10.5.1 General

The functional units shall be equipped with integrated digital protection and control devices, which shall include the protection, automation, measurement, counting, monitoring, diagnosis, and communication functions.

VENDOR may include in the tender an option for fully digital switchgear integrating protection, control and interlocking between functional units within the switchgear and with other switchgear.

10.5.2 Protection Relays

- a) Protection functionality shall be provided in accordance with
 - i. Single line diagrams.
 - ii. Protection and metering diagrams.
- b) Detailed requirements for protection relays are given in Annexure 2 of this specification.
- c) All IED devices shall be procured from manufacturers and suppliers approved by the COMPANY.
- d) VENDOR shall be responsible for protection relay, IED generic configuration and IED functional logic files.
- e) CONTRACTOR will be responsible for provision of protection relay settings specific to the load and the electrical system network.
- f) VENDOR shall submit functional logic diagrams and configuration settings files to CONTRACTOR/COMPANY. A responsibility matrix or flow chart shall be developed between both parties and used as an interface control document.
- g) Test blocks shall be provided for testing protection relays and CT/VT circuits. Necessary test plugs shall be supplied along with the switchgear.

10.5.3 Tripping Circuit

- a) Interlocking shall be provided to ensure that a trip can only occur when the breaker is closed.
- b) Circuit breakers shall be electrically trip-free.

- c) A Trip Circuit Supervision (TCS) facility shall be provided to monitor the trip coil, trip circuit wiring and voltage supply and shall be operable independent of the status of the breaker (open or closed). A trip circuit fault, as detected by the TCS shall initiate an alarm and inhibit closure of the circuit breaker.
- d) When the circuit breaker is in the withdrawn position, the TCS shall be inoperative.
- e) Where defined in the data sheet, dual trip coils shall be provided.
- f) A manual trip pushbutton shall be included in the trip circuit, guarded to prevent inadvertent operation.
- g) The trip circuit for mechanically latched contactors shall be designed as those for circuit breakers.
- h) The trip circuit shall have independent overcurrent protection.
- i) Trip coil shall be "shunt trip". However, where specified, SIL rated fail safe trip coil shall be provided to trip specified critical loads when trip supply fails. (PSR)

10.5.4 Closing Circuit

- a) The closing coil shall be fitted with a mechanical anti-pumping feature to prevent repeated opening and closing of the circuit breaker, when closing is attempted on a standing fault.
- b) The closing circuit shall be interlocked to inhibit a close attempt in the event of an existing trip condition.
- c) The closing circuit shall function correctly for the maximum cable lengths shown on the data sheets.
- d) The closing circuit and spring charge circuits shall have independent overcurrent protection.

10.5.5 High Voltage Detection and Indication

A capacitive, three phase voltage detector shall be provided at the HV cable terminals in each functional unit, and on front of both sides of bus section breakers. The device shall be fitted with test points for connection of an external phase comparator.

10.5.6 External Interfaces

- a) If a functional unit is defined on the circuit schedule as forming part of a machinery package, the interface components shall conform to IEC TR 62061-1 for safety of machinery and control systems; and requirements for related documents.
- b) For emergency shutdown systems, separate SIL rated interface relays shall be used. SIL rated relays shall comply with IEC 61511-1 to the SIL level defined in the circuit schedule. Such shutdown signals shall be hard-wired into the relevant functional unit(s) by way of an external Interposing Relay Panel (IRP). (PSR)
- c) Details of the required I/O for control and monitoring will be given on the data sheet and associated documents.
- d) All defined monitoring and control points shall be transmitted to the ECMS, unless included in Emergency Shutdown logic described above. Digital interfaces with the ECMS shall be based on IEC 61850 protocol and shall conform to IEC 62271-3.
- e) A free-issue switchgear interface unit will be provided to VENDOR to enable interfacing with the ECMS. The interface shall be designed on a dual redundant basis. VENDOR shall liaise with the CONTRACTOR and ECMS supplier to confirm the functionality of the interface.

- f) Where a fully digital switchgear is offered, the above interfacing details shall be amended to suit the arrangement of the systems provided; but shall comprise a fully dual redundant communication system subject to COMPANY approval.

10.5.7 Cyber Security

- a) A role based access control shall be incorporated
- b) Cyber security for the products and external interface shall comply with IEC 62443 series of standards as applicable.
- c) Communication protocols shall comply with IEC 62351.
- d) VENDOR shall provide firewall and malware protection in line with COMPANY corporate cyber security policy.

