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Electricity Specification 310

Issue 5 November 2024

Gas Insulated 132kV Switchgear

Amendment Summary

ISSUE NO. DATE	DESCRIPTION
Issue 5 **November 2024**	This 2024 issue constitutes a complete revision and re-issue of the ES in its entirety therefore change lines are not used. The new ES template has been used. All ENA and BS references have been updated throughout. References to SF_6 have been updated where required to enable the inclusion of alternative gasses including the types of valves needed. Additions / changes have been made to cover learnings from past GIS projects. Links and change lines are not used due to the number of changes. Prepared by: Matthew Kayes Approved by: Policy Approval Panel and signed on its behalf by Paul Turner, PAP Chairperson.

Contents

1 Scope

This specification covers the supply, erection, testing and commissioning of metal - enclosed gas insulated switchgear for use on the 50Hz, solidly earthed, 132kV electricity distribution network of Electricity North West Limited, hereinafter referred to as Electricity North West. The equipment shall be generally in accordance with ENA TS 41-37 Parts 1 and 2. Requirements for associated disconnectors, switch disconnectors, 3 position switches and earthing switches are also described.

2 Definitions

Approval	Sanction by the Engineer that specified criteria have been satisfied.
Contract	The agreement between Electricity North West and the Contractor for the execution of the Works including therein all documents to which reference may properly be made in order to ascertain the rights and obligations of the parties under the said agreement.
Contractor	The person, including personal representatives, successors and permitted assigns, whose Tender has been accepted by Electricity North West.
Engineer	Electricity North Wests Policy and Standards Manager or his successor or such person specifically nominated on his behalf.
Specification	The Specifications and schedules (if any) agreed by the parties for the purpose of the Contract.
Sub-Contractor	Any person (other than the Contractor) named in the Contract for any part of the Works or any person to whom any part of the Contract has been sub-let with the consent in writing of the Engineer, and the legal representatives, successors and assigns of such person.
Supplier	Any person who supplies goods to Electricity North West or Electricity North West contractor.

Tender	An offer in writing to execute work or supply goods at a fixed price.
Tenderer	The person, including personal representatives, successors and permitted assigns, invited by Electricity North West to submit a Tender.
Words	Words importing persons shall include firms and corporations; words importing the singular only, also include the plural, and vice versa where the context requires.
Work	All materials, labour and actions required to be provided or performed by the Contractor under the Contract.
Writing	Any manuscript, typewritten or printed statement under seal or hand as the case may be.

3 General Requirements for Approvals and Testing

3.1 Product not to be Changed

Compliance with this clause shall be in accordance with ES001.

3.2 Electricity North West Technical Approval

Compliance with this clause shall be in accordance with ES001.

3.3 Quality Assurance

Compliance with this clause shall be in accordance with ES001.

3.4 Formulation

Compliance with this clause shall be in accordance with ES001.

3.5 Identification Markings

Compliance with this clause shall be in accordance with ES001.

3.6 Minimum Life Expectancy

The minimum life expectancy of all products covered by this Specification is 40 years.

3.7 Product Conformity

Compliance with this clause shall be in accordance with ES001.

3.8 Confirmation of Conformance

The Tenderer shall complete the conformance declaration sheets in Appendix A. Failure to complete these declaration sheets may result in an unacceptable bid.

4 Requirements for Type and Routine Testing

Compliance with this clause shall be in accordance with ES001.

4.1 Requirement for Type Tests at Suppliers Premises

Compliance with this clause shall be in accordance with ES001.

4.2 Requirement for Routine Tests at the Supplier's Premises

Compliance with this clause shall be in accordance with ES001.

4.3 Requirement for on Site tests

These will normally be included within the scope of onsite commissioning but may be included if appropriate.

5 Technical Requirements

Except where modified by requirements specified elsewhere in this document, switchgear shall be designed, manufactured and tested to comply fully with the requirements of:

ENA TS 41-37 Part 1, Issue 3:2022 "Switchgear for use on 66 and 132 kV Distribution Systems"

ENA TS 41-37 Part 2, Issue 3:2022 "GIS Switchgear for use on 66 and 132kV Distribution Systems"

IEC 62271-203:2022 "Gas-insulated metal-enclosed switchgear for rated voltages above 52kV".

BS EN 62271-1:2017+A1:2021 High-voltage switchgear and controlgear. Part 1: Common specifications for alternating current switchgear and controlgear.

BS EN IEC 62271-102:2018+A1:2022 High-voltage switchgear and controlgear. Alternating current disconnectors and earthing switches

IEC 62271-100:2021 High-voltage switchgear and controlgear. Part 100: Alternating-current circuit-breakers.

If the Tenderer is in any doubt concerning the requirements, he should contact the Policy & Standards Manager. Contracts are to include all equipment necessary to install (including connection to feeders, transformers and reactors), test, commission and operate the equipment including any special tools necessary for maintenance.

Schedules of information included in Appendix A and the Self Certification Conformance Declaration in Appendix B of this document shall be completed by the Tenderer and returned to the Purchaser as part of the Tender documentation.

5.1 General Design Features

5.1.1 Modular Construction

The design and construction of the equipment shall be so arranged that removal and replacement of modular sections is facilitated, without major disruption to the installation. In particular, each switch bay shall preferably be capable of shipment and installation as a complete unit. Switchgear shall also be capable of later extension without major disruption.

5.1.2 Thermal Expansion

The design and construction shall allow for the thermal expansion and contraction of individual switch bays and for the installation as a whole, under load cycling. Differential expansion shall be allowed without permanent distortion, between two adjacent switch bays when simultaneously loaded at zero and the maximum allowable load.

5.1.3 Gas Zones

Details of gas enclosures shall be declared in Schedule E.

The gas system shall be of the type in which gas is reused after filtering and conditioning.

Within any individual switch bay unit, the number of separate gas zones shall be kept to a minimum, but not less than three.

All Gas filling and connection points shall be of colour and type to match the filling gas as detailed in Section 6.2.101 Table 3 of ENA TS 41-37 part I.

All parts of the gas system shall be clearly labelled with their identifying number as per the gas monitoring system diagram and function, in accordance with Sections 6.2.103 and 6.10.100 of ENA TS 41-37 part I. Each gas zone shall be marked with the mass of gas in kg.

The Tenderers shall provide a schematic diagram identifying each gas chamber and the amount of gas in the chamber.

Each zone shall be fitted with an individual pressure relief device or devices whose operation shall be compatible with the safety of personnel, in the event of gas release. To achieve this requirement, each pressure relief device (for example a bursting disc) shall be fitted with a pipe, channel or duct capable of venting any uncontrolled discharge away from those areas to which personnel require access for operation, inspection and maintenance. Discs shall be sited to minimise the risks of accidental damage and a 10% spare of each disc type used shall be provided with each supply contract.

Gas density or temperature compensated pressure monitors shall be provided for each gas zone complying with Section 6.100 of ENA TS 41-37 part II. Gas monitors shall be fitted with electrical contacts for alarm, set in two stages. The first stage is to operate as an alarm that the gas pressure/density has fallen to a critical level. The second stage shall initiate an automatic lock-out of the affected gas zone by disabling the circuit breaker trip or other equivalent action. Lock-out shall be wired into the main protection system and shall only

be initiated when both first and second stages are detected. The lock-out feature for remote indication shall be provided for circuit breakers whenever the gas pressure is less than that permitted by the design for safe operation.

Pipes, pressure and storage vessels containing gases or fluids (SF_6, air, oil, alternative gasses) shall be labelled with their contents in black letters not less than 25mm high. In addition they shall be identified by different paint colours, according to a scheme complying where applicable with BS EN 1089-3:2011 '" Transportable gas cylinders. Gas cylinder identification (excluding LPG). Colour Coding" and whose details shall be submitted with the Tender, for Approval by the Purchaser. This requirement includes vessels containing different gases or different conditions for the same gas.

Joints between switchgear sections shall be externally marked to show whether they are between separate gas zones or alternatively that the gas zone is continuous, and gas may freely circulate.

Preference may be given to equipment that is capable of withstanding normal phase to phase and phase to earth operating voltages should the insulating gas pressure fall to atmospheric pressure. The Tender shall declare if the equipment meets this requirement.

5.1.4 Robust Construction

Enclosures shall comply with the requirements of BS EN 50052:2016 High-voltage switchgear and controlgear. Gas-filled cast aluminium alloy enclosures or with BS EN 50069:2018 High-voltage switchgear and controlgear. Gas-filled welded composite enclosures of cast and wrought aluminium alloys or with BS EN 50068:2018 High-Voltage Switchgear and Controlgear. Gas-filled wrought steel enclosures. All gas enclosures shall be so constructed and of sufficient volume that:

(a) The effects of an internal phase to earth arc at the full rated earth fault current can be withstood for 500ms before puncture of the enclosure wall occurs.
(b) The effects on an internal three phase arc at the full rated short circuit current can be withstood for 1 second without rupture, other than controlled rupture of the pressure relief device or the appearance of a hole in the enclosure.

In either case, there shall be no ejection of debris.

5.1.5 Access for Operation, Maintenance and Inspection

It shall be possible to carry out installation, operation, inspection, maintenance and dismantling before, during and after the service lifetime of the equipment without excessive difficulty and in compliance with the "Health and Safety at Work Act 1974", the "Electricity at Work Regulations 1989" published by the HMSO and the following EC Directives:

- "Management of Health, Safety and Welfare".
- "Manual Handling Regulations".
- "Workplace Health, Safety and Welfare".
- "Provision and Use of Work Equipment Regulations".

All switching operations including opening, closing, earthing, disconnection, isolation and all associated locking procedures shall be capable of being safely carried out by one person unaccompanied from ground level. Safe access, not restricted by cable trays, pipework, etc, shall be provided for inspection and maintenance purposes including access to all gas valves, gas monitors and test points, including where necessary fixed ladders and

platforms. Ladders and platforms shall be fitted with handrails. However, items such as auxiliary switches that may require regular adjustment or inspection shall be capable of access without ladders or special fixtures. It shall also be possible to safely carry out maintenance on one switchbay, including removal and replacement of a circuit breaker, whilst adjacent switch bays are live.

5.1.6 Simplicity of Operation

Switchgear controls and status indicators shall facilitate a clearly defined, unambiguous operating regime. All controls and indications shall be plainly labelled with their function and (for controls) method of operation. Position indicators shall be provided for all circuit breakers, disconnectors and earthing switches showing whether the contacts are in the fully closed or fully open condition. All auxiliary switches, fuses and links shall be clearly labelled in accordance with ENA TS 50-18.

5.1.7 Earthing

The equipment shall be bonded together electrically, and suitable terminals shall be provided for connection to the substation earth. As a minimum each bay shall be connected directly to the earthing system through a fully rated copper connection. However, the design, installation and testing of the earth installation shall not form part of this contract.

5.2 Circuit Breakers

5.2.1 Type

Circuit breakers shall be of the 'Puffer' type suitable for operation at low gas pressures.

5.2.2 Testing and Inspection in an Operational Configuration

Facilities shall be provided for measurement of contact resistance and timing without the need to dismantle any part of the circuit breaker, operating mechanism or fixed covers. Means shall also be provided allowing the inspection of fixed and moving contacts and other enclosed components.

5.2.3 Small Current Interrupting Duties

In addition to the requirements of IEC 62271-100:2021 covering the interruption of terminal faults, circuit breakers shall be capable of interrupting lagging power factor, small magnitude inductive currents associated with transformer and reactor magnetising currents. In addition, circuit breakers shall be capable of interrupting leading power factor currents such as those associated with capacitor banks.

5.2.4 Circuit Breaker Re-Striking

Circuit breakers shall be of the re-strike free type.

5.2.5 Short Line Faults and Out-of-Phase Switching

Circuit breakers shall be capable of interrupting short line faults and such out-of-phase switching as may occur during service.

5.2.6 Minimum Interruption Times

The overall fault clearance time including relay operation shall not exceed 200ms for faults within the gas insulated switchgear, 200ms for faults occurring within the first 80% of the line length from the substation, for

system fault levels within the specified extremes, including any increase of operating time due to direct current transient offset.

