Electricity Distribution

nationalgrid

Company Directive

ENGINEERING SPECIFICATION

EE SPEC: 171/1

145kV Outdoor Live Tank Circuit Breakers

Summary:

This document specifies the requirements for 145kV outdoor live tank circuit breakers

Author: **Anthony Smith**

Implementation Date: **November 2024**

Approved by

Andrew Reynolds
Engineering Policy Manager

Date: **21st November 2024**

Target Staff Group	**Anyone involved with the addition, or alteration of, 132kV substations inclusive of but not limited to Planners, Project Engineers, Technicians, EDS, PND and Purchasing for any tenders**
Impact of Change	**Green – No impact on current working practices**
Planned Assurance Checks	**Team Managers of target staff group shall be contacted within 3 months to confirm staff have been made aware of the documents reissue with minimal changes**

IMPLEMENTATION PLAN

Introduction

This document specifies the requirements for 145kV outdoor live tank circuit breakers for use on the National Grid Electricity Distribution (NGED) 132kV network.

Main Changes

Minor amendments and clarifications to certain clauses in Section 5 to reiterate or make clearer NGED requirements.
Addition of 2.1.4 to utilise more recycled SF6 to BS EN 60480:2019 where possible.
Section 12.1-12.4 inc. Updated IIG leakage rates per BS EN IEC 62271-1 2021
Section 12.6. Addition of 4-20mA signal output from density gauge for CBM.

Impact of Changes

Any new contract will be based on this updated specification.

This specification is not retrospective for current contracts.

Implementation Actions

This updated EESPEC has been issued to allow the tender of replacement contracts for 145kV live tank circuit breakers.

Major Projects, Engineering Design and Procurement to use this specification for future Tenders.

Implementation Timetable

EESPEC 171 may be used as part of the 2024 tender process for 145kV live tank and dead tank circuit breakers.

ICPs will be expected to comply with this new specification within 6 months of its issue.

Items currently on order/under an active quotation by an ICP, to the existing specification shall continue to be acceptable to NGED but new orders, after the 6 months have elapsed will need to comply with this specification.

Exception to this may be made by NGED Engineering Policy team upon formal request.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
November 2024	• Minor additions/clarifications in section 5 to some of the clauses to reiterate or make clearer NGED requirements. • Addition of 2.1.4 to try to utilise more recycled SF6 to BS EN 60480:2019 where possible. • Section 12.1-12.4 inc. Updated IIG leakage rates per BS EN IEC 62271-1 2021 • Section 12.6. Addition of 4-20mA signal output from density gauge for CBM • General typographical error amendments	Anthony Smith
September 2020	This is a new document replacing sections within EESPEC 7 relating to 145kV live tank circuit breakers. Significant changes incorporated from EESPEC 7 are: • Requirement for low or no GWP by the replacement of SF6 gas within the circuit breaker by an alternative technology or gas. • Updating of standards references • Make, type, sizes and colours of gas filling points specified to allow for different gas or gas mixtures. • Requirement for temporary warning notice to deter against operation of the circuit breaker prior to completion of gas fill. • Requirement for permanent notice warning against the operation of the circuit breaker when the gas pressure is below the Minimum Functional Pressure. • Pole referencing and layout clarified for consistency. • Requirement for composite DC schematic diagram. • Creepage distances given as unified specific creepage distance (USCD).	Stephen Hennell / Anthony Smith

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1.0 INTRODUCTION

1.1 This Technical Specification sets out National Grid Electricity Distribution (NGED) requirements for 145kV outdoor live tank circuit breakers for use on its 132kV networks.

1.2 It is based on and must be read in conjunction with the current version of ENA TS 41-37 and other referenced Standards and specifications listed either within ENA TS 41-37 or this NGED specification. NGED options, changes or additions to the ENATS requirements are stated in this NGED document. Unless otherwise stated the requirements of the relevant part(s) of ENATS 41-37 shall apply.

1.3 Any selection of options or changes to this specification shall be made by NGED in writing.

1.4 Where this NGED Technical Specification is being used for Tender purposes then unless otherwise specified in writing at time of Tender, all equipment offered against this Technical Specification shall be compliant with this Technical Specification.

1.5 NGED has a distinct preference for equipment which holds an Energy Networks Association (ENA) Notice of Conformity (NoC) to the current version or a previous version of an ENA Technical Specification (TS). Where equipment does not have an ENA NoC then the following preferences apply in order:-

- Equipment from a design where other ratings have an ENA NoC;
- Equipment manufactured in a facility where other equipment having an ENA NoC is manufactured;
- Other non ENA Assessed equipment.

Where equipment offered does not have an ENA NoC then the manufacturer will be required to provide NGED with details and test data for review that will be equivalent to completing an ENA NoC Assessment. There is no guarantee that following NGED assessment of the equipment that it will be accepted for use by NGED.