10.6 ONLINE CONDITION MONITORING

10.6.1 General

- a) Where specified in the requisition online condition monitoring as below shall be provided.
- b) As a minimum an embedded condition monitoring system shall be included to monitor the following for each switchgear.
 - i. Temperature monitoring
 - ii. Partial discharge measurement
- c) The condition monitoring embedded components and wiring shall not impact the switchgear ratings and certification.
- d) The embedded condition monitoring system shall be maintenance free and subject to COMPANY approval.

10.6.2 Temperature Monitoring:

- a) The temperature detectors shall be installed close to
 - i. Bus bar joint
 - ii. Circuit breaker spouts
 - iii. Cable terminations
- b) Temperature sensors shall be either fibre-optic type or wireless sensors utilising mature technology.
- c) Temperature measurement system shall determine the hot spot absolute temperature as well as the differential temperature above the absolute ambient temperature.
- d) The system shall have the ability to provide load related thermal alarm threshold.

10.6.3 Online Partial Discharge Monitoring:

- a) Online partial discharge monitoring shall be provided for switchgear 6.6 kV and above.
- b) Partial discharge sensors shall be high frequency current transformer (HFCT) type.

10.6.4 Data Gathering and Analyser:

- a) The system shall include
 - i. Data gathering, storage, and analyser module.
 - ii. Data analysers
 - iii. Wired and wireless communication links
 - iv. Communication link to ECMS

10.7 RING MAIN UNITS

- a) Ring main units (RMUs) will be used for tie-ins at remote locations to the HV power distribution systems and for power supply system feeds to site areas.
- b) The RMU shall be a metal-enclosed free-standing assembly, dead-front, dust and vermin proof suitable for indoor or outdoor installations, as specified.
- c) The insulation medium for each compartment containing switching devices or busbars shall be as specified in data sheet and SLD.
- d) The complete RMU installation shall be capable of extension, should additional feeders be required for future installation(s).
- e) Ring-switches, fuse switches, disconnection switches and circuit breakers shall be complete with direct connected position indicators, showing the device status, visible from the front of the panel in which they are housed.
- f) Loss of service continuity as per IEC 62271-200 shall be "LSC1 category" for ring-switches; and of the "LSC2 category" for the outgoing functional units.
- g) All control, protection and metering requirements and data for the RMU design including, rated voltage, current ratings shall be as specified on datasheets and single line diagrams (SLDs).

SECTION C

11 DETAILS SCOPE OF SUPPLY

The scope of supply of shall include:

- a) Detailed design
- b) Supply of materials
- c) Factory and site inspection and testing
- d) Documentation including certification
- e) Installation, commissioning and start-up assistance; where specified in the requisition
- f) Spare parts for 2 years operation

Refer to the project requisition document for detailed requirements

12 QUALITY CONTROL AND ASSURANCE

Equipment shall only be purchased from vendors approved by ADNOC Category Management. This approval indicates that the VENDOR has an approved Quality management system and a proven track record in supply of this type of equipment.

12.1 SUBCONTRACTORS/SUBVENDORS

The VENDOR shall assume unit responsibility and overall guarantee for the equipment package and associated equipment.

The VENDOR shall transmit all relevant purchase order documents including specifications to his sub-vendors and sub-contractors.

It is the VENDOR'S responsibility to enforce all purchase order and specification requirements on his sub-vendors and sub-contractors.

The VENDOR shall submit all relevant subvendor and subcontractor drawings and engineering data to the CONTRACTOR.

The VENDOR shall obtain and transmit all subvendor and subcontractor's warranties to the CONTRACTOR/COMPANY, in addition to the system warranty.

13 MATERIAL & CERTIFICATIONS

Not applicable

14 INSPECTION & TESTING REQUIREMENTS

14.1 GENERAL

- a) Before leaving the VENDOR'S works, each item of equipment shall be inspected and tested in accordance with the relevant IEC Standards as listed in Section A of this specification.
- b) The VENDOR shall provide an Inspection and Testing Plan (ITP) at least 8 weeks' notice prior to the testing date.
- c) The ITP shall be submitted for review and acceptance by the COMPANY and include Witness and Hold points in the programme for VENDOR, CONTRACTOR, and the COMPANY.
- d) The COMPANY/CONTRACTOR or his nominee shall inspect the equipment and witness the required tests indicated in the Requisition at the time the equipment is offered for final inspection.
- e) A detailed test procedure of factory tests shall be submitted at least 3 months in advance of any testing, detailing the proposed inspection, testing and witness testing programme throughout the design and build of the equipment.
- f) Test certificates for each item of equipment shall be submitted prior to delivery for COMPANY acceptance.