5.2.7 Transient Recovery Voltage

Attention is drawn to the Transient Recovery Voltage (TRV) requirements of IEC 62271-100:2021. If not specifically stated in the type test documents, the schedules forming part of this specification that are intended to be returned with the Tender shall state whether the TRV to which the circuit breaker was subjected during the short circuit tests was the most severe condition that could be imposed by the available test equipment for the first phase to clear factor of 1.5. The rated TRV at 100% of the rated short circuit breaking current shall be 249kV peak.

5.2.8 Lock Out Facilities

Circuit breakers shall be provided with lock out facilities.

5.2.9 Ancillary Re-Striking Voltage Devices

Where ancillary devices are employed to limit the rate of rise of re-striking voltage, or to limit or damp any voltage oscillations across the opening contacts, they shall have a life expectancy equivalent to that of the switchgear and the design shall be subject to the Purchaser's approval.

5.2.10 Parallel Operation

Circuit breakers shall be suitable for parallel operation, for example if used in a 1.5 or 1/3 circuit breaker mesh configuration, or as bus section or bus coupler switches in double busbar arrangement.

5.2.11 Auto Reclosing

Circuit breakers intended to control overhead lines shall be suitable for auto reclosing, including the interruption of currents produced by out-of-synchronism conditions, with a rated out of phase breaking capability of 100A. Where auto reclosing is required, circuit breakers shall be suitable for a rated operating sequence over the range O - 0.3s - CO - 15 to 180s - CO. The drive mechanism shall store sufficient energy for the completion of an O - C - O duty cycle, even with the auxiliary power supply disconnected.

5.2.12 Continued Operation without Gas Recharge

Circuit breakers shall remain capable of operation, without pressure replenishment of the gas or oil supply, for at least eight hours.

5.3 Circuit Breaker Operating Mechanisms – General Requirements

Circuit breaker operating mechanisms shall comply with Section 6 of ENA TS 41-37 parts I and II and shall also fulfil the following requirements.

5.3.1 Type of Mechanism

Circuit breaker operating mechanisms shall be of the spring or hydraulic type, however other types may be acceptable, subject to specific agreement by the Purchaser.

5.3.2 Capability

Circuit breaker mechanisms shall be capable of fully closing and latching circuit breakers against their rated making current and of opening circuit breakers against their rated breaking current. Opening shall be initiated in the event that the circuit breaker is tripped during its closing operation.

5.3.3 Anti Pumping

Relays or other devices shall be fitted to prevent repetitive closing, should the circuit breaker closing coil remain energised and the circuit breaker either fail to latch or is tripped during closing.

5.3.4 Pole Discrepancy

The difference in time between the first and last pole to close, during circuit breaker closing, shall not exceed 5ms.

5.3.5 Operation and Adjustment of Single Phase Units

Where three phase circuit breakers comprise three ganged single phase units, it shall be possible to make independent adjustments to mechanisms of each unit. In addition, all units shall both make and break circuits in accordance with the time defined in sub-section 5.3.4. In the event that any single phase unit fails to complete a closing operation, all three phases shall be automatically tripped and an alarm condition indicated at the remote control panel.

5.3.6 Energy Charge and Recharge of Operating Mechanisms

Operating mechanisms shall be recharged automatically immediately following completion of closing. Preferably, operating mechanisms shall store sufficient energy for two complete trip/close operations without recharging. Mechanisms not capable of storing energy shall use the substation direct current supply.

5.3.7 Immunity from Inadvertent Operation

The design of operating mechanisms shall be such that the circuit breaker is not operated by external mechanical shock for example short circuit forces, operation of adjacent units, or seismic event.

5.3.8 Operation Counter

Operating mechanisms shall be fitted with 4 digit counters.

5.3.9 Indication of OPEN and CLOSED Status

Mechanisms shall be fitted with mechanical position indicators, operated from the circuit breaker, showing the position of poles either OPEN or CLOSED. These indicators shall be positively actuated from the driven side of the mechanism.

5.3.10 Manual Operation of Circuit Breakers

Provision shall be made for mechanically operated local manual tripping and closing. This shall be inaccessible for normal operation. This facility shall be labelled “Emergency operation only, refer to manufacturer’s handbook”. The label shall comply with BS ISO 3864-1:2011 Graphical symbols. Safety colours and safety signs. Design principles for safety signs and safety markings.

5.3.11 Slow Operation for Maintenance

Operating mechanisms shall facilitate manual slow opening and slow closing of circuit breakers for maintenance purposes. However, it shall not be possible to slow open or slow close circuit breakers when in an operational configuration.

5.3.12 Labelling

Each unit of switchgear shall be identified with a label at the front and rear of the fixed part, marked with the circuit designation (rated normal current, description and connected equipment number) as specified on the project single line diagram.

Labels shall be provided to identify the functions of the main components.

All labels shall be in English.

5.4 Circuit Breaker Operating Mechanisms – Requirements for Hydraulic Units

Operating units that are hydraulically powered shall fulfil the following requirements.

5.4.1 Pressure Indication and Monitoring

A pressure gauge or gauges shall be provided, giving indication of operating oil pressure. Clearly marked red warning lines shall be marked on the gauge dial or dials showing critical low and high pressures, outside of which operation of the mechanism may be compromised. A pressure operated switch or switches shall also be fitted to initiate pumping action, complete with alarm and blocking functions as appropriate. The pressures at which closing (CO), tripping (O) and auto reclosing (OCO) operations will be blocked shall be stated. In the event of slow loss of pressure, monitors shall facilitate tripping of circuit breakers before the onset of blocking. All gas gauges must be able to be tested without removing the gauge from the switchgear. Electricity North West would consider dual gauges if this redundancy can be shown to be satisfactory.

5.4.2 Loss of Operating Pressure in Single Phase Unit

In the event of loss of hydraulic operating pressure in the operating mechanism of a single-phase unit comprising part of a ganged three phase circuit breaker, facilities shall be provided for blocking of all phases.

5.4.3 Excessive Time Operation of Pressure Pump

An alarm shall be provided to indicate excessive running of the hydraulic pressure pump or pumps, based upon the pump running time exceeding a predetermined period of time. In addition, an hour run meter shall be fitted to the hydraulic pump or pumps.

5.4.4 Accumulator Gas Pressure

The hydraulic mechanism, pipes, pumps and accumulators shall be so designed and constructed that leakage of compressed gas from the accumulator into the system is prevented. Means shall be provided to monitor gas pressure in the accumulator and to facilitate blocking operation in the event of excessive loss of gas.

5.4.5 Accumulator Energy

The energy stored in the hydraulic accumulator shall be sufficient to power one C-O-C-O duty cycle of one (three phase) circuit breaker, with the accumulator pressure at the pump start pressure setting, without recharging.

5.4.6 Bleeding of Hydraulic System

Means shall be provided for bleeding trapped gas from the hydraulic system.

5.4.7 Hydraulic Fluid Reserve

An alarm shall be fitted warning of low fluid level in the main hydraulic fluid reservoir.

5.5 Circuit Breaker Operating Mechanisms – Requirements for Spring Powered Units

Operating units that are spring powered shall fulfil the following requirements.

5.5.1 Speed of Recharging

Recharging of the energy storage spring or springs after completion of a circuit breaker closing operation shall be completed in not more than 30s.

5.5.2 Prevention and Indication of Slow or incomplete Closure

Means shall be provided to ensure that the energy storage spring or springs are fully charged before a circuit breaker closure is initiated. In the event of the operating spring or springs failing to fully charge, an indicating device shall announce the condition at the local control panel and also provide electrical means (for example a pair of contacts) allowing the supervisory system to also announce the condition.

5.5.3 Manual Charging

Manual charging of operating mechanisms that are normally power driven shall be possible without the need to open a mechanism cover, although opening of the switch cubicle is acceptable. Manual operation shall not require the application of force greater than 275N and its use shall be restricted by a security system that shall be described in outline in the Tender and subsequently agreed between the Purchaser and the Contractor, following the award of contract. During manual charging, effective electrical or mechanical means shall be provided to prevent power charging, thereby ensuring the safety of the operator and preventing damage to the equipment.

5.6 Disconnectors and Switch-Disconnectors

In addition to the general requirements for the equipment described elsewhere in this document, disconnectors and switch-disconnectors shall be designed, manufactured and tested in accordance with BS EN IEC 62271-102:2018+A1:2022 High-voltage switchgear and controlgear. Alternating current disconnectors and earthing switches and BS EN IEC 62271-104:2020 High-voltage switchgear and controlgear. Alternating current switches for rated voltages higher than 52 kV In addition, they shall fulfil the following requirements.

5.6.1 Safe Maintenance

Maintenance of a disconnector or switch disconnector shall be possible, with complete safety of maintenance personnel, when adjacent switchbays are live.

5.6.2 Power Operation

Disconnectors and switch disconnectors shall normally be direct current power operated. In the event of failure of auxiliary supplies, manual operation shall be possible, either from the normal ground level operating position or from fixed access platforms. A dedicated sub-circuit shall be provided, each with its own padlockable MCB, within the Local Control Cubicle (LCC) for each disconnector motor.

All three position switches must not require any special tools to remove covers that must be removed for locking off and/or Operation. All covers must be replaceable when all padlocks are applied with the padlocks and caution notices being visible. The covers must be removeable without the need to use a tool, hinged covers with padlocks or thumbscrews are the preferred method of cover retention.

5.6.3 Interlocking – Metallic Screens

Disconnectors and switch disconnectors incorporating metallic screens shall be interlocked to prevent operation of the metallic screen or closing of contacts, if the contacts are not fully open, or if the metallic screen is not fully withdrawn.

5.6.4 Insulation Level

The insulation level for the isolating distance between disconnector or switch disconnector contacts shall be 15% greater than the insulation level for the remainder of the equipment. In the event of gas leakage, the disconnector or switch disconnector shall be capable of withstanding at least twice the phase to earth voltage, at the nominal system voltage. If this requirement is not fulfilled, automatic means shall be provided to electrically isolate the disconnector or switch disconnector.

5.6.5 Load Currents

Disconnectors or switch disconnectors shall be capable of switching load currents when shunted by a parallel path. They shall also be capable of switching capacitance-charging currents associated with busbars, bushings and capacitor voltage transformers. Disconnectors or switch disconnectors not capable of fulfilling these requirements with the insulating medium at atmospheric pressure shall be automatically inhibited from operation.

5.7 Maintenance Earthing Switches

In addition to the general requirements for the equipment described elsewhere in this document, maintenance earthing switches shall be designed, manufactured and tested in accordance with IEC 62271-102:2018+A1:2022. In addition, they shall fulfil the following requirements.

5.7.1 Provision and Location of Maintenance Earthing Switches

Maintenance earthing switches may be integrally mounted with switch disconnectors or mounted separately. They shall be provided to earth sections of switchgear during maintenance, to ensure the safety of maintenance personnel.

5.7.2 Power Operation

Earthing switches shall normally be direct current power operated. In the event of failure of auxiliary supplies, manual operation shall be possible, either from the normal ground level operating position or from fixed access platforms. A dedicated sub-circuit shall be provided, each with its own padlockable MCB, within the Local Control Cubicle (LCC) for each earth switch motor.

All three position switches must not require any special tools to remove covers that must be removed for locking off and/or Operation. All covers must be replaceable when all padlocks are applied with the padlocks and caution notices being visible. The covers must be removeable without the need to use a tool, hinged covers with padlocks or thumbscrews are the preferred method of cover retention.

5.7.3 Visual Confirmation of Operation

Preferably, the correct operation of earthing switches shall be capable of direct visual confirmation.

5.7.4 Testing Facilities

Facilities shall be provided allowing earthing switches to function as points of connection for primary current injection testing. For this purpose, the earth sides of switches shall be capable of disconnection from earth by the removal of bolted links. Links shall be capable of withstanding the rated short circuit current of the switchgear; when links are removed the earth side test points shall be capable of withstanding a test point to earth voltage of at least 10kV rms.

5.8 High Speed Earthing Switches

High speed earthing switches shall fulfil the following requirements.

5.8.1 Method of Operation

High speed earthing switches shall be power operated and capable of rapid closure onto a live circuit. They shall be incapable of slow closure. A dedicated sub-circuit shall be provided, each with its own padlockable MCB, within the Local Control Cubicle (LCC) for each earth switch motor.

5.8.2 Rating

High speed earthing switches shall be fully type tested and capable of making the rated peak withstand current and of sustaining for three seconds the rated short circuit current of the switchgear.