1.6 145kV live tank circuit breakers may be useful where the substation layout prevents the use of a dead tank circuit breaker, or where no protection CTs are required in the circuit breaker eg to allow the removal of a fault throwing switch.

1.7 Where the term "shall" or "must" is used in this document, it means the requirement is mandatory. The term "should" is used to express a recommendation. The term "may" is used to express permission.

2.0 REQUIREMENTS

2.1 General

2.1.1 Suppliers and Manufacturers shall satisfy the requirements of BS EN ISO 9000 and BS EN ISO 9001 for all products supplied

2.1.2 All equipment and systems shall satisfy requirements of the EMC directive. EMC emissions and immunity requirements shall, as a minimum, satisfy the requirements of the generic emission and immunity standards for industrial environments BSEN 61000-6-2 and BSEN 61000-6-4 and also all relevant EMC product standards.

2.1.3 Accepting that this is an early period with the technology and availability of products in an initial phase of market readiness, NGED would prefer equipment that has a Global Warming Potential (GWP) of 1 or less, however equipment utilizing alternative IIGs or SF6 may be offered in the event that manufacturer cannot offer a low GWP unit. Where both are available then the supplier shall offer both as an option to NGED.

2.1.4 Where equipment is offered containing SF6 the manufacturer shall certify that the circuit breaker can utilise recycled SF6 to BS EN IEC 60480:2019 and the first fill shall be made using recycled SF6 to the same standard and shall not be made with new technical grade SF6.
If the circuit breaker cannot operate with recycled SF6 the manufacturer shall clearly detail why.

2.1.5 Where equipment has ratings greater than that ordered then those ratings shall be applied to the equipment rating plates.

2.2 **Guarantee**

2.2.1 The supplier of the plant / equipment covered by this specification shall provide a guarantee for that equipment. The guarantee period that the supplier warrants will be a minimum of 60 months (five years) from the date of completion of cold commissioning on site of the relevant plant / equipment; or where equipment has been manufactured but not delivered to NGED but placed into storage at NGED request, or delivered to NGED but not cold commissioned within 6 months, then the warranty period shall be 66 months from the date of storage or delivery.

2.2.2 Note, this requirement shall apply to plant / equipment purchased by Independent Connection Providers (to be adopted by NGED) as well as equipment purchased directly by NGED.

2.3 **Safety Labels**

Safety labels, warning signs and notices shall be compliant with UK standards in terms of colours, pictograms and layout. [BS5499]

3.0 MODIFICATIONS AND ADDITIONS TO ENA TS 41-37

3.1 **References**

3.1.1 References are in accordance with ENA TS 41-37 with the following additions in Table 1, below.

3.1.2 Users of all standards and technical specifications shall ensure they are applying the most recent editions together with any amendments.

3.1.3 Whilst the IEC base document is listed for information, the prime document that shall take priority is the British Standard enacting the European Standard (EN) or European Harmonisation Document (HD).

BS No.	Title	IEC / ISO base
BSHD 60269	Cartridge fuses for voltages up to and including 1000V ac and 1500V dc	IEC 60269
BSEN 60898	Circuit breakers for overcurrent protection for household and similar installations	IEC 60898
ENA TS 48-4	DC Relays Associated with a Tripping Function in Protection Systems	
ENA TS 48-5	Environmental Test Requirements for Protection and Control Equipment and Systems	

Table 1 Additional References

4.0 SPECIFIC REQUIREMENTS

4.1 System earthing (BSEN 62271-1 – clause 9.1)

The equipment shall be suitable for use on three phase systems at 132kV in which the neutral is solidly earthed.

4.2 Normal Service Conditions

4.2.1 NGED require switchgear to be suitable for outdoor use with an ambient air temperature in the range -25°C to +40°C outdoor. [ENATS 41-37 Part 1 - 2.1.2]

4.2.2 The altitude does not exceed 1000m.

4.2.3 Other service conditions shall be as BSEN 61869-1 clause 4.2.5:-

- the average value of the ambient air temperature, measured over a period of 24 h, does not exceed 40 °C;
- solar radiation up to a level of 1 000 W/m2 (on a clear day at noon) should be considered;
- the ambient air may be polluted by dust, smoke, corrosive gases, vapours or salt. The pollution does not exceed the pollution levels given in IEC 60815;
- the wind pressure does not exceed 700 Pa (corresponding to a 34 m/s wind speed);
- the presence of condensation or precipitation should be taken into account;
- the ice coating does not exceed 10 mm.