14.2 TESTS REPORTS

- a) Test reports in accordance with the relevant IEC standards including the following shall be submitted to COMPANY.
 - i. The design values
 - ii. The tolerance values
 - iii. The real values as measured, including, if any, the intermediate values causing provisional refusal.
- b) VENDOR shall compile the records of all inspections and tests including routine tests and special tests in one document and shall submit as part of technical documentation.

14.3 TYPE TESTS:

- a) Vendor shall submit the type test certificates for each item of equipment for tests as required in the applicable IEC standards, including the following additional tests.
 - i. Tests to evaluate the insulation of the equipment by the measurement of partial discharges.
- b) Type test certificates shall be submitted with the bid.

- c) Test certificates shall be from an internationally recognised, independent testing authority, and shall be subject to Company acceptance.

14.4 ROUTINE TESTS:

- a) Routine tests shall include but not be limited to the following.
- b) Routine tests shall be carried out in accordance with the IEC 62271-200 as per table below.

Table 14.1 Routine Tests

IEC 62271-200 Clause Reference	Test
7.1	Dielectric tests on main circuits
7.2	Tests on auxiliary and control circuits
7.3	Measurement of resistance of the main circuits
7.4	Tightness tests
7.5	Design and visual checks
7.101	Partial discharge measurement where stated on the data sheet
7.102	Mechanical operational tests
7.103	Not applicable to air insulated switchgear
7.104	Tests of auxiliary electrical, pneumatic and hydraulic devices
7.105	Tests after erection on site
7.106	Not applicable to air insulated switchgear

- c) Routine tests on switchgear components shall be carried out as per the relevant IEC standards.
- d) Routine tests shall also include:
- i. Full functional tests including proving of interlocking, operating mechanisms, and limit switches, ancillary devices, etc.
 - ii. Relay primary and secondary injection tests
 - iii. Conformity of tags, labels, wires, and terminals markings.

- iv. Interface with remote panels provided by a third party VENDOR
- v. ECMS Simulation Tests: Proving of successful interfacing of all necessary communication devices between ECMS and DCS systems. This shall include full functional tests on switchgear and its feeders such as: remote control, automatic starting, automatic transfer and load shedding, etc.

15 SPARE PARTS

- a) The VENDOR shall propose:
 - i. A list of commissioning spare parts
 - ii. A list of 2 years operation spare parts
 - iii. A list of special tools required for erection, commissioning and maintenance
- b) Special tools required for erection, commissioning and maintenance shall be shipped together with the Switchgear.
- c) Each spare part shall be separately packed and clearly identified for storage management.

16 PAINTING, PRESERVATION & SHIPMENT

16.1 PAINTING

- a) Surface preparation and painting shall be in accordance with the COMPANY standard.
- b) Alternatively, VENDOR may propose the standard for enhanced protection against corrosion in outdoor climates. The paint system applied shall provide adequate protection against the adverse effects of the climatic conditions specified. Full details of VENDOR's painting specification shall be provided with the proposal for COMPANY approval.
- c) The equipment shall be fully tropicalized.
- d) Colour shade shall be grey, RAL 7035.

16.2 SHIPMENT

Manufacturer's standard packing shall be acceptable unless otherwise stated in the COMPANY's preservation and export packing procedure and on data sheet. Installation of impact recorders on individual packing boxes and containers shall be included.

17 COMMISSIONING

The requirements of commissioning shall be included in the requisition document.

18 TRAINING

The requirements of commissioning shall be included in the requisition document.