5.8.3 Location

High speed earthing switches shall be located at feeder terminal points and busbars where the status of the point to be earthed (energised or unenergised) cannot be known with certainty.

5.8.4 Testing Facilities

Facilities shall be provided allowing high speed earthing switches to function as points of connection for primary current injection testing. For this purpose, the earth sides of switches shall be capable of disconnection from earth by the removal of bolted links. Links shall be capable of withstanding the rated short circuit current of the switchgear; when links are removed the earth side test points shall be capable of withstanding a test point to earth voltage of at least 10kV rms.

5.8.5 Interruption of Induced Currents

High speed earthing switches shall be capable of interrupting the currents induced in overhead line feeders by inductive coupling with adjacent circuits.

5.9 Combined Disconnector and Earth Switches

Three position combined disconnector and earth switch units are an acceptable alternative to separate items of plant, provided that the configuration provided allows complete control of the circuit arrangement and does not limit operational flexibility.

5.9.1 Power Operation

Both the disconnector and earth switch shall preferably be motor operated. Attention must be given to the requirements of operational safety with regards to isolating disconnector supplies before applying earths.

If this procedure cannot be provided, earth switches shall be hand operated only.

In the event of failure of auxiliary supplies, manual operation shall be possible, either from the normal ground level operating position or from the fixed access platforms. A dedicated sub-circuit shall be provided, each with its own padlockable MCB, within the Local Control Cubicle (LCC) for each disconnector/earth switch motor.

All three position switches must not require any special tools to remove covers that must be removed for locking off and/or Operation. All covers must be replaceable when all padlocks are applied with the padlocks and caution notices being visible. The covers must be removeable without the need to use a tool, hinged covers with padlocks or thumbscrews are the preferred method of cover retention.

5.9.2 Visual Confirmation of Operation

Confirmation of the correct operation of earth switches shall be capable by direct visual means.

5.10 Operating Cubicles

An operating cubicle shall be provided for each switchbay and it shall fulfil the following requirements.

5.10.1 Cubicle Equipment

Cubicles shall contain all the control, interlocking and auxiliary power fuses and links appropriate to the particular switchbay. In addition, cubicles shall contain all the controls (both electrically and manually operated) and indications including instruments and mimic diagrams required for operation and maintenance of the circuit breaker, switch disconnectors and earthing switches appropriate to the particular switchbay. These items shall be mounted on the front panel.

5.10.2 Local/Remote Operation

Cubicles shall be provided with switches to select between local and remote operation.

5.10.3 Wiring Marshalling

Cubicles shall be fitted with small wiring terminals located within marshalling boxes for multicore cabling purposes, facilitating connections between the switchbay and all external equipment. The cables shall comply with the requirements of ES400 C13 “Multipair and Multicore Auxiliary Cables”. Factory assembled multicore cables with plug and socket connectors may be used between switchgear and cubicles, providing that they are clearly, permanently and unambiguously marked.

5.10.4 Demonstration of Immunity to Electromagnetic Interference

The Tender documents shall include reports of tests demonstrating that the low voltage control and protection equipment of the type to be provided with the switchgear is immune to the effects of voltage transients generated by the making and breaking of power currents. If these tests were undertaken with earthed metallic screens in place, equivalent screens shall be provided in the equipment supplied.

5.11 Interlocking Facilities

Circuit breakers, disconnectors, switch disconnectors and earthing switches shall be fitted with an interlocking system that complies with Section 6.12 of ENA TS 41-37 part I, achieved by mechanical or electrical means, or a combination of both. The interlocking system shall, so far as is practicable, prevent the closure of line earth switches onto a live system and the energising of any section of switchgear to which an earth is already applied. Interlocks shall ensure the safety of operational personnel under all conditions, in addition to preventing the imposition of faults onto the 132kV system caused by human error. However, the interlocking system shall be confined to the switchgear to be supplied, and plant within the confines of the local substation. It shall not extend to any other operational site. Any switchbay in which the interlocking facilities are, for any reason, less comprehensive than those elsewhere on the switchgear, shall be fitted with a prominent label, permanently fixed in a position close to the switchgear normal operating position. This label shall state the nature of the interlocking limitation.

A GIS interlocking bypass scheme shall be provided by a lockable mechanical key system with secondary electrical switching located on the Local Control Cubicle (LCC). The arrangement shall allow all interlock bypass keys to be located in a locked key cabinet under normal operating conditions.

5.11.1 Mechanical Interlocking

Manually operated equipment or equipment that may be operated only from a local position may be fitted with mechanical interlocking. Mechanical interlocking is also acceptable where interlocking is used to control access, for example to a cubicle. Care shall be taken that mechanical interlocks are sufficiently robust to prevent inappropriate operation through the manual application of excessive force and that they do not apply stress to any part of the equipment that is sufficient to cause permanent deformation.

5.11.2 Electrical Interlocking

Electrical interlocks shall be resistant to defeat by manual interference. In addition, the loss of auxiliary power supplies and their subsequent restoration shall not cause or permit faulty operation. Electrical interlocks reliant upon interrupting the power supply to motors or solenoids shall break both the supply and neutral connections or in the case of three phase motors, all three phase connections.

5.11.3 Electrical Interlocking of Manual Operation

It is acceptable for manual operation to be permitted by a solenoid operated bolt that is energised only when the equipment is safe to operate manually and when the operating handle is brought to the position corresponding to the start of the operating stroke. Visible indication of the bolt position shall be provided either LOCKED or FREE and an approved means shall be fitted allowing the bolt to be operated in an emergency, for example loss of auxiliary supplies.

5.11.4 Circuit Breaker Gas Pressure

Circuit breakers shall be interlocked to prevent closure if the gas system is not properly pressurised or if the operating system is not properly charged.

5.11.5 Circuit Breaker Opening

No interlock shall prevent the opening of a circuit breaker, other than in circumstances that shall be agreed with the Purchaser.

5.11.6 Interlocking of Disconnectors and Switch Disconnectors

Disconnectors and switch disconnectors shall be so interlocked that breaking of load currents is prevented, other than in the circumstance that a parallel path or paths exist in the same switchgear, through which the load current may be commutated. The interlocking system shall ensure that such a parallel path or paths exist before circuit breaker opening is facilitated.

5.11.7 Interlocking of Maintenance and High-Speed Earthing Switches

Maintenance earth switches shall be so interlocked that the making of current is prevented. High speed earthing switches that may be required to break capacitive currents may not be interlocked with switchgear at another substation. However, they shall be fitted with interlocks to prevent closure onto a live conductor in all other circumstances.

5.11.8 Free Operation Under Maintenance

The interlocking system shall be so designed and constructed that all switches may be maintained (that is, freely operated) without defeating the interlocking wiring with wiring modifications. A lockable interlock override switch or equivalent shall be provided.

5.11.9 Emergency Operation

Provision shall be made allowing interlocks to be over-ridden under emergency conditions, for example by removal of a padlock, so allowing switches to be operated.

5.11.10 Repeat Relays

For electrical interlocking circuits, auxiliary contacts direct from the plant item shall preferably be used. If repeat relays are required, then a monitoring scheme shall be provided. The scheme shall operate in a fail safe manner.

5.12 Locking Facilities

Circuit breakers, disconnectors, switch disconnectors and earthing switches shall be fitted with locking facilities that are additional to the interlocking system described elsewhere in this document. Locking facilities shall comply with the following requirements.

5.12.1 Direct Local Locking

Locks shall be applied to mechanisms as close as possible to the point at which force (either manual or power) is applied, and not to remote or ancillary linkages.

5.12.2 Locking of Equipment

Locking facilities shall be provided as follows.

- Circuit breaker mechanisms in the OPEN position and any associated manual operating device in the NEUTRAL position.
- Disconnector, switch disconnector and earthing switches in both OPEN and CLOSED positions.
- Control position selector switches in all available positions.
- Air or gas system isolating valves in the OPEN and CLOSED positions.

5.12.3 Padlocking and Key Cabinet

All locking shall be implemented by means of removable padlocks, which shall be supplied. Padlocks shall be brass with a 38mm square body and a 7mm diameter shackle, with a clear inside width 20mm and an inside length of at least 16mm. Each padlock shall be unique, engraved with its location and function and supplied with two keys.

A key and padlock storage facility shall be provided which shall be segregated into individual circuit compartments capable of housing the maximum number of locks per bay. This shall be a floor standing lockable cabinet and will include capacity for future extensions to the switchgear.

5.13 Auxiliary Switches and Contactors

5.13.1 Sufficiency of Provision

Circuit breakers, disconnectors, switch disconnectors and earthing switches shall be provided with sufficient contactors and auxiliary switches that local and remote control, indication and all (electrical) interlock facilities may be implemented. Provision shall also be made for future requirements by the fitting, to each switch, of two additional normally open and two normally closed auxiliary switches (four auxiliary switches per circuit breaker, disconnector, switch disconnector or earthing switch in total).

5.13.2 Exclusion of Repeat Relays

Repeat relays shall not normally be fitted. If these are required, then a monitoring scheme shall be utilised to ensure correct operation. The repeat relays shall operate in a fail safe manner.

5.14 Current and Voltage Transformers

Current transformers shall comply with the requirements of BS EN 61869-2:2012 Instrument transformers. Additional requirements for current transformers. In addition, they shall comply with the following requirements.

5.14.1 Location of CTs

Current Transformer chambers on both sides of the circuit breaker are normally required. If this is not possible, the Tenderer shall quote an alternative for an arrangement of CTs on the line side of the circuit breaker, preferably housed in the circuit breaker enclosure.

Where CTs are mounted on the line side of the circuit breaker only, a suitable interlock overcurrent scheme shall be provided.

The switchgear design shall accommodate for the supply and installation of slip-over CTs on the Electricity North West 132kV cables as detailed on the circuit specific key line diagrams as supplied with the Tender.

The electrical characteristics of the slip over CTs shall be to this ES and shall be suitable for outdoor use. Their magnetisation curves shall match the CTs within the GIS. Special attention must be given to the cable sheath earthing design and the requirement to cancel any sheath currents through the slip over CTs.

5.14.2 Marking and Positioning of CTs

The position of each CT with respect to its P1 and P2 terminals shall be permanently marked, either in the chambers or on labels permanently fixed to the chamber covers. The preferred order of CTs within chambers shall be as specified in Part 4 of ENA TS 41-15 “132kV busbar substation - feeder circuits”.

5.14.3 Requirement for CTs

Protection CTs shall be 30VA 5P20 or Class X as appropriate to the application. Instrument CTs shall be Class 1and those for metering, if metering is additionally specified, shall be Class 0.2.

CT ratio requirements will be specified in Tender.

Feeder main protection CTs shall conform to the following parameters.

$V_k > (85200/N)*(R_s + 1.5)$ Volt

$Im < 50/N$ ampere @ Vk

Where N = CT ratio, R_s = CT secondary resistance.

The following are the maximum values for R_s for the range of ratios.

R_s (max) = 1.5Ω for 500:1

R_s (max) = 2.0Ω for 600:1

R_s (max) = 2.5Ω for 800:1

R_s (max) = 3.0Ω for 1000:1

R_s (max) = 4.0Ω for 1200:1

Transformer main protection CTs shall conform to the following parameters.

$V_k > ((48*flc)/N)*(R_s + 3)$ Volt

$I_m < 50/N$ ampere for phase CTs

$I_m < 20/N$ ampere for neutral CTs

Where N = CT ratio, R_s = CT secondary resistance, flc = full load current.

The maximum values of secondary winding resistance shall be the same as those specified for feeder CTs.

Busbar protection CTs shall conform to the following parameters.

$V_k > (66000/N)*(R_s + 3)$ Volt

$I_m < 50/N$ ampere @ V_k

R_s (max) = 6.0Ω

Where N = CT ratio, R_s = CT secondary resistance.

Backup protection CTs shall conform to the following parameters.

$V_k > (60R_s + 150)$ Volt

$I_m < 50/N$ ampere @ V_k

Where N = CT ratio, R_s = CT secondary resistance.

The following are the maximum values for R_s for the range of ratios.

R_s (max) = 1.0Ω for 200:1

R_s (max) = 1.5Ω for 300:1

R_s (max) = 2.0Ω for 400:1

R_s (max) = 2.5Ω for 500:1

R_s (max) = 3.0Ω for 600:1

R_s (max) = 4.0Ω for 800:1

R_s (max) = 5.0Ω for 1000:1

R_s (max) = 6.0Ω for 1200:1

5.14.4 Dual Ratio CTs

Where dual ratio CTs are specified in the Tender, the performance specification as detailed above shall be provided for the low ratio tapping.