4.3 Requirements for the external insulation

4.3.1 NGED requires insulators for Site Pollution Severity Class e (IEC/TR 60815:1986) or Class IV (IEC/TR 60815:1986).

4.3.2 Insulators having an alternating shed profile are preferred.

4.3.3 The creepage distances shall be as given in Table 3 below:-

Site Pollution Severity Class	**Minimum mm/kV**	**Ratio = creepage distance divided by arcing distance**
IEC/TS 60815:2008 e	Unified specific creepage distance 53.7	≤4.0
IEC/TR 60815:1986 IV Very Heavy	Specific creepage distance 31	

Table 3 Creepage distances [IEC/TR60815 & IEC/TS60815]

4.3.4 Tenderers shall state what shed profile is being offered and which Site Pollution Severity Class is being offered where this is not in accordance with 4.3.1 and 4.3.2 above.

4.3.5 Bushing insulators may be porcelain or composite. Porcelain insulators shall be coloured brown however by NGED agreement grey may be offered where this provides a cost advantage or reduced delivery timescales.

4.4 Corrosion protection

4.4.1 All exposed hardware shall be stainless steel.

4.4.2 Any aluminium castings shall be anodized.

4.4.3 NGED prefer fabrication from stainless steel for auxiliary enclosures.

4.4.4 Other exposed non-aluminium or non-stainless steel metal parts shall be shot blasted and spray galvanized. This shall be followed by two coats of zinc rich primer and two coats of polyurethane based paint. The preferred paint colour is Dark Admiralty Grey (BS381C 632), however other colours may be acceptable (eg RAL 7033).

4.5 Auxiliary enclosures

4.5.1 The degree of protection for low-voltage and/or auxiliary enclosures shall be at least IP44 according to BS EN 60529.

4.5.2 Shall be fabricated of stainless steel and painted.

4.5.3 Shall be provided with a securing and locking device that provides security against unauthorised access. The locking arrangement shall be robust and accommodate a padlock with 41mm square body and with a 4mm to 7mm diameter shackle having a clear inside width of 21mm and an inside length of 16mm to 45mm. The holes provided for the shackle shall not be less than 8mm diameter.

4.5.4 Where an auxiliary enclosure (eg. terminal box) is fitted it shall be placed so that work can be carried out on this box with the equipment live after the equipment is installed and cables terminated.

4.5.5 Auxiliary enclosures shall be suitable for the termination of armoured multicore cables using cable glands.

4.5.6 Sufficient terminal blocks shall be provided to terminate all the cores of all multicore cables as detailed in the Summary of Technical Parameters for the circuit breaker.

4.5.7 Auxiliary enclosures shall be accessible from ground level without the use of ladders of platforms.

4.5.8 Auxiliary enclosures shall be fitted with adequate ventilation so as to prevent condensation when used in conjunction with an anti-condensation heater. Any ventilation shall be such that vermin and insects are prevented from entering the enclosure.

4.6 Flood resilience

4.6.1 To provide resilience against flooding all mechanisms and control equipment, including auxiliary cable glands and terminations shall be located as high as practicable above ground level and at a minimum height to base of enclosure of 500mm.

4.6.2 Tenderers shall provide outline general arrangements drawings showing the proposed location and height above ground level.

5.0 RATINGS

5.1 Rated Voltage (Ur)

The rated voltage shall be 145kV. [ENATS 41-37 Part 1 cl 4.1]

5.2 Rated insulation level

The rated insulation levels shall be as in the table below:

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

5.3 Rated Frequency (fr)

The rated frequency shall be 50Hz.

5.4 Rated normal current (Ir)

The rated normal current shall be a minimum of 2500A. [ENATS 41-37 Part 1 cl 4.4.1] (refer to 2.1.5 if equipment has higher ratings)

5.5 Rated short-time withstand current (Ik)

The rated short-time withstand current shall be a minimum of 31.5kA with a DC time constant per 5.9. [ENATS 41-37 Part 1 cl 4.4.1] (Note: the values of short-time rated current are the same for single-phase and three-phase.)
(refer to 2.1.5 if equipment has higher ratings)

5.6 Rated duration of short circuit (tk)

The value of rated short circuit current shall be 3 seconds.

5.7 Rated peak withstand current (Ip)

The rated peak withstand current shall be 2.7 times the rated short-time withstand current.

5.8 Rated short circuit breaking current (Isc)

The rated short-circuit breaking current shall be not less that the rated short-time withstand current as specified in 5.5 above ie 31.5kA.

5.9 Rated DC time constant

The rated value of short-circuit breaking current shall be assigned at a minimum dc time constant of 120ms. (refer to 2.1.5 if equipment has higher ratings)

5.10 **Rated short-circuit making current**

The rated short-circuit making current shall be equal to 2.7 times the rms value of the ac component of the rated short-circuit breaking current in 5.8 above.

5.11 **Rated operating sequence**

Circuit breakers shall be suitable for rapid auto-reclosing.

The rated operating sequence shall be O – 0.3s – CO – 3min – CO.