19 DOCUMENTATION/VENDOR DATA RECORDS

19.1 GENERAL

- a) VENDOR shall submit the type and number of drawings and documentation for CONTRACTOR'S authorization or information as listed in the Material Requisitions and Purchase Orders.
- b) Schedule of documents and data submittal shall be as agreed in the purchase order.
- c) Comments made by CONTRACTOR on drawing submittal shall not relieve the VENDOR of any responsibility in meeting the requirements of the specifications. Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is confirmed in writing.
- d) Each drawing shall be provided with a block in the bottom right-hand corner incorporating the following information:
 - i. Official trade name of the VENDOR.
 - ii. VENDOR'S drawing number.
 - iii. Drawing title giving the description of contents whereby the drawing can be identified.
 - iv. A symbol or letter indicating the latest issue or revision.
 - v. Purchase order number and item tag numbers.
- e) Revisions:
 - i. Document and drawing revisions shall be identified with symbols adjacent to the alterations.
 - ii. A brief description of each revision shall be given in tabular form.
 - iii. If applicable, the authority and date of the revision shall be listed. The term "Latest Revision" shall not be used.
- f) All documents shall show the relevant order number, item tag numbers and VENDOR'S references and shall be distributed as specified in the purchase order documents.
- g) Graphic symbols for electrical diagrams shall be according to IEC 60617-DB. Device code numbers shall be as per ANSI C-37.2 -1996.
- h) All documents and drawings shall be in English.
- i) Installation, operating and maintenance manuals shall be arranged as follows:
 - i. The front cover, spine and inside page shall state the purchase order number and VENDOR'S reference number.
 - ii. The inside front page shall carry an index listing the contents of each section of the manual.
 - iii. Individual sections shall be completed and shall refer to the equipment actually supplied.
 - iv. Published data shall also be included, including published data for bought-in items.

- v. Full detail for installation setting up shall be included.
- vi. Recommended test data shall be stated, covering initial and also regular testing shall be given. For example high voltage AC or DC test values.
- vii. Items requiring regular inspection, checking, testing and maintenance shall be listed and the time scale clearly indicated.
- viii. Important items shall be cross referenced to other part of the manual as necessary.
- ix. Fault finding chapter shall be included.
- x. As built panel and interconnection wiring diagrams.
- xi. CD ROM for programming protection relays.
- xii. Parts and equipment lists.

19.2 DELIVERABLES

Unless otherwise stated in the requisition or purchase order documents, the VENDOR shall as a minimum supply the following documents. The language used shall be ENGLISH.

With Bid:	
a.	Preliminary single-line diagram.
b.	Preliminary general arrangement and floor plan drawings.
c.	Minimum clearances around the assemblies for ventilation and safety during operation and maintenance.
d.	Type Test Certificates. Test values shall be furnished with test certificates.
After placement of order:	
a.	Single-line diagram.
b.	Schematic diagrams of all different types of circuits.
c.	Final assembly arrangement drawing showing main circuits, main dimensions, foundation plan, shipping section and cable termination arrangement details.
d.	Minimum clearances around the assemblies for ventilation and safety during operation and maintenance.
e.	Total mass of the assembly and of the individual shipping sections.

f.	Transport, installation, commissioning, operation and maintenance instructions, limited and specific to the assembly and its components.
g.	List of spare parts (commissioning, insurance & two years operations)
h	Test report of the final routine testing. Test values shall be furnished with test certificates.
i	Details, catalogues and characteristics of protective relays.
j	Interface wiring diagram

20 GUARANTEES & WARRANTY

The VENDOR shall guarantee, in accordance with the general conditions that the equipment shall meet the performance conditions specified in this specification, associated documents and data sheets.

SECTION D

21 DATA SHEETS TEMPLATES

Data sheet shall be inserted and decided by ADNOC

Data sheet (Document number to be advised later)

22 STANDARD DRAWINGS

To be advised later

SECTION –E

23 ANNEXURE-1: AUXILIARY AND CONTROL EQUIPMENT ADDITIONAL REQUIREMENTS:

1.0 SCOPE

This Annexure specifies the requirements for the auxiliary and control equipment such as enclosures and components, anti-condensation heaters, wiring, earthing, identification labels and markings, colour coding etc., where these are not fully covered by the main specification.

2.0 NORMATIVE REFERENCES:

- | | |
|-------------|---|
| IEC 60204 | Safety of Machinery. Electrical Equipment of Machines. |
| IEC 60332 | Tests on electric and optical fibre cables under fire conditions. |
| IEC 60364 | Low Voltage Electrical Installations |
| IEC 60445 | Basic and safety principles for man-machine interface, marking and identification. Identification of equipment terminals, conductor terminations and conductors |
| IEC 60754-1 | Test on gases evolved during combustion of materials from cables. Determination of the halogen acid gas content |
| IEC 61034-2 | Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements. |
| IEC 61439 | Low Voltage Switchgear and Controlgear Assemblies |