5.14.5 CT Ratings

All current transformers shall fully match the ratings of the primary equipment they are installed within. These ratings include long time thermal, short time emergency and fault ratings.

For example, A 1000/500:1 feeder protection CT fitted to a 2000A circuit breaker shall have a rating of $I_{thermal}$ = 200%. A 400:1 transformer protection CT fitted to a 90MVA grid transformer shall have a short time rating of 600A to allow for a cyclic loading of 1.3 times transformer rating.

5.14.6 Magnetisation, Core Loss and Secondary Resistance Curves

Magnetisation, core loss and secondary resistance graphs shall be provided for each type and rating of CT used in the construction of the equipment. Where CTs are tapped or otherwise multi ratio, graphs shall be provided for all available combinations.

5.14.7 Requirements for VTs

VTs shall comply with BS EN 61869-3:2011 Instrument transformers. Additional requirements for inductive voltage transformers. Two VT fuses or links per phase shall be provided at a location that is accessible to operators from ground level (for example within a marshalling cubicle). The fuses / links shall be lockable with a padlocking bar. To avoid confusion for operational staff VT secondary earthing links shall be of a different type to the phase fuses / links.

The VT primary star point shall be connected directly to earth without intermediate terminal connections. The VT star point shall be as local to the windings as possible with the star point being made at this point. The star point shall not be made through the earth connection.

The required ratings for the VTs are detailed below:

Transformation Ratio = 132000/√3 : 110/√3

Accuracy Class = 0.5/3P

Burden = 50VA per secondary winding

Rated Voltage Factor = 1.5/30 seconds

NOTE:

For feeder circuits with distance protection, two secondary windings shall be provided. Winding 1 shall be utilised for the distance protection only. Winding 2 shall be utilised for the remaining functions such as synchronising, DAR, analogues. This will be detailed in the Tender return.

Tenderers shall supply a method statement for isolation of the VT to facilitate cable testing.

5.15 Surge Arresters

Surge arresters are not required on incoming or feeder equipment. Where surge arresters are required for lightning protection purposes (see CP314) or to absorb switching over-voltages generated internally, this shall be declared in the Tender together with the type and number of arresters. If arresters are fitted they shall

comply with BS EN 60099-4 Surge arresters. Metal-oxide surge arresters without gaps for a.c. systems or BS EN IEC 60099-8:2018 Surge arresters. Metal-oxide surge arresters with external series gap (EGLA) for overhead transmission and distribution lines of a.c. systems above 1 kV. The Tender documents shall include reports of compliance with the tests specified in these standards and in addition.

- The effects of an internal arc within the arrester housing.
- Pressure tests on the enclosure(s), including long term gas leakage rates.
- Dielectric tests on the insulation between active materials and where applicable, between phases.

The nature of the tests to validate these requirements shall be agreed with the Purchaser. Where arresters are fitted within gas filled enclosures, the following requirements shall be fulfilled.

5.15.1 Gas Insulation of Surge Arresters

Where surge arresters are installed within gas filled enclosures, they shall be either totally immersed in the gas, or having the active elements contained within an inner housing that is filled with a gas other than the insulating gas but surrounded by said gas. Where the gas is in contact with active elements of arresters, compatibility of materials, without degradation of performance, shall be assured over the life of the switchgear. In addition, to avoid contamination by ionised products, the gas used for insulation shall not mix with that used for arc interruption.

5.15.2 Protection Against Excess Pressure

Where surge arresters are installed in gas filled enclosures, pressure relief devices shall be fitted and co-ordinated with the gas pressure in the main switchgear compartments where they are located, so as to eliminate the possibility of explosive disintegration, including explosive disintegration when main compartments are de-pressurised for maintenance.

5.15.3 Monitoring of Gas Pressure

Where surge arresters are installed in gas filled enclosures, enclosure pressure shall be monitored in the same manner as the monitoring of pressure in the main switchgear enclosures. The rating plate shall specify the gas overpressure at 20°C.

5.15.4 Insulation Level

Where surge arresters are installed in gas filled enclosures, the insulation level between the live, active parts of arresters and their metal enclosures shall be the same as the same arresters would achieve to the external housing under 'stand alone' conditions. Three phase arresters shall attain the same phase to earth insulation level as single phase units.

5.15.5 Enclosure Requirements

Where surge arresters are installed in gas filled enclosures, the enclosures shall fulfil the same requirements embodied in IEC 62271-203:2022 as those specified for the main switchgear enclosure.

5.16 Power Cable Termination

5.16.1 Cable Boxes

Cable boxes and support steelwork shall be supplied as part of contracts and shall allow compliance with ENA TS 09-2 “Specification for the supply, delivery & installation of power cables with operating voltages in the range 11 kV to 400 kV and associated auxiliary cables”, and ES400 E5 “Specification for the Installation and Repair of Underground Cables Operating at 33kV and 132kV”, and with BS EN IEC 62271-209:2019+A1:2022 High-voltage switchgear and controlgear. Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV - Fluid-filled and extruded insulation cables - Fluid-filled and dry-type cable terminations.

They shall facilitate the termination of cables manufactured to:

- BS 7912 “Power Cables with XLPE insulation and metallic sheaths and their accessories for rated voltages from 66kV (Um – 72.5kV) to 132kV (Um = 145kV)” and
- ENA TS 09-16 “Testing specification for metallic sheathed power cables with extruded cross-linked polythene insulation and accessories for system voltages of 66kV and 132kV”.

5.16.2 Cable Cleats and Cable Ancillaries

Cleats and other ancillary items not forming part of the cable boxes shall not be supplied. These will be the responsibility of the Purchaser. However, the method by which cable boxes will be dismantled and re-assembled after cable termination is complete shall be specified in writing.

5.16.3 Protection from Arc Products

If cable boxes are also used to enclose switch disconnectors and/or earth switches, effective means shall be provided to prevent damage to cables and terminations by the gaseous and condensation products of arcing.

5.16.4 Thermal Expansion

Cables terminations and switchgear shall be so inter-connected that thermal expansion and contraction in either or both is absorbed. Mechanical stresses shall not be induced in cable terminations or connection bushings during load cycling.

5.16.5 Testing Voltage and test Bushing

Cable box clearances and insulating barriers (if cable boxes are so designed) shall be sufficient to allow the application of an AC test voltage as per the requirements of CP319 “Applied High Voltage Test” during switchgear commissioning and at any later time when cable testing may be required. For this purpose a test bushing (which shall be air insulated and gas filled) shall be provided, which when fitted will allow sufficient clearance to earthed metal that the specified voltage may be applied without danger of flashover. If the test bushing is designed to project to the rear of the equipment then it shall also be possible to fit an equivalent flexible test cable, complete with associated plugs and terminations (which shall be provided). In addition, removable bolted links shall be provided allowing isolation of the HV cables from the remainder of the switchgear, with gaps when removed that are sufficient to withstand application of the specified maximum test voltage to either the cable or the switchgear, when the other is earthed.

5.16.6 Terminations in Unused Switch Bays

Where switch bays are supplied that are to be connected and commissioned at a later date, cable end units shall be supplied and shall meet all the specified requirements. Suitable insulating inserts shall be supplied for these cable end units.

5.16.7 Testing of Switchgear Prior to Connection of Cables

Where switchgear is to be erected and tested prior to the connection of cables, temporary end covers shall be provided to allow safe testing to proceed.

5.17 Bushings

Bushings shall comply with the requirements of BS EN 60137:2017 “Insulated bushings for alternating voltages above 1kV”.

5.18 Multicore and Auxiliary Cables

Multicore cables shall be of the armoured type when not in trenches.

5.18.1 Compliance with Specification

Multicore and auxiliary terminations shall comply with the requirements of ES400 C13 “Multipair and Multicore Auxiliary Cables” and with ENA TS 50-18 “Design and application of auxiliary electrical equipment”.

5.18.2 Multicore Wiring Included in the Contract

All connections from the switchgear to marshalling kiosks and control equipment and local control panels including supporting trays and steelwork shall form part of the contract. All connections from the marshalling kiosks to the Purchaser's remote control equipment shall also be provided to a marshalling cubicle. Cables from this cubicle to the remote telecontrol unit shall be the responsibility of the Purchaser. Any cross site cabling required for CTs or VTs shall also be included.

All cabling shall have suitable mechanical protection, with attention to any cabling between the GIS switchgear and LCCs which may utilise a plug and socket type cable system. Electricity North West preference is for all multicore cables to be of the Steel Wire Armoured type.

5.18.3 Multicore Cable Schedule

The contractor shall provide, within two months of award of contract, all necessary drawings and other information allowing the preparation of a multicore cable Schedule in good time to meet the Scheduled commissioning date.

5.18.4 Cable Containment

All cables shall be provided with appropriate support and containment facilities on the switchgear such that all cables are neatly secured to tray or contained within trunking. No cabling shall be unsupported, bundled or cable tied in an ad-hoc manner.

Wiring across door hinges shall be protected against mechanical damage, preferably by the use of flexible conduits.

Switchgear units inter-wiring ducts shall be accessible without the need for de-energising any circuits.

Sufficient space shall be left in ducts and trunking for at least an additional 10% of wires to be installed.

All multicore cable installation on the complete assembly shall be provided with means of earthing the armouring and screens at both ends of the cable. All multicore cables shall be provided with 10% spare cores.

5.18.5 Cable Type

The use of non-armoured multicore and auxiliary cables within the switchroom building shall be permitted provided that it can be demonstrated that they are encased in continuous earthed metalwork throughout their length and that appropriate cable management measures are in place to ensure that there is no risk of mechanical damage.

All panel wiring and multicore cable shall be provided with LS0H sheathing.

5.19 Fire Precautions

5.19.1 General Fire Precautions

Fire precautions shall comply with the requirements of Engineering Recommendation S2/4 “Limitation of fire risk in Substations at 132kV and below in enclosed cableways”. Halon gas shall not be used as a fire-extinguishing medium.

5.19.2 Minimising the Risk of Fire and Consequential Damage

All equipment, connections and cabling shall be so designed and constructed that the risk of fire and subsequent damage by fire is minimised.

5.20 Control and Indication and Alarms

5.20.1 Local Control

Local electrical control shall be provided for all electrically powered equipment.

5.20.2 Mimic Diagram/Standby Control Panel

Under a separate contract, a mimic diagram/standby control panel is to be sited remotely from the equipment in the substation auxiliary room. All the remote control, alarm, indication and analogue circuits from the switchgear shall be terminated in this panel.

5.20.3 ON/OFF and other Indicators

Indication inscriptions shall be either ON or I, OFF or O, EARTH ON or EARTH OFF in accordance with Table 4 of ENA TS 41-37. These indications shall be in contrasting colours.

5.20.4 Gas Alarms

If the switchgear supplied has any gas zone that has a normal operating pressure higher than the remaining zones then all adjacent zones shall be fitted with an "Gas Pressure High" alarm. This is to alarm should a gas barrier rupture between zones of different pressures. It shall be possible to test these alarms without de-gassing any chambers.

5.20.5 Alarms

Alarms shall be marshalled and grouped into specific functions. Where there are multiple similar alarms, a logic diagram shall be provided to prioritise specific conditions for ease of recognition and severity.

5.21 Ratings

5.21.1 Ratings

The ratings of the Switchgear shall be as described in Section 4 of ENA TS 41-37 part II with the following addition.

RATED VOLTAGE U_R KV (RMS VALUE)	RATED SHORT-DURATION POWER-FREQUENCY WITHSTAND VOLTAGE U_D KV (RMS VALUE)		RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE U_P KV (PEAK VALUE)	
	Common Value	Across the isolating distance	Common Value	Across the isolating distance
145	275	315	650	750

The purchaser will advise the particular ratings required for each installation to which this specification is applicable.

Fault rating requirements will be advised in the Tender.

5.21.2 Variation of Power Frequency Withstand Voltage with Gas Density

The Tender shall declare

- The density of gas at which a circuit breaker can withstand two fully asynchronous power frequency voltages, each equal to 84.0kV, applied to opposite terminals of the same pole in the OPEN position.
- The density of gas at which a circuit breaker can withstand a power frequency voltage of 125.6kV between its terminals and earth.