5.12 **Rated Supply Voltage of Closing and Opening Devices and of Auxiliary and Control Circuits (Ua)**

Switchgear shall be capable of all normal operations without any effect affecting its rated performance, within the voltage ranges specified in table below:-

Nominal voltage V	**Criteria for rated supply voltage operating range**	**Closing and opening releases and operating devices**		**Other operating devices**
		Close volts V	**Open volts V**	**Volts V**
110	Maximum operating voltage (max. charging voltage)	137.5	137.5	137.5
	Minimum operating voltage	87.5 [80% of nominal voltage]	77 [70% of nominal voltage]	87.5

5.13 Rated supply frequency of closing and opening devices and of auxiliary circuits

The rated supply frequency shall be dc.

6.0 MECHANISM

6.1 **Stored energy closing**

Mechanisms using a motor-wound spring are preferred by NGED.

6.2 **Three pole operation**

Circuit breakers shall be arranged for three pole simultaneous operation. This shall be enabled by mechanical linkage and not by electronic or electrical means.

6.3 **Local manual operation**

Provision shall be made for mechanically operated local manual tripping and closing.

6.4 **Slow closing device**

Where facilities are provided then the necessary loose parts, handles, safety blocks etc shall be supplied (1 set per site).

6.5 **Anti-pumping**

In the event of a continuous close signal being maintained after a failure to latch in the closed position, or an opening operation immediately following a closing operation, and a continuous close signal being maintained, there shall not be repeated attempts to close the circuit breaker.

6.6 **Operating systems interlocks**

Operating systems shall be arranged to prevent a close operation if sufficient energy is not available to complete a normal Close/Open (CO) operation.

6.7 **Trip circuit supervision**

Circuit breaker tripping coils and their associated circuits shall be suitable for continuous supervision which is functional regardless of the state of the circuit breaker (open or closed).

6.8 **Trip and close coil isolation**

Isolation facilities shall be provided to the circuit breaker trip and close coils. These shall be labelled appropriately. These facilities shall be such that the open-circuit supervision system shall detect isolation of the opening coils.

6.9 **Speed/Travel Transducer**

Equipment offered shall either be fitted with a speed/travel transducer or the facility to permanently install one at a later date without major equipment modification or work affecting the circuit breaker operating mechanism.

7.0 EARTHING

7.1 **Earthing conductors**

Earthing conductors and connections to them, for outdoor switchgear, shall be provided in accordance with the requirements of BSEN 50522 and shall be accessible from ground level.

7.2 **Earthing of compartments and enclosures**

Facilities shall be provided to bond all compartments and enclosures to the main substation earth via the earthing conductor. The method of bonding shall be capable of withstanding the rated short-time current.

8.0 AUXILIARY EQUIPMENT & SECONDARY WIRING

8.1 **Auxiliary switches**

8.1.1 The tolerance in the drive train to auxiliary switches shall be such that the correct operation is maintained at extreme ends of tolerance.

8.1.2 In addition to auxiliary switches required for normal circuit breaker function, further auxiliary switches shall be provided for NGED use and all these, including any spares, shall be wired out to an accessible terminal block within the fixed portion.

The minimum provided shall be:-

- 6 off normally open circuit breaker auxiliary switches
- 6 off normally closed circuit breaker auxiliary switches
- 2 off normally open springs charged auxiliary switches
- 2 off normally closed springs charged auxiliary switches

8.1.3 Additional auxiliary switches shall be provided as part of the direct drive mechanism. Repeat relays shall not be utilised.

8.1.4 The circuit breaker shall be provided with a pair of normally open volt-free contacts that provide will indication in the event that the operating spring has failed to charge correctly.

The arrangement shall include a time delay to prevent spurious alarms during a normal spring charge cycle, as well as visual indication of the spring charge alarm state.

8.2 **Secondary wiring identification**

At the interface between switchgear and protection and control gear, wiring and ancillary electrical equipment shall be identified in accordance with ENATS 50-19.

8.3 **Auxiliary Supplies**

Circuit breaker spring winding motor and protection/alarm relay auxiliary supplies for new equipment are normally rated at 110Vdc.

8.4 **Small Wiring and Terminals**

Small wiring and terminals shall comply with ENA TS 41-37 with the following additions:

8.4.1 The application of small wiring, ancillary electrical equipment and protection shall in general follow the principles in Engineering Recommendation S15.

8.4.2 Secondary wiring shall comprise of:

8.4.3 AC wiring: 2.5mm2 (minimum) copper stranded cable with PVC insulation to BS6231 Type BR, or equivalent tri-rated cable complying with BS6231.

8.4.4 DC wiring: 1.5mm2 (minimum) copper stranded cable with PVC insulation to BS6231 Type BR, or equivalent tri-rated cable complying with BS6231.

8.4.5 Terminal blocks used for protection, alarm and control circuits shall be screw clamp with spring type, in accordance with EATS 50-18 Type B. Terminal blocks for 24VDC and 48VDC tele-control wiring, and for transducer output wiring shall be screw clamp type, to EATS 50-18 Type C with a hinged link for isolation purposes. Sufficient space shall be allowed so that connections can be tightened or un-tightened and wires removed and re-inserted. Spare cores shall be terminated at the terminal blocks furthest from the cable gland.