In addition, the auxiliary and control equipment and components shall comply with the relevant IEC standards

3.0 ENCLOSURE

3.1 The auxiliary control panels shall be:

- a) Fabricated sheet steel, or GRP where specified in the data sheet.
- b) Painted and finished in accordance with the VENDOR as well as COMPANY standard for indoor or outdoor installation as applicable whichever is stringent.
- c) Have bottom cable entry, unless specified otherwise on the data sheets.
- d) Provided with LED type panel light, operated by a door switch, unless specified otherwise.
- e) Pad-lockable incoming supply switch where applicable.
- f) Equipped with an anti-condensation heater

- 3.2 Floor mounted panels shall be rigid, self-supporting, and installed on a base frame.
- 3.3 Enclosures and doors shall be fabricated of heavy gauge steel of minimum thickness of 2mm with structural reinforcing members as 3mm minimum.
- 3.4 Wall mounted panels shall be suitable for bolting to a frame to be fixed to the wall.
- 3.5 Components mounted within the control panels shall be din rail mounted on a removable back-plate.
- 3.6 Door mounted metering, protection, and indication components shall be flush mounted.

4.0 WIRING AND TERMINATION

- 4.1 Wire Conductor material shall be stranded copper
- 4.2 Minimum conductor size shall be as below.
 - a) Power circuit: 2.5 sq. mm
 - b) Control circuit: 1.0 sq. mm
 - c) Data communication: Unless otherwise specified the minimum conductor size for data communication shall be as per Table 5 of IEC 60204-1.
- 4.3 Wire insulation shall be:
 - a) 450/750V grade for power circuits
 - b) 250V grade for instrumentation.
- 4.4 Wiring, including accessories and trunking shall be as below:
 - a) Flame retardant complying with IEC 60332 series standards.
 - b) Where specified on data sheet these shall be low smoke and halogen free complying with the following requirements.
 - i. Minimum light transmission value of 60%, conforming to IEC 61034-2.
 - ii. Maximum halogen gas emission of 0.5%, when tested in accordance with IEC 60754-1.
- 4.5 Cables shall be run in trunking or conduits. Separate trunking shall be provided within the panel for CONTRACTOR wiring to be completed at site, where terminal blocks are not mounted adjacent to incoming cable glands.
- 4.6 Trunking fill shall be limited to maximum 70%.
- 4.7 Gland plates shall be undrilled metallic compatible with cable armour and panel material.
- 4.8 Terminals and lugs shall be one of the following:
 - a) Crimped bootlace type lugs.
 - b) Crimped ring type copper lugs.
 - c) Screw-less push-in type terminals (if approved by Approving Authority).

- 4.9 Wires shall be identified at terminating points using printed heat-shrink sleeves.
- 4.10 20% spare terminals shall be provided in each section of terminal blocks for future use.
- 4.11 All spare I/O contacts of protection and auxiliary relays shall be wired to terminal blocks and numbered as per VENDOR documentation.
- 4.12 Unless the access to live terminals is prevented by interlocking (or otherwise), terminal and lugs at voltage above 110 V shall be shrouded.
- 4.13 Terminal Arrangement and Segregation:
 - a) Terminal blocks shall be grouped into separate terminals for internal and external connections.
 - b) Terminals carrying different voltages shall be segregated.
 - c) Only one conductor shall be terminated in one side of a terminal
- 4.14 Where necessary shorting terminals (or switch terminals) shall be used to facilitate operations and testing.
- 4.15 Terminals associated with inductive CT circuits shall be provided with shorting links mounted in an accessible position in LV compartment.
- 4.16 Disconnection links shall be used for earthing of control supplies and CTs.
- 4.17 VTs shall be provided with isolating type terminals.
- 4.18 The VENDOR shall include in his scope of supply test plugs and connection cables for relay testing purposes

5.0 Colour Coding and Marking:

- 5.1 The colour and marking of actuators (push buttons) shall be in accordance with IEC 60204-1.
- 5.2 The following colour code shall be used:
- 5.3 Status signal light:
 - a) On/closed: RED
 - b) Off/Open: GREEN
 - c) Fault/Trip: YELLOW
 - d) Voltage presence: WHITE
 - e) Anti-con heater on WHITE
- 5.4 Non-illuminated push button:
 - a) On/Close/Start: GREEN
 - b) Off/Open/Stop: RED
 - c) Emergency Stop RED
 - d) Lamp test BLACK