5.22 Environment, Operating Conditions and Duty

5.22.1 Service Conditions

The normal service conditions shall be as defined in Section 4 of ENA TS 41-37 parts I and II. No special anti pollution measures are required.

5.22.2 Noise

The maximum sound level shall not exceed 90db.

5.22.3 Emergency Operating Performance (EOP)

In addition to the test duty requirements of Section 7of ENA TS 41-37 parts 1 and II, circuit breakers shall be capable of an Emergency Operating Performance as follows:

- 15 CLOSE and 15 OPEN operations at 100% rating or
- 40 CLOSE and 40 OPEN operations at 50% rating.

The EOP shall be achieved without significant damage to contacts or reduction in breaking capacity. If the circuit breaker cannot achieve either of the specified requirements, the Tender document shall declare the number of CLOSE/OPEN operations and the rating level, which can be achieved.

5.23 Auxiliary Supplies

Mechanisms, alarms, indications, controls and where appropriate, pumps for hydraulic systems shall normally be 110V direct current operated. The maximum current drawn under operational conditions and a recommended storage battery capacity (in ampere-hour) for the auxiliary supplies shall be declared in the Tender document. Auxiliary equipment intended to operate on 50Hz alternating current supplies shall be declared in the Tender documents.

5.24 Finish Colour

The Tenderer shall agree the finish colour of the switchgear with the purchaser. Control panels shall be finished according to ENA TS 50-18 “Design and application of ancillary electrical equipment”. Switchgear intended for outdoor siting shall be galvanised or Zinc sprayed and paint finished in accordance with Section 6.21 of ENA TS 41 – 37 part I.

5.25 Switchgear, operating Cubicles and Panels

The following requirements shall apply to all switchbays, cubicle and panels.

5.25.1 Ferruling

All cables and wiring shall be clearly marked with cable numbering and ferrules at each point of termination. These shall be clearly identified on the wiring diagrams such that all internal wiring is unambiguously identifiable. This shall apply to all elements of the installation from the switchgear assembly to marshalling and control kiosks, control panel and junction boxes.

All control and internal wiring shall be easily identifiable and traceable throughout the circuit schematic and wiring diagrams.

Wiring shall be fitted with interlocking numbered ferrules. Ferrules shall be fitted at both ends of the wire unless the wire is individually routed and less than 100mm long. Ferrules shall be indelibly marked. It shall be necessary to disconnect the termination to remove the ferrules.

5.25.2 Terminals and Terminal Blocks

Conductor ends shall be fitted with a crimped terminated device having an insulated shank. Terminals having different voltages shall be separated. The voltage shall be marked on the terminals. All terminals shall be fully segregated and insulated from adjacent terminals so that inadvertent contact is prevented. Sufficient spare terminals shall be provided to cater for spare cores on multicore cables.

All terminal blocks provided within the control cubicle, for multicore cable terminations, shall be able to accept a hooked palm type crimp termination. Whilst insulation displacement type terminal blocks will be accepted for internal cubicle wiring, these shall not be permitted for multicore terminations.

All terminal blocks associated with all CT wiring and all interface wiring on the 132kV switchgear and all associated control and protection panels and cubicles shall be equipped with spring loaded terminal blocks (for example - WDUx/SL or equivalent). Push in type terminals blocks are not permitted.

5.25.3 Internal Wiring

Internal wiring conductors shall have a minimum cross-section of 1.5mm2 and a minimum of seven copper strands, unless otherwise approved. Any CT wiring shall have a minimum cross-section of 2.5mm2. The insulation shall be LS0H.

5.26 Special Tools

Requirements for special tools and equipment (including HV test probes) necessary for the erection, operation, testing and maintenance of the switchgear shall be detailed and provided by the manufacturer. A dedicated set of tools such as operator handles, and inspection cameras shall be provided with the switchgear It is preferable, that items are supplied in a suitable padlockable box and the purpose of each tool and device labelled.

6 Erection and Site Assembly

6.1 Final Erection in Works

Erection in works shall be carried out under clean room conditions. Facilities shall be made available for the Purchaser, or his authorised inspection contractor, to view and approve the equipment after final assembly.

6.2 First Filling of Gas

The Tender shall include the first pressurising of all enclosures with gas and any topping up of gas required during the period of warranty.

6.3 Site Tests

The Tender documents shall include a comprehensive programme of on site testing, presented in tabular form, which shall be approved by the Purchaser. The programme shall comply with the requirements of BS EN 62271-1:2017+A1:2021 High-voltage switchgear and controlgear. Part 1: Common specifications for alternating current switchgear and controlgear and include the following.

- Voltage tests on main circuits.
- Measurement of resistance of main circuit.
- Gas tightness tests.
- Checks on correct assembly and correct small wiring.
- Functional tests on auxiliary equipment, locks and interlocks.
- Functional tests on all high voltage switches.
- Checks on surge arresters.
- Circuit breaker tests in accordance with IEC 62271-100.
- Gas content, Dew Point and Acidity tests on all gas chambers.
- Full chemical analysis of all gasses to provide a fingerprint for future analysis
- The estimated time to complete site testing after erection shall be declared.

6.4 Test Equipment

All test equipment required for type testing, works and site testing shall be provided by the manufacturer or the manufacturer's contractor.

7 Drawings

The drawings to be submitted for approval by the Purchaser are specified in the following tables.

Table of drawings to accompany the Tender:

STAGE	REQUIREMENT
Accompanying the Tender documents and sufficiently detailed to allow space and foundation requirements to be accurately determined.	1. Switchboard scaled general arrangement with overall switchboard and per-switchbay dimensions. This drawing shall also specify foundation loads in kg, both static and dynamic and clearances between bays inclusive of any cable runs or pipework. 2. Single line diagram of main high voltage connections. 3. Cross - sectional views of circuit breakers, disconnectors, earth switches, busbars and connections showing gas zones and general constructional details. 4. General arrangement layout of control panels. 5. General arrangement of mimic diagram/standby control panel. 6. Diagram showing typical unit and busbar zone protection. 7. General arrangement and schematic of gas systems.

Table of drawings within two months following awards of contract:

STAGE	REQUIREMENT
A Within two months following award of contract.	1. Switchboard scaled and detailed general arrangement with principal dimensions and including the positions of circuit breakers, disconnectors, earthing switches, multicore cable marshalling boxes, power cable terminations and gas tight barriers. 2. Detailed general arrangements and sectional drawings of circuit breakers, disconnectors and earthing switches. 3. Dimensioned general arrangement of local control cubicles. 4. Diagrams of unit and busbar zone protection. 5. General arrangement and schematic of gas system identifying each gas chamber and the mass of gas in that chamber. 6. Circuit breaker details including CTs and VTs, foundation fixing bolts and loads and cable entry positions. 7. Disconnector and earthing switch details including foundation fixing bolts and loads. 8. Detailed drawings and foundation details of any other structures forming part of the contract. 9. Busbar connection and fixing details including loadings. 10. Details and circuit diagram of interlocking scheme(s). 11. Complete multicore circuit diagrams, complete with ferrule labelling describing: (a) DC tripping connections. (b) DC control and indication connections. (c) CT connections (d) AC connections for protection, indication and synchronising. (e) Connections for electrical interlocking (f) Busbar zone protection connections. 12. Complete diagrams of main connections. 13. SF_6 / Alternative Gasses Temperature adjustment chart. 14. Details and schematic of gas handling equipment. 15. Details of CTs including wiring and drilling dimensions.

	16. Details and arrangement drawings of auxiliary plant and kiosks including foundation fixings and cable entries. 17. Material lists. 18. Details of lifting and handling equipment including any floor fixings required to install equipment. 19. General arrangement of key cabinet with Schedule of locks and keys. 20. Main cable entry positions, allowing a trench plan to be constructed

Table of drawings required for final records on completion of commissioning:

STAGE	REQUIREMENT
Final Records	1. Contract drawing list with number, title and revision of each drawing. 2. Two paper prints of each drawing and equivalent AutoCad (.dwg) and Adobe Acrobat (pdf) format files.

NOTES ON DRAWING AND DRAWING FORMAT

(a) Orthographic drawings shall use metric units and be reproduced to a scale that is declared on each print. The scale for general arrangement drawings shall not be less than 1 to 50 and that for detail drawings shall not be less than 1 to 20.

(b) All drawing, schematic and wiring diagrams shall comply with UK ESI convention and be produced on conventional format up to a maximum A1 paper size. AC and DC schemes shall be depicted as comprehensively on one drawing as possible. Multi-page A4 is not acceptable.

(c) Drawings shall be submitted for approval by the Purchaser on paper in duplicate. They shall also be accompanied by equivalent AutoCad .dwg format files via email.

(d) The name of the site, the drawing number and the date and number of revision shall be marked on all drawings. All drawings shall be numbered according to a logical scheme.

8 Operational Life, Inspection, Maintenance and Training

8.1 Operational Life

The switchgear shall be designed and constructed for an operational lifetime of at least 40 years. The supplier shall provide technical support and a source of spares over this period.

8.2 Operating and Maintenance Manuals

All necessary operating and maintenance manuals for the switchgear and all ancillary equipment including the gas handling plant shall be provided within two months of the award of contract, including recommended Schedules of inspection and maintenance.

8.3 Failure Mode, Effect and Cause Analysis

The Tenderer shall provide a Failure Mode, Effect and Cause Analysis (FMECA) study with the Tender.

8.4 Sample Materials

Sample materials may be requested by the Purchaser.

8.5 Training

Training requirements relating to operation, inspection, and maintenance of the switchgear and equipment supplied shall be specified in the Tender documents in the form of a Schedule.

9 Handling of Gas and Decontamination Procedures

9.1 Gas Handling Equipment

The Tender shall include the provision of a complete gas servicing plant for switchgear maintenance purposes, equipped with gas analysis instruments. The gas servicing plant shall be capable of evacuating, refilling and filtering the gas contained within the switchgear enclosures, including transfer and measurement of gas to and from high pressure gas cylinders to BS 5045-7:2000 - "Transportable gas containers". The gas cart shall be supplied be the Tenderer and have a gas receiver sized to facilitate all necessary foreseen maintenance and testing activities throughout the lifetime of the installation. The actual receiver size and specification shall be confirmed during the Tender.

9.1.1 Rate of Gas Transfer

The maximum rate of gas transfer achieved by the plant shall be sufficient to empty, or refill, the largest compartment in the switchgear within two hours.

9.1.2 Vacuum Performance

The minimum pressure achievable by the gas handling plant, when evacuating enclosures shall be declared in the Tender documents.

9.1.3 Operation of Gas Plant

The gas handling plant shall be transportable and mounted on a wheeled trolley. It shall be capable of operation by one person, including connection and disconnection. Its characteristics shall be declared in the Tender.

9.1.4 Gas Analysis

Instruments shall be provided (with compatible test leads) capable of carrying out all the tests specified in BS EN IEC 60376:2018 Specification of technical grade sulphur hexafluoride (SF_6) and complementary gases to be used in its mixtures for use in electrical equipment and in BS EN IEC 60480:2019Specifications for the re-use of sulphur hexafluoride (SF_6) and its mixtures in electrical equipment. The following analyses shall be supported.

- Gas identification by thermal conductivity or other approved method.
- Oxygen content by magnetic susceptibility or by gas chromatography.
- Measurement of dew point.
- Determination of hydrolysable fluorides of mineral oil.
- Gas content
- Measurement of acidity

9.1.5 Decontamination at the End of Service Lifetime

When the equipment reaches the end of its service lifetime it will have to be decontaminated and disposed of safely. It is important that this requirement is allowed for in the design of the equipment. Tenders shall include a detailed procedure by which the switchgear offered may be safely de-gassed and decontaminated prior to disposal at the end of its service life. This requirement applies to enclosures that have contained gas as an insulator as well as those where gas has been used as an arc interrupting medium. It is a requirement of this Specification that companies submitting Tenders shall have safe procedures in place and facilities available to:

- Decontaminate the equipment and site as necessary and recover switchgear for examination/disposal as required.
- Decontaminate the equipment on site or elsewhere, as required to carry out modifications.
- Decontaminate the equipment prior to disposal.

10 Variations

The Tender shall include using Schedule I attached, any variations from the foregoing Technical and Performance Specification, including those that in the Tenderer’s opinion enhance the performance of the equipment.