8.4.6 Test sockets shall be provided on the trip and close circuits in order to allow the ready connection of test leads when timing the circuit breaker during maintenance.

8.5 Fuses and Links

8.5.1 Secondary fuselinks, links and fuse carriers shall be in accordance with EATS 50-18 and BS HD 60269-2 reference A.

8.5.2 Fuses and fuse holders up to 20A rating shall be in accordance with BS HD 60269-2 reference A1.

8.5.3 The fuse holders and bases shall be coloured as follows:

- 2A, 4A, 6A, 10A fuselink ratings: black
- 16A fuselink rating: green
- Solid links: white

2A, 4A and 10A fuse holders and bases shall have supplementary markings applied to denote the fuse rating. These markings shall be applied using permanent self-adhesive coloured vinyl tapes as follows:

- 2A Purple
- 4A Blue
- 10A Grey

[See example photo right.]

8.5.4 GE Power Controls/Eaton Bussmann or Mersen Red Spot fuse holders shall be provided unless otherwise agreed at the time of tender.

8.5.5 All fuses and links shall be mounted vertically, grouped logically and consistently in the panel and shall be clearly labelled.

The label shall show the function of the fuses/links and include the fuse/link number as specified on the schematic drawings. The fuse rating shall also be included on the label.

Where a double row of fuses and links is required, the labelling of the bottom row may need to be mounted on a stand-off bracket to ensure they are clearly visible.

8.5.6 Fuse terminals shall be suitably shrouded to minimise electric shock hazards. The incoming (supply) side of each circuit shall be connected on the bottom terminal of the fuse/link.

8.6 Ancillary Equipment

Requirements for ancillary equipment including relays, contactors, control / selector switches, transducers, push buttons and lamps are specified in EESPEC:136.

8.7 **Anti-Condensation Heaters**

A heater shall be provided at an appropriate location in the mechanism box. The heaters shall be 230Vac. A control thermostat shall be provided. The supply to the heater/s shall be controlled by a double pole switch which shall be located at a readily accessible position and clearly labelled/identified.

Heaters shall have a low surface temperature, or be guarded if high surface temperature, in order to minimise the likelihood of burn injuries.

8.8 **SCADA**

Each power operated switching device shall be equipped with a local/remote control selector switch. The facility shall be provided to enable SCADA indication of the open/close position of this switch.

9.0 INTERLOCKING DEVICES AND PADLOCKING FACILITIES

9.1 Operational and Safety Padlocking

Padlocking arrangements shall be suitable to accommodate a NGED padlock having a 7mm diameter hasp. [ENATS 41-37 Part 1 – clauses 3.104.3 & 3.104.4]

9.2 Interlocking shall be achieved by mechanical or electro-mechanical means. Each switching device shall have provision for the fitting of key interlocks by which it will be possible to trap and release keys when the switching device is open or closed. This facility will be used in conjunction with the user's interlocking schemes.

9.3 Where mechanical interlocking is provided it shall also be possible to fit an electro-mechanical interlocking device to each mechanism such that the device is prevented from operating until the interlocking device is energised.

9.4 Electro-mechanical interlocking shall be fail safe. In the event of a loss of dc supply, blowing of fuse, removal of fuse or link should not allow the interlocking device to be defeated.

9.5 Software / IED based interlocking is not permitted.

9.6 When manually operated they shall be provided with labels which are readily visible and which contain clear concise instructions for operation.

9.7 In the event that interlocking is required to other plant items then Castell Type Q or Fortress Type H are required. Numbering/legend will be provided at the time of order.

9.8 The interlock shall be designed so that the key of the interlock is trapped when the circuit breaker is in the closed position, and is released when the circuit breaker is in the open position.

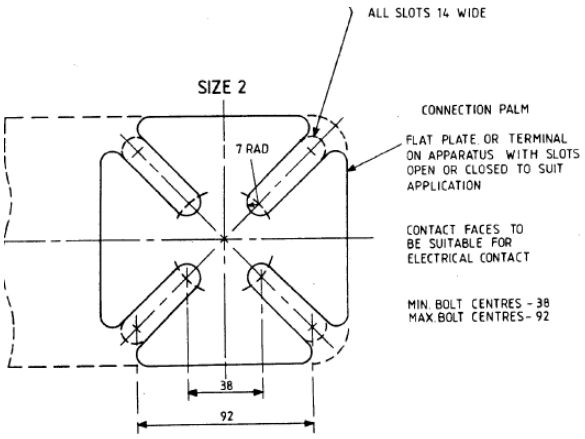
9.9 Attempted removal of the key from the circuit breaker mechanism when the circuit breaker is closed shall not trip the circuit breaker. It shall not be possible to close the circuit breaker unless the key is inserted and secured in the interlock.