- e) Reset BLUE (if any)
- 5.5** Mechanical indication shall be provided for the following positions of circuit breakers, if applicable:
- a) Close / Open position
 - b) Test / Service / Withdrawn position
 - c) Spring charged / discharged condition
 - d) Earth switch position Open / Closed
- 5.6** Conductors and terminals shall be in compliance with the IEC 60445

6.0 EARTHING AND BONDING

- 6.1** A separate earth bar shall be provided within the panel for termination of all earth wires.
- 6.2** The earth bar shall be insulated from the back-plate but connected by one earthing conductor to the back-plate. Unless otherwise specified, this bus bar shall have a minimum cross-sectional area in accordance with clause 8.2.2 of IEC 60204-1.
- 6.3** Earthing bus bars and conductors shall be hard-drawn, high-conductivity copper.
- 6.4** A means of earthing the incoming cable glands and the enclosure to this central earthing point shall also be provided.
- 6.5** An earth stud shall be provided on all doors, with earthing straps across hinges.
- 6.6** Panels containing instrument circuits requiring instrument reference earth shall be equipped with a separate instrument earth bar insulated from the enclosure protective earth.
- 6.7** A separate IS earth bar, insulated from both the PE and the instrument earth bar, shall be provided for non-galvanic IS components located in the panel.

7.0 LABELS AND IDENTIFICATION

- 7.1** Equipment and components shall be tagged as per the ADNOC tagging and numbering procedure, document reference (Document number will be advised later)
- 7.2** Each equipment and component shall be labelled as per the general arrangement drawings.
- 7.3** Warning labels shall be provided with white characters on a red background for the following.
- a) Terminals remaining live when a function is isolated
 - b) Terminals associated with an external source of supply
- 7.4** Labels shall be laminated, engraved Traffolyte with black letters on a white background. The text shall be in the language nominated on project documentation.

8.0 ANTI-CONDENSATION HEATER:

- 8.1** Each assembly section of enclosures shall be equipped with anti-condensation heaters.
- 8.2** The capacity of heaters shall be sufficient to prevent the formation of possible condensation under the service conditions.
- 8.3** Anti-condensation heaters shall:
 - a) Have IP 2X protection
 - b) Be fitted with a guard.
- 8.4** Anti-condensation heaters shall be controlled by hygrostats.
- 8.5** The heater shall be energised from an external power source at 240/220VAC, single phase and neutral.
- 8.6** Each heater circuit shall be provided with a manually controlled cut off switch mounted at the control cubicle/compartment.
- 8.7** Each heater circuit shall be supplied from a residual current circuit breaker (RCCB) equipped with the following:
 - a) 30 mA earth leakage protection.
 - b) Auxiliary contacts for 'tripped' and status indication.
 - c) Padlocking facility.
- 8.8** 'Heater circuit live' indication shall be provided by means of white colour LED or lamp.
- 8.9** Panel power supplies for anti-condensation heater circuits associated with external equipment, e.g. excitation systems, shall be switched on automatically when the equipment is not running.

24 ANNEXURE-2: PROTECTION RELAYS:

1.0 SCOPE

The purpose of this Annexure is to define the technical, installation and connection requirements for protection relays and auxiliary components associated with electrical equipment covered in this specification.

2.0 NORMATIVE REFERENCES

IEC 60255 (all parts)	Measuring Relays and Protection Equipment
IEC 60870	Tele-control Equipment and Systems
IEC 61850 (all Parts)	Communication Networks and Systems for Power Utility Automation
IEC 62271-3	High-voltage Switchgear and Controlgear. Digital Interfaces based on IEC 61850
IEC 62439	Industrial Communications Networks

3.0 FUNCTIONAL REQUIREMENTS

- 3.1 Protection relay design, manufacture and testing shall comply with IEC 60255.
- 3.2 Protection relays shall be micro-processor based, multi-function type, incorporating a digital display and serial communication facilities.
- 3.3 The relay shall be selected to suit the protection functions and circuit configuration (as applicable) and shall include Event and Disturbance recording facilities / Data logging, etc.
- 3.4 An inbuilt Trip coil & Close coil supervision facility shall be provided for protection relays associated with circuit breaker feeders.
- 3.5 Where fully digital switchgear is offered, the protection relays shall be provided with the necessary Low Energy Analogue Input facilities, Transducers, etc.
- 3.6 Protection relays shall be located on the low voltage compartment of the switchgear panels unless otherwise specified.
- 3.7 Protection devices shall have an HMI on which metering, circuit monitoring and alarm/trip parameters shall be displayed.
- 3.8 HMI and front of panel-mounted relays shall be flush mounted and of withdrawable design. CT connections shall be automatically shorted if the device is withdrawn.
- 3.9 Each protection relay shall have facilities for calibration and injection testing without disconnection of secondary wiring.
- 3.10 Accessible test blocks, for calibration and testing of the protection relay functions, shall be located adjacent to the device to which they are connected.