11 Documents Referenced

DOCUMENTS REFERENCED	
Health and Safety at Work Act 1974	
Control of Substances Hazardous to Health Regulations 2002	
Health and Safety Manual Handling Operation Regulations 1992	
The Electricity at Work Regulations 1989	
EC Directives	"Management of Health, Safety and Welfare". "Manual Handling Regulations". "Workplace Health, Safety and Welfare". "Provision and Use of Work Equipment Regulations".
IEC 62271-100:2021	High-voltage switchgear and controlgear. Part 100: Alternating-current circuit-breakers
BS EN IEC 62271-102:2018+A1:2022	High-voltage switchgear and controlgear. Alternating current disconnectors and earthing switches
IEC 62271-203:2022	Gas-insulated metal-enclosed switchgear for rated voltages above 52kV
BS EN ISO 9000	Quality Management and Quality Assurance Standards
BS EN 1089-3:- 2011	Transportable gas cylinders. Gas cylinder identification (excluding LPG). Colour coding
BS EN 14001	Environmental Management Systems
BS EN 50068:2018	High-Voltage Switchgear and Controlgear. Gas-filled wrought steel enclosures.

BS EN 50069:2018	High-voltage switchgear and controlgear. Gas-filled welded composite enclosures of cast and wrought aluminium alloys.
BS EN 61869-2:2012	Instrument transformers. Additional requirements for current transformers
BS EN 61869-3:2011	Instrument transformers. Additional requirements for inductive voltage transformers.
BS EN 60099-4	Surge arresters. Metal-oxide surge arresters without gaps for a.c. systems
BS EN IEC 60099-8:2018	Surge arresters. Metal-oxide surge arresters with external series gap (EGLA) for overhead transmission and distribution lines of a.c. systems above 1 kV.
BS EN 60137:- 2017	Insulated bushings for alternating voltages above 1 kV
BS EN IEC 62271-104:2020	High-voltage switchgear and controlgear. Alternating current switches for rated voltages higher than 52 kV.
BS EN 62271-1:2017+A1:2021	High-voltage switchgear and controlgear. Part 1: Common specifications for alternating current switchgear and controlgear.
BS 5045-7:2000	Transportable gas containers
BS EN IEC 60376:2018	Specification of technical grade sulphur hexafluoride (SF_6) and complementary gases to be used in its mixtures for use in electrical equipment.
BS EN IEC 60480:2019	Specifications for the re-use of sulphur hexafluoride (SF_6) and its mixtures in electrical equipment
BS ISO 3864-1:2011	Graphical symbols. Safety colours and safety signs. Design principles for safety signs and safety markings.
IEC 62271-209:2019+A1:2022	High-voltage switchgear and controlgear. Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above

	52 kV - Fluid-filled and extruded insulation cables - Fluid-filled and dry-type cable terminations.
BS EN 50052:2016	High-voltage switchgear and controlgear. Gas-filled cast aluminium alloy enclosures.
BS 7912	Power cables with XLPE insulation and metallic sheath, and their accessories, for rated voltages from 66 kV (U_m=72.5 kV) to 132kV (U_m=145kV). Requirements and test methods
ENA List of Switchgear Approvals and Certificates	
ENA TS 09-2	The Installation of 33 kV and Higher Voltage Power Cables and Auxiliary Cables".
ENA TS 09-16	Testing Specification for Metallic Sheathed Power Cables with Extruded Cross-Linked Polythene Insulation and Accessories for System Voltages of 66 kV and 132 kV
ENA TS 41-37 Part 1, Issue 3:2022	Switchgear for use on 66 and 132 kV Distribution Systems
ENA TS 41-37 Part 2, Issue 3:2022	GIS Switchgear for use on 66 and 132kV Distribution Systems
ENA TS 41-15	132 kV Busbar Substation - Feeder Circuits
ENA TS 50-18	Design and Application of Auxiliary Electrical Equipment
Engineering Recommendation S2/4	Limitation of Fire Risk in Substations at 132 kV and Below in Enclosed Cableways"
ES400 C13	Multipair and Multicore Auxiliary Cables
ES001	Main Specifications

ES400 E5	Specification for the Installation, Commissioning and Repair of Underground Cables Operating at 33kV and 132kV, and the Restoration of Excavated Areas
CP314	Lightning Protection of High Voltage Overhead Line Systems
CP319	Applied High Voltage Test

12 Keywords

132kV; gas; plant; switchgear

Appendix A – Schedules of Information

Schedule A - Manufacturers and Location of Manufacturing, Inspection and Testing

To be completed by the Tenderer

ITEM	MANUFACTURER	LOCATION OF MANUFACTURE	LOCATION OF TESTING AND INSPECTION
Main Equipment			
Fabrication of Structural Steelwork			
Galvanising			
Fabrication of Aluminium Casings			
Rigid busbar and connections			
Flexible busbars and connections			
Insulators			
Insulator Fittings			
Large Porcelains			
Disconnectors, by-pass and earthing switches			
Switch Disconnectors			
Circuit Breakers			
Circuit Breaker Insulators			
Insulating Chambers			

Protective Equipment			
Protective Relays			
Current Transformers			
Voltage Transformers			
Control and Relay Panels			
Instruments			
Multicore Cables			
Neutral Earthing			
Resistances			
Auxiliary Equipment			
Motors for circuit breaker equipment			
Rectifier Equipment			
Contactors			
Hydraulic/Pneumatic Plant & Equipment			
Compressors			
Compressor Motors			
Air Receivers			
Pipes			
Pipe Joints			

Stop Valves			
Safety Valves			
Reducing Valves			
Contact Making Gauges			
Filters			
Dryers			
Pressure Maintaining Valves			
Gas Handling Equipment			
Compressors			
Compressor Motors			
Vacuum Pumps			
Vacuum Pump Motors			
Gas Receivers			
Pipes			
Pipe Joints			
Stop Valves			
Reducing Valves			
Contact Making Gauges			
Filters			

Dryers			
Pressure Maintaining Valves			
Temperature Compensated			
Pressure Switches			
Overpressure Relief Devices			

Schedule B - General Particulars and Guarantees

Schedule B1 - General Particulars

These items are declared by the Purchaser

ITEM	REQUIREMENT
Inclusion or exclusion of power and/or control cables from the contract price	
Power supply for electrical operation of circuit breakers, disconnectors and earth switches	(a) Closing – 110VDC (b) Opening – 110VDC
Power supply for compressor operation	110VDC
Supply voltage for auxiliary equipment	110VDC
Finish of control and relay panels	To ENA TS 50-18 “Design and application of ancillary electrical equipment”
Provision of voltage transformer HV links	
Provision of three phase auto reclosing (a) High speed (b) Low Speed	
Suitability of circuit breakers for later adoption of three phase auto reclosing (a) High speed (b) Low speed	

Schedule B2 - Minimum Factors of Safety required for structural and other materials and items used in the construction of the switchgear

These items are declared by the Purchaser

ITEM	Factor of Safety
Busbars or other connections, based upon an elastic limit or other 0.1% proof stress	2.5
Fully assembled insulator units, based upon mechanical test	2.5
Insulator fittings based upon mechanical test	2.5
Steel structures based upon elastic limit of tension members and on crippling loads of compression members	2.5
Structure foundations against overturning or up-rooting under maximum simultaneous imposed working load.	2.5

Schedule B3 - Quality of Materials

To be completed by Tenderer

Ferrous Materials

PARTICULARS	STEEL STRUCTURES, CIRCUIT BREAKERS, OPERATING RODS, ETC.							INSULATOR FITTINGS	
	CAST STEEL	SECTION & PLATES	STEEL	FASTENERS	STEEL	HIGH TENSILE	MILD STEEL	STEEL	MALLEABLE CAT IRON
1. Tensile breaking strength MN/m^2									
2. Elongation on breaking percentage									
3. Gauge length of specimen									
4. Diameter of specimen mm									
5. Elastic limit as percentage of breaking strength									
6. Modulus of elasticity MN/m^2									

Non - Ferrous materials

MATERIAL	SPECIFICATION OR ANALYSIS
1. Casings for current carrying components	
2. Conductors	
3. Other Purposes	

Schedule C - Ratings

Schedule C1 - Circuit Breakers

To be completed by Tenderer

	TYPE		
1	Type reference of circuit breaker		
	Rated values and characteristics		
2	Number of poles		
3	Class: Indoor (I) or outdoor (O)		
4	Rated voltage		
	(a) Rated lightning impulse withstand voltage to earth and between poles	kV	
	(b) Rated lightning impulse withstand voltage between terminals of open poles	kV	
	(c) Rated 1 minute power frequency withstand voltage	kV	
5	Rated frequency	Hz	
6	Rated normal current	A	
7	Rated line charging breaking current	A	
8	Rated cable charging breaking current	A	
9	Rated (single) capacitor breaking current	A	
10	Rated low inductive breaking current		

	(a) Transformer, frequency 500Hz	A	
	(b) Reactor, frequency 2 – 3kHz	A	
11	Rated, short circuit breaking current		
	(a) Symmetrical single phase	A	
	(b) Symmetrical three phase	A	
	(c) Asymmetrical single phase	A	
	(d) Asymmetrical three phase	A	
12	Rated transient recovery voltage		
	(a) First reference voltage U_1	kV	
	(b) Time to reach U_1 - t_1	ms	
	(c) TRV peak value U_c	kV	
	(d) Time to reach U_c - t_2	ms	
	(e) Time delay td	ms	
	(f) Voltage co-ordinate U'	kV	
	(g) Time co-ordinate t'	ms	
	(h) Rate of rise U_1/ t_1	kV/ms	
13	Rated short circuit making current		
	(a) Peak three phase	kV	

	(b) Peak single phase	kV	
14	Rated operating sequence		
15	Rated short time current/duration		
	(a) Three phase	kA/s	
	(b) Single phase	kA/s	
16	Rated out of phase breaking current	kA	
17	Opening time without current	ms	
18	Minimum break time at rated breaking current	ms	
19	Minimum auto reclose dead time following opening under fault conditions	ms	
20	Closing time without current	ms	
21	Close - open time; maximum time to open following closure onto a prepared trip fault	ms	
22	Type tests verifying the above ratings		
	Constructional Features		
23	Mass of each installed circuit breaker	kg	
24	Shock loading of circuit breaker	kg	`
25	Filling gas		
	(a) Total gas quantity in circuit breaker enclosure		

	(b) Normal operating temperature at 20°C	bar g	
	(c) Maximum operating temperature at 20°C	bar g	
	(d) Low pressure alarm pressure at 20°C	bar g	
	(e) Low pressure lock out pressure at 20°C	bar g	
	(f) Minimum gas pressure to achieve rated breaking current at 20°C	bar g	
	(g) Minimum pressure to withstand two asynchronous rated power frequency voltages across open poles at 20°C	bar g	
	(h) Minimum pressure to withstand 1.5 x phase to earth voltage between terminals and earth at 20°C	bar g	
	(i) Maximum leakage rate of gas from circuit breaker enclosures		
	(j) Type of filter	percentage per annum	
26	Number of breaks in series per pole		
27	Minimum clearance		
	(a) Between poles	mm	
	(b) To earth	mm	
28	Stroke of moving contacts	mm	
29	Material of main contacts	mm	
30	Material of moving contacts		
31	Type of arc control device		

32	Type of device used to limit rate of rise of re-striking voltage		
33	Resistance across main contacts at rated current	mW	
34	Is the contact current used to increase the contact pressure?		
35	Material of tank		
36	Thickness of tank		
37	Routine pressure test on circuit breaker enclosure	bar g	
38	Type pressure test on circuit breaker enclosure	bar g	
	Operating Mechanism		
39	Type reference of circuit breaker operating mechanism		
40	Is the circuit breaker trip free or fixed trip?		
41	Method of operating circuit breaker, for example, stored energy		
42	Pre-charge pressure of energy storage system	bar g	
43	Capacity of energy storage system, pump cut in to pump cut out	Litre	
44	Operating sequences available with stored energy at pump cut out		
45	Pneumatic or hydraulic pressures		
	(a) Pump motor cut in	bar g	
	(b) Pump motor cut out	bar g	