10.0 PRIMARY CONNECTIONS AND MARKINGS

10.1 Terminal Palms

10.1.1 Terminal palms to match the requirements of ENATS 41.16 section 3.1.2 Figure 1, size 2 below are preferred by NGED.

Where these cannot be provided (or will increase cost) the Tenderer shall specify what is offered.



10.2 Labelling and Marking

Labelling and marking shall comply with ENATS 41.37 Part 1 clause 5.10 and relevant sub-clauses.

10.3 Phase Identification

10.3.1 The identity of all primary terminals shall be indelibly marked on the main structure adjacent to the terminals. The marking shall not be on removable covers.

10.3.2 Phases shall be identified in accordance with ENATS 41.37 Part 1 clause 5.10.101; that is U1 U2, V1 V2, W1 W2 for three-pole units. Any alternative offered by a supplier (for example LA, LB, LC) shall be agreed in writing by NGED where acceptable.

10.3.3 The following standard identification sequences shall apply:

Pole	Left Hand	Centre	Right Hand
Marking	U	V	W
	LA	LB	LC
		CONTROL CUBICLE	

	Pole Marking		
CONTROL CUBICLE	U	V	W
	LA	LB	LC

10.3.4 A set of phase identification discs shall be supplied and these shall be interchangeable on site between poles as required. The NGED requirement shall be:

- L1 / L2 / L3 (Black text on White)

10.3.5 Phases shall be identified consistently across all manufactured units and orders supplied to NGED.

11.0 CLEARANCES FOR OVERHEAD CONDUCTOR CONNECTED EQUIPMENT

11.1 Minimum clearance from ground level of a fixed access platform to exposed live conductors shall be basic electrical clearance (as defined in BSEN61936) plus 300mm plus personal reach. Clearance to support insulation shall be 300mm plus personal reach.

11.2 For the purposes of this specification personal reach is 2.25m giving a minimum clearance to base of insulators of 2.55m.

12.0 GAS SYSTEM

12.1 **Closed pressure systems for gas** [BS EN IEC 62271-1, 6.16.3

12.2 Equipment not utilising SF6 shall have a maximum relative leakage rate of no greater than 1% per year at 20^{O}C.

12.3 Equipment utilising SF6 shall have a maximum leakage rate of no greater than 1% per year at 20^{O}C

12.4 **Sealed pressure systems for gas**

The leakage rate shall not exceed 0.1% per year at 20^{O}C [BS EN IEC 62271-1, 6.16.4]

12.5 **Gas filling points**

12.5.1 Gas filling points shall be fitted with self-sealing valves and shall have a padlockable cover or closure that can be secured using a NGED standard operational padlock. [See 4.5.3 & 9.1 above.]

12.5.2 Gas filling points shall follow the colour scheme and connection type / sizing as specified in the table below:

Gas / Gas Mixture	Colour	RAL	Connection
SF_6	Pure Orange	2004	DILO DN8 with M26 thread or DILO DN20 with M45 thread
N_2 / O_2 mixtures	Light Blue	5012	DILO DN12 with M30 thread or DILO DN20 with M50 thread
Mixtures containing C4-FN (C_4F_7N)	Yellow Green	6018	DILO DN8 with M28 thread or DILO DN20 with M48 thread
Mixtures containing C5-FK ($C_4F_{10}N$)	Telemagenta	4010	DILO DN8 with M24 thread or DILO DN20 with M43 thread
CO_2 / O_2 mixtures	Dusty Grey	7037	Malmquist valve with M32 thread

[*Note: Table may be subject to revision to maintain alignment with future ENATS*.]

12.5.3 These requirements shall be achieved without the use of adaptors.

12.5.4 All filling points shall be clearly labelled to indicate the type of gas contained within the circuit breaker.

12.5.5 Labels shall be engraved and mechanically secured such that they cannot be removed other than by disassembly of the circuit breaker filling point.

12.5.6 The same colour coding and sizing shall also be used on monitoring devices and gas handling equipment.

12.6 Gas monitoring and indicators

Closed pressure systems filled with gas for insulation, operation or interruption shall be provided with a two-stage pressure/density indication.

12.7 Gas density gauge or indicator

The gas density or temperature compensated gas pressure in each compartment shall be continuously monitored and indicated locally along with a 4-20mA output signal for remote monitoring.

The monitoring device shall provide at least two sets of alarm levels for pressure or density (alarm and minimum functions pressure or density). A means of checking initiation of the “falling” and “low” density alarms without reducing the pressure in the main circuit compartment shall be provided. This shall be achieved in such a way that operation of as much of the alarm circuit as is reasonable practical is confirmed.

12.8 Trip/Close lockout for low gas

12.8.1 In the event of low gas pressure such that the circuit breaker would be unable to interrupt full load or fault current, then operation shall be prevented.