- 3.11 The power supply to the relays shall be derived from the trip/close power supply as defined in the data sheets. Loss of supply shall not initiate a main circuit trip.
- 3.12 Protection relays shall include provision for input of a number of RTDs, where specified, for temperature monitoring using PT100 sensors and shall be capable of inclusion of Arc Flash detection systems.
- 3.13 Protection relays shall be designed to withstand the environmental conditions defined in Clause 4.3 Table 1 of IEC 60255-1.
- 3.14 Circuit breaker status signals into the protection relay shall be taken directly from the breaker auxiliary contacts, not via interposing relays.

4.0 DIGITAL COMMUNICATION INTERFACE

- 4.1 Digital communications interface shall be provided to ensure compliance with IEC 61850 (all parts) as detailed in IEC 62271-3.
- 4.2 Protection devices shall be provided with two ports for serial communication to enable integration into the electrical control and monitoring system (ECMS), via an ECMS interface unit in each switchgear.
- 4.3 A further port, located on the front panel, shall be provided for connection of an Engineering Laptop. It shall be possible to update relay parameters from the remote Engineering Workstations (part of the ECMS system) and local lap-tops.
- 4.4 The relay shall be capable of supporting differing communication protocols, however the communication between relays and ECMS shall be IEC 61850 with ring topology as redundancy communication.
- 4.5 Protection relays shall be capable of time synchronizing with an external master clock, located in the ECMS, via the communication network.
- 4.6 Relays shall support file transfer protocol (FTP) and file transfer through IEC 61850.
- 4.7 For fully digital switchgear options, the process bus network connections shall be fully redundant, with GOOSE (Generic Object Oriented Substation Events to IEC 61850) communication and PRP (Parallel Redundancy Protocol to IEC 62439) included to provide vertical and horizontal communication.

5.0 HMI

- 5.1 User interface shall provide a colour LCD front panel display, and navigation keys
- 5.2 The HMI display shall include the applicable Single Line representation of the circuit with online metering, status and alarm information and control functionality.
- 5.3 The HMI shall be capable of displaying measured values, calculated values, I/O status, device status, target messages, events and configured relay settings
- 5.4 The HMI shall be capable of displaying up to 32 digital and 16 analogue data channels
- 5.5 The HMI shall include an event recorder, displaying an extensive listing of time-stamped events.

- 5.6** The HMI shall be capable of displaying fault and disturbance data to assist in diagnostics in the event of a fault trip. The recorder shall include displays of selectable analogue and digital monitoring points.

6.0 SOFTWARE AND HARDWARE

- 6.1** The protection relays shall have a common hardware and firmware platform that shall support each functional unit application(s). The relay shall be equipped with separate processors for protection and for communication related functions.
- 6.2** The relay design shall include self-diagnostic, watchdog, checking, monitoring, and alarms
- 6.3** The relay shall store all its recorded data in non-volatile memory.
- 6.4** Time synchronizing and remote access parameterization for all protection relays shall be provided.
- 6.5** Protection relays shall have capabilities for time stamping, remote access parameterization in accordance with the selected communication protocol.
- 6.6** Relays shall support user defined logic to build control schemes supporting logic gates, timers, non-volatile latches.
- 6.7** An in-built relay configuration tool shall be provided, having embedded graphical user interface to build programmable logic.
- 6.8** Electronic board assemblies shall have conformal coating for harsh environments.
- 6.9** Microprocessor based protective relays shall employ IPC (Institute for Interconnecting and Packaging Electronic Circuits) Class 3 printed circuit boards (PCB); specifically, IPC Class 610-3.
- 6.10** Protection relays shall be provided with a security hierarchy, with separate password access for differing levels of use; for example, observing measured quantities, operator access for executing commands and administrator access for modifying relay configuration or protection settings, etc.