	(c) Close lock out pressure	bar g	
	(d) Close lock out reset pressure	bar g	
	(e) Trip lock out	bar g	
	(f) Trip lockout	bar g	
	(g) Low pressure alarm	bar g	
	(h) Low pressure alarm reset	bar g	
	(i) Safety device operate	bar g	
	(j) Safety device reset	bar g	
46	Pump motor		
	(a) Electrical supply AC or DC?		
	(b) Rated voltage of operation	V	
	(c) Starting current	A	
	(d) Operating current	A	
	(e) Motor speed	RPM	
47	Type of compressor		
48	Type of safety valve		
49	Type of non return valve		
50	Type of isolating valve		

51	Type of pressure switch		
52	Closing coils		
	(a) Rated voltage	V	
	(b) Current to close circuit breaker at rated voltage	A	
	(c) Minimum operating voltage	V	
53	Trip coils		
	(a) Rated voltage	V	
	(b) Current to open circuit breaker at rated voltage	A	
	(c) Minimum operating voltage	V	
54	Current rating and type of auxiliary switches provided		
55	State the number of circuit breaker interruptions that may be performed before maintenance is required		
	(a) At the rated current		
	(b) At 10kA		
	(c) At 20kA		
56	State the method by which contact wear is externally indicated and/or may be measured		

Schedule C2 - Disconnectors

To be completed by Tenderer for each type

	TYPE		
1	Type reference of disconnector		
	Rated Values and Characteristics		
2	Number of poles		
3	Class: Indoor (I) or outdoor (O)		
4	Rated voltage	kV	
5	Rated insulation level		
	(a) Rated lightning impulse withstand voltage to earth and between poles	kV	
	(b) Rated lightning impulse withstand voltage between terminals of open poles	kV	
	(c) Rated 1 minute power frequency withstand voltage	kV	
6	Rated frequency	Hz	
7	Capacitive current switching ability		
	(a) Making	A	
	(b) Breaking	A	
8	Rated normal current	A	
9	Rated short time current/duration		
	(a) Three phase	kA/s	

	(b) Single phase	kA/s	
10	Trip impulse to contact separation time	s	
11	Closing impulse to contact make time	s	
12	Type test to verify the above ratings		
	Constructional features		
13	Weight of installed earth switch	Kg	
14	Filling gas		
	(a) Minimum pressure to withstand two asynchronous rated power frequency voltages across open poles at 20°C	bar g	
	(b) Minimum pressure to withstand 1.5 x phase to earth voltage between terminals and earth at 20°C	bar g	
15	Minimum clearance		
	(a) Between poles	mm	
	(b) To earth	mm	
16	Stroke of moving contacts	mm	
17	Material of main contacts		
18	Resistance across main contacts at rated current	μΩ	
19	Is the contact current used to increase the contact pressure?		
	Operating Mechanism		

20	Type reference of operating mechanism		
21	Method of operating circuit breaker, for example, stored energy		
22	Operating motor		
	(a) Type, AC or DC?	V	
	(b) Rated voltage		
	(c) Opening current on starting	A	
	(d) Opening current running	A	
	(e) Closing current starting	A	
	(f) Closing current running	A	
	(g) Speed	RPM	
23	Method of indicating contact status, OPEN and CLOSED		
24	Current rating and type of auxiliary switches provided		

Schedule C3 - Earth Switches

To be completed by Tenderer for each type

	TYPE		
1	Type reference of earth switch		
	Rated Values and Characteristics		
2	Number of poles		
3	Class: Indoor (I) or outdoor (O)		
4	Rated insulation level		
	(a) Rated lightning impulse withstand voltage to earth and between poles	kV	
	(b) Rated lightning impulse withstand voltage between terminals of open poles	kV	
5	Rated frequency	kV	
6	Rated short time current/duration	Hz	
	(a) Three phase		
	(b) Single phase	A	
7	Rated short circuit making current (if applicable)	A	
8	Type test to verify the above ratings		
	Constructional Features		
9	Weight of installed earth switch	kg	
10	Minimum clearance between live parts and earth	mm	

11	Stroke of moving contacts	mm	
12	Material of main contacts		
13	Resistance across closed contacts	μΩ	
	Operating Mechanism		
14	Type reference of earth switch operating mechanism		
15	Method of operating earth switch for example manual or motor		
16	Operating motor		
	(a) Type, AC or DC?		
	(b) Rated voltage	V	
	(c) Opening current on starting	A	
	(d) Opening current running	A	
	(e) Closing current starting	A	
	(f) Closing current running	A	
	(g) Speed	RPPM	
17	Method of indicating contact position		
18	Current rating and type of auxiliary switches provided		

Schedule D - Current and voltage transformers

To be completed by Tenderer

Schedule D1 - Current transformers

1	**Feeder Unit Protection**		
	Highest equipment voltage	kV	
	Insulation level	kV	
	Frequency	Hz	
	Rated continuous primary thermal current	A	
	Rated primary/secondary currents	A	
	Rated output	VA	
	Class of accuracy		
	Rated accuracy limit factor		
	Short time current and duration	A	
		s	
	Rated primary current	A	
	Normal turns ratio		
	Knee point emf V_k	V	
	Maximum secondary winding resistance at 75° C	Ω	
	Exciting current at $V_k/2$	V	
2	**Feeder Back-Up Protection**		

	Highest equipment voltage	kV	
	Insulation level	kV	
	Frequency	Hz	
	Rated continuous primary thermal current	A	
	Rated primary/secondary currents	A	
	Rated output	VA	
	Class of accuracy		
	Rated accuracy limit factor		
	Short time current and duration	A	
		s	
	Rated primary current	A	
	Nominal turns ratio		
	Knee point emf V_k	V	
	Maximum secondary winding resistance at 75° C	Ω	
	Exciting current at $V_k/2$	V	
3	**Metering**		
	Highest equipment voltage	kV	
	Insulation level	kV	

	Frequency	Hz	
	Rated continuous primary thermal current	A	
	Rated primary/secondary currents	A	
	Rated output	VA	
	Class of accuracy		
	Rated accuracy limit factor		
	Short time current and duration	A	
		s	
	Rated primary current	A	
	Nominal turns ratio		
	Knee point emf V_k	V	
	Maximum secondary winding resistance at 75° C	W	
	Exciting current at $V_k/2$	V	
4	**Instrumentation**		
	Highest equipment voltage	kV	
	Insulation level	kV	
	Frequency	Hz	
	Rated continuous primary thermal current	A	

	Rated primary/secondary currents	A	
	Rated output	VA	
	Class of accuracy		
	Rated accuracy limit factor		
	Short time current and duration	A	
		s	
	Rated primary current	A	
	Nominal turns ratio		
	Knee point emf V_k	V	
	Maximum secondary winding resistance at 75° C	W	
	Exciting current at $V_k/2$	V	
5	**Busbar Protection Discriminating**		
	Highest equipment voltage	kV	
	Insulation level	kV	
	Frequency	Hz	
	Rated continuous primary thermal current	A	
	Rated primary/secondary currents	A	
	Rated output	A	

	Class of accuracy		
	Rated accuracy limit factor		
	Short time current and duration	A	
		s	
	Rated primary current	A	
	Nominal turns ratio		
	Knee point emf V_k	V	
	Maximum secondary winding resistance at 75° C	W	
	Exciting current at $V_k/2$	V	
6	**Busbar Protection Check**		
	Highest equipment voltage	kV	
	Insulation level	kV	
	Frequency	Hz	
	Rated continuous primary thermal current	A	
	Rated primary/secondary currents	A	
	Rated output	VA	
	Class of accuracy		
	Rated accuracy limit factor		

	Short time current and duration	A	
		s	
	Rated primary current	A	
	Nominal turns ratio		
	Knee point emf V_k	V	
	Maximum secondary winding resistance at 75° C	W	
	Exciting current at $V_k/2$	V	

Schedule D2 – Voltage Transformers

1	Type (reference of voltage transformer)		
2	Method of transformation (winding configuration)		
3	Transformation ratio		
4	Rated output per phase (for protection & instrumentation)	VA	
5	Class of accuracy (for protection & instrumentation)	VA	
6	Rated output per phase (for metering)	VA	
7	Class of accuracy (for metering)	VA	
8	Voltage factor		
9	Rated time	s	
10	Electrostatic capacity of each capacitor, line to earth	pF	
11	Insulating medium		
12	Total volume of insulating medium, per single phase unit	Litre	
13	Weight of complete unit ready for service	kg	

Schedule E –Gas and Enclosure Details

To be completed by the Tenderer

1	**Number of segregated gas enclosures for each circuit breaker type**		
	(a) Single feeder		
	(b) Banked feeder		
	(c) Supergrid transformer		
	(d) Bus section		
	(e) Bus coupler		
2	**Purpose (insulation, arc extinction or both) and volume of gas in each type of gas enclosure**		
	(a) Purpose of enclosure Volume of enclosure Weight of enclosed gas Pressure of enclosed gas	 m^3 kg bar g	
	(b) Purpose of enclosure Volume of enclosure Weight of enclosed gas Pressure of enclosed gas	 m^3 kg bar g	
	(c) Purpose of enclosure Volume of enclosure Weight of enclosed gas Pressure of enclosed gas	 m^3 kg bar g	
	(d) Purpose of enclosure Volume of enclosure Weight of enclosed gas Pressure of enclosed gas	 m^3 kg bar g	
	(e) Purpose of enclosure		

	Volume of enclosure Weight of enclosed gas Pressure of enclosed gas	m^3 kg bar g	
	(f) Purpose of enclosure Volume of enclosure Weight of enclosed gas Pressure of enclosed gas	 m^3 kg bar g	
	(g) Purpose of enclosure Volume of enclosure Weight of enclosed gas Pressure of enclosed gas	 m^3 kg bar g	
	(h) Purpose of enclosure Volume of enclosure Weight of enclosed gas Pressure of enclosed gas	 m^3 kg bar g	
3	**SF_6 gas pressures**		
	(a) Normal operating pressure at 20°C (b) Pressure falling alarm at 20°C (c) Pressure low alarm at 20°C (d) Pressure high alarm at 20°C (e) Pressure at which safety device operates	bar g bar g bar g bar g bar g	
4	**Type of pressure gauge**		
5	**Type of safety device**		
6	**Type of isolating valve**		
7	**Method of joining piped sections**		
8	**Method of jointing pipes and valves**		

9	**Type of gas filter**		
10	**Material of enclosure casing**		
11	**Thickness of enclosure casing**	mm	
12	**Routine test pressure for enclosures**	bar g	
13	**Type test pressure for enclosures**	bar g	
14	**Total gas content of installed switchboard**	kg	
15	**Estimated total gas leakage rate of installed switchboard.**	Percentage per Annum	
16	**Withstand voltage of chambers subject to DC voltage when testing power cables**	kV	
17	**Enclosure burn through time at rated earth fault current**	ms	
18	**Shortest time to rupture of a bursting disc at rated short circuit currents**	ms	

Gas details (at 20°C Normal Operating Pressure)

1	Water content – maximum	mg/kg	
2	Nitrogen content – maximum	g/kg	
3	Oxygen content – maximum	g/kg	
4	Carbon tetrachloride CCl_4 content – maximum	g/kg	
5	Free acidity expressed as HF maximum	mg/kg	
6	Hydrolysable fluoride compounds - expressed as F - maximum	mg/kg	

Schedule F - Insulators

To be completed by Tenderer

1	Type (Maker's designation)		
2	Insulator material		
3	Form (conical, disc, etc.)		
4	Dimensions	mm	
5	Weight of complete insulator	kg	
6	Method of bonding to		
	(a) Casing		
	(b) Conductor		
7	Material of fittings		
	(a) Casing		
	(b) Conductor		
8	Electrostatic capacity of complete insulator	pF	
9	Minimum creepage distance over insulator (state if more than one type)	mm	
10	String distance over insulator surface between conductor and casing (state type if more than one)	mm	
11	Maximum partial discharge magnitude at 67% of rated voltage	pC	
12	Method of drying insulators		
	(a) At works		

	(b) Prior to commissioning		
	(c) After maintenance – state anticipated duration of drying process		

Schedule G - Gas Servicing Equipment

To be completed by Tenderer

1	Type of plant - static or mobile		
2	Type of connection between pumping equipment and		
	(a) New and used gas storage receivers		
	(b) Switchgear		
3	Type of compressor		
4	Speed compressor	RPM	
5	Type of motor		
6	Motor rating (BS Rating)	kW	
7	Speed of motor at rated output	RPM	
8	Motor full load current	A	
9	Motor maximum starting current	A	
10	Compressor output		
	(a) At normal working inlet pressure	Litre/min	
	(b) At atmospheric inlet pressure and 20 °C	Litre/min	
11	Normal delivery pressure and temperature	°C	
12	Type of vacuum pump		