12.8.2 A closed circuit breaker shall remain closed.

12.8.3 An open circuit breaker shall be prevented from closing.

12.8.4 A safety sign shall be applied adjacent to the manual mechanical open/close mandating against operation of the circuit breaker in the event that the gas pressure is below the minimum functional pressure for the device. [See Appendix A1]

The size and positioning shall be agreed by NGED for the first supplied unit, and this shall then be applied to all subsequent units supplied for installation/use on the NGED network.

12.9 Temporary Warning Notice

12.9.1 In order to try to prevent the operation of a circuit breaker until the gas fill has been completed, then temporary labels shall be attached on any manual means of closing a circuit breaker, and on the local open/close switch. [See Appendix A2]

12.9.2 The specific colour, wording and size shall be agreed between NGED and the manufacturer; however the design of the notice shall not resemble a safety sign required for the purposes of ensuring operator safety.

12.9.3 The labels shall be removed at cold commissioning once the gas fill has been satisfactorily completed.

12.10 **Bursting discs and explosion vents**

12.10.1 Pressurized systems shall be provided with pressure relief devices such as bursting discs.

12.10.2 Bursting disks and explosion vents shall be installed so that exhaust gasses are directed away from the normal local operating position of the circuit breaker.

13.0 RATING PLATES

13.1 Where equipment is provided with ratings that exceed those in this specification or order, then these higher values shall be those applied to the equipment rating plate/s. (per 2.4.1)

14.0 INSTALLATION AND COMMISSIONING TESTS

14.1 The manufacturer shall carry out the site works to just cold commission the circuit breaker or to install, test and cold commission the circuit breaker in conjunction with NGED in accordance with Schedule X of this specification.

14.2 Any changes to this shall be agreed in writing by NGED either by the Engineering Policy Team for the overall contract arrangements or by the NGED Site Project Engineer on a specific site basis.

14.3 The manufacturer shall provide a price at the time of tender for these activities that is separate to the price for the circuit breaker.

15.0 DRAWINGS

15.1 The manufacturer shall provide the following drawings for approval within one month of the commencement date of the contract or by mutually agreed date at the placement of the order:

- General Arrangement of each circuit breaker / cubicle
- Schematic Diagram for each circuit breaker / cubicle
- Wiring diagram for each circuit breaker / cubicle

15.2 The manufacturer shall provide a composite DC schematic diagram which includes all parts of the DC circuits within the circuit breaker.

The manufacturer may also provide individual sheets for each element of the DC circuitry however these shall not be a replacement for the composite DC schematic diagram.

15.3 Once approval has been obtained an additional copy of the drawings shall be provided.

15.4 After on-site installation and commissioning has been completed the manufacturer shall incorporate any alterations within 3 months of the drawings being returned for correction and provide a final copy of the drawings.

15.5 All drawings shall be provided electronically in .dwg/.dxf CAD format.

16.0 TEST RESULTS

16.1 The manufacturer shall provide copies of test results following completion of factory routine tests and site cold commissioning tests.

16.2 These shall be provided in hardcopy and electronically in .pdf format to the NGED project engineer responsible for the works.

17.0 DOCUMENTATION TO BE PROVIDED AT TIME OF TENDER.

The manufacturer shall provide the following list of documents or information at the time of tender:

- Installation, operation and maintenance manuals
- Summary of recommended inspection and maintenance requirements
- Recommended parts list
- Details of site commissioning tests
- End-of-Life disposal information/guide

18.0 TYPE TESTS

Type tests shall be as per BSEN 62271-100 clause 6, clause 6 of ENATS 41-37 Part 1 and clause 6 of ENATS 41-37 Part3.

19.0 ROUTINE TESTS

Routine tests shall be as per clause 7 of ENATS 41-37 Part 1 and BSEN 62271-100 clauses 7.1 to 7.101.

APPENDIX A NGED SPECIFIC SAFETY SIGNS AND WARNING NOTICES

A1 Safety Notice

A2 Temporary Warning Notice

WARNING

This circuit breaker shall not be closed and/or opened by manual or electrical means until the gas fill has been completed.

APPENDIX B SUPERSEDED DOCUMENTATION

This document supersedes EE SPEC: 171 dated September 2020 which has now been withdrawn.

APPENDIX C ASSOCIATED DOCUMENTATION

ENA TS 41-37 Part 1 - Issue 3	Switchgear for use on 66kV and 132kV distribution systems – Part 1 Common clauses
ENA TS 41-37 Part 3 - Issue 3	Switchgear for use on 66kV and 132kV distribution systems – Part 3 Alternating Current Circuit Breakers
ENA TS 41-24	Guidelines for design, installation, testing and maintenance of main earthing systems in substations
ENA TS 41-38	Power installations exceeding 1kVac – Design of high-voltage open-terminal stations
ENA TS 50-18	Application of ancillary electrical equipment
EE SPEC: 136	Ancillary Electrical Equipment for Use in Conjunction with Switchgear and Protection/Control Panels

APPENDIX D IMPACT ON COMPANY POLICY

None.

APPENDIX E RECORD OF COMMENTS DURING CONSULTATION

No Comments required as only minor amendment.

APPENDIX F IMPLEMENTATION OF POLICY

This document may be implemented on issue for new tenders and contracts.
This specification is not retrospective for current contracts based on EEPSEC 171.

APPENDIX G KEYWORDS

Circuit Breaker, Live Tank, 145kV, 132kV

SCHEDULE A NGED Requirements for 145kV Live Tank Circuit Breaker

Information	Sub-clause of ENATS 41-37 Part1	NGED requirement
Particulars of system		
Voltage kV		145
Frequency Hz		50
Number of phases		3
Neutral earthing		Solid
Switch characteristics		
Number of poles		3
Class	1.2	Outdoor -25^{O}C to +40^{O}C
Nominal Voltage U_n (kV)		132
Rated Voltage U_{Ne} (kV)	4.1	145
Rated power frequency withstand voltage U_d (kV)	4.2	275
Rated lightning impulse withstand voltage U_p (kV)	4.2	650
Rated frequency (Hz) f_r	4.3	50
Rated Normal current (A) Ir	4.4	Minimum of 2500A
Rated short-time withstand current (kA) I_k	4.5	Equal to or greater than 31.5kA
Rated duration of short circuit (sec) t_k	4.7	3
Rated short-circuit breaking current I_{SC} (kA)	4.101	Equal to rated short-time withstand current. With a 120ms TC
Rated short-circuit making current (kA)	4.6 / 4.103	2.7 times rated short-circuit breaking current
Voltage factor (k_p)		1.4
First pole to clear factor (k_{pp})		1.5
Rated supply voltage of opening and closing devices, and auxiliary and control circuits U_a • Closing & tripping • Indication • Control	4.8	110Vdc
Rated supply frequency of closing and opening and of auxiliary circuits	4.9	dc
Rated operating sequence	4.104	O - 0.3s – CO - 3min - CO
Classification in regard of electrical endurance	4.111	Class M1
Classification of mechanical operations	4.110	Class M1 - 2000
Rated capacitive switching currents	4.107	Class C2
Rated cable-charging breaking current I_c (A)	4.107	160
Rated line charging breaking current I_l (A)	4.107	50
Gas monitoring indicator	5.9.101	-Pressure/density gauge/indicator -Two stage pressure switch

SCHEDULE B Manufacturer Declaration for 145kV Live Tank Circuit Breaker

Information	Declaration
Mechanism type	
Closing mechanism power consumption (mA) and duration of consumption (s)	
Operating time – Close operation (ms)	
Operating Time – Open operation (ms)	
Noise (during operation and/or activity) (dB)	
Arc interruption medium	
Insulation medium	
Type of gas	
Mass of gas (kg)	
Rated filling pressure	
Alarm pressure	
Minimum functional pressure	
Mass of complete unit (kg)	
Maximum dynamic floor/support loading(s) (kN)	
Dimensions (m)	
AIS bushing details	
Colour of paint	
Additional information	

SCHEDULE X Scope and Responsibilities for Site Works

	Manufacturer	NGED
Pre-site Visit Activity	• Liaison with Client • Supply, as requested, documentation required for CDM including relevant schedule of work, method statements, risk assessments, training/qualifications	• Liaison with Manufacturer • Request documentation as necessary for site H&S requirements / CDM • Installation / preparation of foundations
Delivery*	• Off-loading of delivery lorry	• Site induction as required for delivery • Access for delivery vehicle • Hard-standing area for off-loading
First Site Visit*	• Removal of packing material • Inspection for damage to insulators, gas piping, covers etc. during shipping • Supply and installation of “Hilti” type chemical anchors • Assembly of support structure and location on foundations • Install circuit breaker on support structure	• Site induction • Site supervision • Provision of welfare facilities • Power supply for construction tools • Movement of equipment from off-loading area to installation position
Between Site Visits		• Connect circuit breaker to substation earth • Complete secondary wiring to circuit breaker • Install HV busbars
Second Site Visit	• Check IIG system for gas-tightness • Fill circuit breaker with IIG to rated/normal working pressure • Test IIG from circuit breaker for impurities and dew-point Complete cold commissioning:- • Verify low gas alarm • Inspect mechanism/functional tests • Inspect auxiliary system • Check control system components • Insulation tests • CT injection testing (#) • Measure contact resistance • Timing Tests / pole synchronisation • Fill out commissioning sheets	• Site induction • Site supervision • Safety Documents • Power supply for test equipment etc • Provide means of access (MEWP) for connection of test leads • Provision of general helper to assist with test lead connection etc

[* *Delivery to be combined with first site visit where possible and practicable*.]

[# *Requirement applies to dead tank circuit breakers only.*]