13	Speed of vacuum pump	RPM	
14	Type of motor		
15	Motor rating (BS Rating)	kW	
16	Speed of motor at rated output	RPM	
17	Motor full load current	A	
18	Motor maximum starting current	A	
19	Output of vacuum pump		
	(a) At normal working inlet pressure (state pressure at 20 °C	litre/min	
	(b) At atmospheric inlet pressure and 20 °C	litre/min	
20	Type of compressor after cooler		
	(a) Cooling medium		
	(b) Design cooler		
	(c) Power consumption at maximum gas flow rate		
21	Type of gas evaporator unit		
	(a) Heating medium		
	(b) Design of evaporator		
	(c) Power consumption at maximum gas flow rate		
22	Number and grouping of storage receivers for		

	(a) New Gas		
	(b) Used Gas		
23	Water volume of storage receivers for		
	(a) New Gas		
	(b) Used Gas		
24	Total gas stored at normal operating pressure at 20 °C in storage receivers for		
	(a) New Gas (Litres at atmospheric pressure and 20 °C)	litre	
	(b) Used Gas (Litres at atmospheric pressure and 20 °C)	litre	
25	Maximum and normal operating pressure in storage receivers for		
	(a) New Gas	bar g	
	(b) Used Gas	bar g	
26	Filling ratio of storage receivers		
27	Time to extract gas from circuit breaker (all compartments) from normal working pressure to		
	(a) Atmospheric pressure	hour	
	(b) 20 mm mercury pressure	hour	
28	Time to evacuate air from circuit breaker (all compartments) to 1 mm mercury pressure	hour	
29	Time to evacuate air from largest item of plant (all compartments) from normal working pressure to		
	(a) Atmospheric pressure	hour	

	(b) 20 mm mercury	hour	
30	Time to evacuate air from largest item of plant (all compartments) to 1 mm mercury	hour	
31	Time recommended for holding vacuum prior to refilling with gas	hour	
32	Time to refill equipment with SF_6 from vacuum to normal working pressure	hour	
33	Rate at which gas in equipment can be re-circulated through filters	litre/min	
34	Maximum pressure that can be applied to connections between servicing equipment and switchgear	bar g	
35	Maximum pressure that can be applied to compressor inlet	bar g	
36	Maximum pressure that can be applied to vacuum pump inlet	bar g	
37	Bursting pressure of bursting discs; state location and pressure		
38	Weight of filter material in filters	kg	
39	Type of containers for topping up switchgear with any gas		
40	Weight of item 39 with full gas load	kg	
41	Weight of containers for dry Nitrogen	kg	
42	Volume of Nitrogen stored at 15 °C	litre	
43	Type of leak detector		
44	Type of Oxygen analyser		
45	Type of moisture meter		

Schedule H - List of Sub-Contractors

NAME OF SUB-CONTRACTOR	ITEM TO BE SUPPLIED

Name of Tenderer _____

Schedule I - List of Variations from the Specification

NO. OF CLAUSE	DETAILS OF ITEM NOT IN ACCORDANCE WITH THE SPECIFICATION

Name of Tenderer _____

NOTE:

Additional sheets may be inserted as required

Schedule J – Tools and Spare Parts

List of tools recommended for use with each installation

DESCRIPTION	PRICE EACH £	TOTAL PRICE £

Recommended spare parts, to be ordered at the discretion of the company

DESCRIPTION	PRICE EACH £	TOTAL PRICE £

Appendix B – Conformance Declaration

SECTION-BY-SECTION CONFORMANCE WITH SPECIFICATION

The Tenderer shall declare conformance or otherwise for each product/service or range of products/services, section-by-section, using the following Conformance Declaration Codes.

Conformance Declaration Codes:

N/A =	Clause is not applicable/appropriate to the product/service.
C1 =	The product/service conforms fully with the requirements of this clause.
C2 =	The product/service conforms partially with the requirements of this clause.
C3 =	The product/service does not conform to the requirements of this clause.
C4 =	The product/service does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

Manufacturer:
Product/Service Description:
Product/Service Reference:

Name: **Company:** **Signature:** **Date:**

SECTION-BY-SECTION CONFORMANCE			
SECTION	**SECTION TOPIC**	**CONFORMANCE DECLARATION CODE**	**REMARKS * (MUST BE COMPLETED IF CODE IS NOT C1)**
1	**Scope**		
3.1	**Product not to be changed**		
3.2	**Electricity North West technical approval**		
3.3	**Quality assurance**		
3.4	**Formulation**		
3.5	**Identification markings**		
3.6	**Minimum Life Expectancy**		
3.7	**Product conformity**		
3.8	**Confirmation of Conformance**		
4.1	**Requirment for type tests at the suppliers' premises**		
4.2	**Requirement for routine tests at the suppliers' premises**		
4.3	**Requirement for on-site tests**		
5	**Technical and performance requirements**		
5.1	**General design features**		
5.1.1	**Modular construction**		
5.1.2	**Thermal expansion**		
5.1.3	**Gas zones**		

5.1.4	**Robust construction**		
5.1.5	**Access for Operation, Maintenance and Inspection**		
5.1.6	**Simplicity of operation**		
5.1.7	**Earthing**		
5.2	**Circuit breakers**		
5.2.1	**Type**		
5.2.2	**Testing and inspection in an operational configuration**		
5.2.3	**Small current interrupting duties**		
5.2.4	**Circuit breaker re-striking**		
5.2.5	**Short line faults and out-of-phase switching**		
5.2.6	**Minimum interruption times**		
5.2.7	**Transient recovery voltage**		
5.2.8	**Lock out facilities**		
5.2.9	**Ancillary re-striking voltage devices**		
5.2.10	**Parallel operation**		
5.2.11	**Auto reclosing**		
5.2.12	**Continues operation without has re-charge**		
5.3	**Circuit breaker operating mechanisms – general requirements**		
5.3.1	**Type of mechanism**		

5.3.2	**Capability**		
5.3.3	**Anti-pumping**		
5.3.4	**Pole discrepancy**		
5.3.5	**Operation and adjustment of single phase units**		
5.3.6	**Energy charge and recharge of operating mechanism**		
5.3.7	**Immunity from inadvertent operation**		
5.3.8	**Operation counter**		
5.3.9	**Indication of OPEN and CLOSED status**		
5.3.10	**Manual operation of circuit breakers**		
5.3.11	**Slow operation for maintenance**		
5.3.12	**Labelling**		
5.4	**Circuit breaker operating mechanisms – requirements for hydraulic units**		
5.4.1	**Pressure indication and monitoring**		
5.4.2	**Loss of operating pressure in singe phase unit**		
5.4.3	**Excessive time operation of pressure pump**		
5.4.4	**Accumulator gas pressure**		
5.4.5	**Accumulator energy**		
5.4.6	**Bleeding of hydraulic systems**		

5.4.7	**Hydraulic fluid reserve**		
5.5	**Circuit breaker operating mechanisms – requirements for spring powered units**		
5.5.1	**Speed of recharging**		
5.5.2	**Prevention and indication of slow or incomplete closure**		
5.5.3	**Manual charging**		
5.6	**Disconnector and switch-disconnectors**		
5.6.1	**Safe maintenance**		
5.6.2	**Power operation**		
5.6.3	**Interlocking – Metallic screens**		
5.6.4	**Insulation level**		
5.6.5	**Load Currents**		
5.7	**Maintenance earthing switches**		
5.7.1	**Provision and location of maintenance earthing switches**		
5.7.2	**Power operation**		
5.7.3	**Visual confirmation of operation**		
5.7.4	**Testing facilities**		
5.8	**High speed earthing switches**		
5.8.1	**Method of operation**		
5.8.2	**Rating**		
5.8.3	**Location**		

5.8.4	**Testing facilities**		
5.8.5	**Interruption of induced currents**		
5.9	**Combined disconnector and earth switches**		
5.9.1	**Power operation**		
5.9.2	**Visual confirmation of operation**		
5.10	**Operating cubicles**		
5.10.1	**Cubicle equipment**		
5.10.2	**Local/remote operation**		
5.10.3	**Wiring marshalling**		
5.10.4	**Demonstration of immunity to electromagnetic interference**		
5.11	**Interlocking facilities**		
5.11.1	**Mechanical interlocking**		
5.11.2	**Electrical interlocking**		
5.11.3	**Electrical interlocking of manual operation**		
5.11.4	**Circuit breaker gas pressure**		
5.11.5	**Circuit breaker opening**		
5.11.6	**Interlocking of disconnectors and switch disconnectors**		
5.11.7	**Interlocking of maintenance and high speed earthing switches**		
5.11.8	**Free operation under maintenance**		
5.11.9	**Emergency operation**		

5.11.10	**Repeat relays**		
5.12	**Locking facilities**		
5.12.1	**Direct local locking**		
5.12.2	**Locking of equipment**		
5.12.3	**Padlocking and key cabinet**		
5.13	**Auxiliary switched and contractors**		
5.13.1	**Sufficiency of provision**		
5.13.2	**Exclusion of repeat relays**		
5.14	**Current and voltage transformers**		
5.14.1	**Location of CTs**		
5.14.2	**Marking and positioning of CTs**		
5.14.3	**Requirement for CTs**		
5.14.4	**Dual ratio CTs**		
5.14.5	**CT ratings**		
5.14.6	**Magnetisation, core loss and secondary resistance curves**		
5.14.7	**Requirements for VTs**		
5.15	**Surge arresters**		
5.15.1	**Gas insulation of surge arresters**		
5.15.2	**Protection against excess pressure**		
5.15.3	**Monitoring of gas pressure**		
5.15.4	**Insulation level**		

5.15.5	**Enclosure requirements**		
5.16	**Power cable termination**		
5.16.1	**Cable boxes**		
5.16.2	**Cable cleats and cable ancillaries**		
5.16.3	**Protection from arc products**		
5.16.4	**Thermal expansion**		
5.16.5	**Testing voltage and test bushing**		
5.16.6	**Terminations in unused switch bays**		
5.16.7	**Testing of switchgear prior to connection of cables**		
5.17	**Bushings**		
5.18	**Multicore and auxiliary cables**		
5.18.1	**Compliance with specification**		
5.18.2	**Multicore wiring included in this contract**		
5.18.3	**Multicore cable schedule**		
5.18.4	**Cable containment**		
5.18.5	**Cable type**		
5.19	**Fire precautions**		
5.19.1	**General fire precautions**		
5.19.2	**Minimising the risk of fire and consequential damage**		
5.20	**Control and indication and alarms**		
5.20.1	**Local control**		

5.20.2	**Mimic diagram/standby control panel**		
5.20.3	**ON/OFF and other indications**		
5.20.4	**SF_6 Alarms**		
5.20.5	**Alarms**		
5.21	**Ratings**		
5.21.1	**Ratings**		
5.21.2	**Variation of power frequency withstand voltage with gas density**		
5.22	**Environment, operating conditions and duty**		
5.22.1	**Service conditions**		
5.22.2	**Noise**		
5.22.3	**Emergency operating performance (EOP)**		
5.23	**Auxiliary supplies**		
5.24	**Finish colour**		
5.25	**Switchgear, operating cubicles and panels**		
5.25.1	**Ferruling**		
5.25.2	**Terminals and terminal blocks**		
5.25.3	**Internal wiring**		
5.26	**Special tools**		
6	**Erection and site assembly**		
6.1	**Final erection in works**		

6.2	**First filling of gas**		
6.3	**Site tests**		
6.4	**Test equipment**		
7	**Drawings**		
8	**Operational life, inspection, maintenance and training**		
8.1	**Operational life**		
8.2	**Operating and maintenance manuals**		
8.3	**Failure mode, effect and cause analysis**		
8.4	**Sample materials**		
8.5	**Training**		
9	**Handling of Gas and Decontamination Procedures**		
9.1	**Gas handling equipment**		
9.1.1	**Rate of gas transfer**		
9.1.2	**Vacuum performance**		
9.1.3	**Operation of has plant**		
9.1.4	**Gas analysis**		
9.1.5	**Decontamination at the end of service lifetime**		
10	**Variations**		

Additional Notes: