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Circuit-Breakers and Switches

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CIRCUIT-BREAKERS AND SWITCHES

FOREWORD

This document defines the technical requirements for circuit-breakers and switches connected to the National Grid Company Transmission System and rated at 145, 300 and 420 kV.

1 SCOPE

This document defines the functional performance and test requirements for circuit-breakers and switches connected to the National Grid Company Transmission System. It supports the more general conditions defined in the companion documents NGTS 1 and NGTS 2.2.

2 REFERENCES

2.1 International and British National Documentation

This document makes reference to, or should be read in conjunction with, the documents listed below. Where a British Standard is equivalent or identical to an IEC document both references are given.

Noise at Work Regulations 1989

IEC 56 (BS 5311)	High-voltage Alternating Current Circuit-breakers
IEC 265 (BS 5463)	High-voltage Switches
IEC 517 (BS 5524)	Gas-insulated Metal-enclosed Switchgear for Rated Voltages of 72.5 kV and Above
IEC 427 (BS 7441)	Report on Synthetic Testing of High-voltage Alternating Current Circuit-Breakers
IEC 694 (BS 6581)	Common Clauses for High-voltage Switchgear and Controlgear Standards
BS 381/C	Specification for Colours for Identification, Coding and Special Purposes

2.2 National Grid Technical Specifications

The following NGTS documentation is relevant to Switchgear and should be read in conjunction with this document as appropriate.

NGTS 1	-	Overview
NGTS 2.2	-	Switchgear for the National Grid System
NGTS 2.6	-	Protection
NGTS 2.7	-	Substation Control Systems
NGTS 2.12	-	Substation Auxiliary Supplies
NGTS 2.13	-	Electronic Equipment
NGTS 3.7.19	-	Local Control Point Facilities

NGTS 3.12.1 - 48 V D.C. Supplies

NGTS 3.12.2 - 110 V D.C. Supplies

3 GENERAL REQUIREMENTS

3.1 General Requirements Common to Circuit-Breakers and Switches

In addition to the requirements of IEC 56, IEC 265 and the NGTS documentation listed above, the following clauses apply to the design of the operating mechanisms, auxiliary equipment and enclosures of circuit-breakers and switches. The NGC requirements for switches are as General-purpose Switches, or as Special-purpose Switches with the capability of performing an increased number of operating cycles, as defined in IEC 265, and as such, their general requirements are similar to those of a circuit-breaker.

3.1.1 Circuit-breakers and switches shall be arranged for three-phase operation by powered mechanism or mechanisms to the tolerance specified in IEC 56 (BS 5311), except where specified by the purchaser for single phase auto-reclose.

3.1.2 The mechanism and control scheme shall be such that if a close or open operation has been initiated the operation shall be completed.

3.1.3 The mechanism and control scheme shall be such that in the event of a failure to latch in the closed position the circuit-breaker, when opening, shall be demonstrated to be capable of interrupting its short-circuit current and shall fully open. Similarly, a switch shall be capable of interrupting its load current and shall fully open.

3.1.4 The mechanism and control scheme shall be such that in the event of opening immediately following a close operation and a continuous close signal being maintained, the mechanism shall not make repeated attempts to close the circuit-breaker or switch.

3.1.5 Operating mechanisms shall be provided with local initiation of closing and opening and selection of the local/remote control at the equipment. The requirements of this equipment are given in NGTS 2.7 and NGTS 3.7.19.

3.1.6 Where phases or phase modules have an independent drive mechanism, in the event of failure to complete a closing operation provision shall be made for automatic opening of phases which have closed and a remote alarm indicating phases or phase modules not together shall be initiated.

3.1.7 If the opening (tripping) circuit is initiated, the closing circuit shall be rendered inoperative.

3.1.8 Operation shall be prevented unless the arc extinguishing medium and insulating medium are within their specified design densities and the operating system is in the correct functional state. The limiting conditions shall be remotely alarmed.

Operating system lockouts (blocks) shall be arranged such that if it is possible to close the circuit-breaker or switch normally then opening is not prevented due to the energy consumed during that close operation.

In satisfying this the pressure monitoring device maximum tolerance on setting and an allowance for drift and short time adiabatic change together with either an ambient temperature change of up to 10°C or the loss of pressure due to leakage during a two hour period, whichever has the greater effect, shall be taken into account.

Where practical the close lockout (block) setting shall be equal to or less than 85 per cent of the rated working pressure as specified in IEC 56 (BS 5311).

3.1.9 Loss of stored energy from the mechanism shall not cause the primary contacts to part.

3.1.10 Facilities shall be provided to permit manual slow closing and slow opening of the interrupter assembly and its drive mechanism. These facilities must be secured such that they may only be capable of being used for maintenance purposes.

3.1.11 Indication that the stored energy system is in a state at which it is unable to safely complete an operating cycle, close-open (CO) shall be given locally and remotely alarmed.

This 'stored energy system incorrect' indication shall not be initiated due to normal operation of the circuit-breaker or switch.

3.1.12 Means shall be provided to allow the stored energy system to be charged and discharged when the equipment is closed or open without causing operation of, or damage to, that equipment. This does not apply to springs connected directly to the equipment moving contacts, as in the case of opening springs.

3.1.13 Where a hydraulic system utilizes a compressed gas for energy storage, the precharge pressure of this gas related to the ambient temperature at the time of precharging shall be sufficient to prevent the initiation of a low gas alarm under normal operating conditions when the ambient temperature falls to the minimum specified in NGTS 1.

3.1.14 Where applicable, changes in ambient temperature of 20°C shall not initiate more than two operations of the self contained stored energy replenishment systems as numerous operations under such conditions may mask the presence of genuine energy loss. A replenishment system excessive running time alarm shall be fitted. The operating level of safety/relief valves fitted to such systems shall be set with sufficient margin above the system replenishment cessation level to accommodate an ambient temperature rise of 10°C.

3.1.15 Stored energy systems shall not be released due to vibration caused by operation of the primary equipment or otherwise.

3.1.16 A mechanical CLOSED/OPEN indicating device shall be provided and shall be positively driven in both directions. Only one inscription shall be visible at one time. The NGC preference is for the indicator to be inscribed CLOSED in white letters on Signal Red (BS 381/C Code 537) background and OPEN in white letters on Grass Green (BS 381/C Code 218) background, or internationally agreed equivalent colours.

3.1.17 Indications, in the form of relay flags, counters or LEDs, associated with monitoring the requirements of clauses 3.1, 3.2 and 3.3, shall be provided adjacent to the circuit-breaker or switch. These devices shall be capable of being reset at this location. Provision shall be made for initiation of remote monitoring.

3.2 General Requirements for Circuit-Breakers

3.2.1 On 300 kV and 420 kV circuit-breakers, two opening releases per operating mechanism shall be provided and supplied from independent battery systems. These shall have segregated circuits and failure of one device in a circuit shall not prevent opening of the circuit-breaker.

3.2.2 If the opening (tripping) d.c. power supply is removed from either circuit of a circuit-breaker control scheme, the closing circuit or mechanism shall be rendered inoperative.

3.2.3 Circuit-breaker trip coils and their associated trip circuits shall be provided with a continuous supervision scheme with the circuit-breaker open and closed. This shall apply to both phase-segregated and three-phase operated circuit-breakers.

The alarm output shall not operate under normal circuit-breaker operations. The system shall be self monitoring and failure of a single component shall not cause the circuit-breaker to operate.

The system shall be supplied as part of the circuit-breaker control equipment or be available as separate equipment for mounting on or in the control cubicle of other equipment.

3.2.4 Isolation facilities shall be provided for circuit-breaker open and close coils. These shall be labelled appropriately.

3.2.5 Provision shall be made for the forced opening (tripping) of a closed circuit-breaker in the event of the loss of stored energy to below the limiting conditions of the operating system. Such provision shall negate the need of any device required to lock the mechanism closed under such loss of stored energy.

3.2.6 The stored energy system of a circuit-breaker mechanism shall be such that with the system at the replenishment initiation level, it is possible to perform a Close, Open, Close (COC) operating sequence and after an ambient temperature fall of 20°C a further Open (O) operation. These two stored operations (CO,CO) shall be possible without replenishment and having due regard to the tolerance of monitoring device operational settings. It shall also be capable of an O-10s-CO-30s-CO operating sequence with replenishment during the 10 and 30 second periods.

3.2.7 The requirement of Clause 3.1.13 shall not prevent the hydraulic mechanism of a circuit-breaker from performing a COCO operation after its system, when at the replenishment initiation level, has been subject to an ambient temperature rise from 15°C to 40°C.

3.3 General Requirements for Switches

The NGC requirements for switches for Shunt Reactor, Overhead Line and Cable Switching Duties are for Special-purpose Switches with the capability of performing an increased number of operating cycles. For Transformer Switching Duties NGC requirements are for General Purpose Switches. As such the general requirements of IEC 265 apply.

4 PERFORMANCE REQUIREMENTS

4.1 Performance Requirements Common to Circuit-Breakers and Switches

4.1.1 The voltage measured at the terminals of the equipment during operation (as defined in IEC 694) shall be 110 V d.c. related to the rated supply voltage of 125 V d.c.

4.1.2 Electronic equipment shall be suitable for operation in Class Z conditions as specified in NGTS 2.13. Electrical and electronic equipment shall perform as specified with the appropriate power supply systems given in NGTS 3.12.1 and 3.12.2 and meet the requirements of NGTS 2.2, 2.7 and 2.7 as appropriate.

4.1.3 When switching within its declared rating the circuit-breaker or switch shall be restrike free. This is of particular importance when switching capacitive circuits. In addition to the IEC 56 requirements NGC require additional tests as detailed in Clause 5.

4.1.4 The Supplier shall state the density of the gaseous insulating medium at which the circuit-breaker or switch can withstand two fully asynchronous power frequency voltages applied to the opposite terminals of the same pole when in the OPEN position. Each voltage to be equal to the rated phase to earth power frequency voltage.

The Supplier shall similarly state the density at which the gas insulation can withstand 1.5 times the rated phase to earth power frequency voltage between its terminals and earth.

4.1.5 Circuit-breakers and switches shall give a no-load sound pressure level of not greater than 90 dB (linear) measured at a distance of 25 metres from the centre line of the circuit-breaker or switch in the most disadvantageous direction. In addition, impulse and steady state noise levels shall not exceed the Action Levels specified in the UK Noise at Work Regulations.

4.2 Performance Requirements of Circuit-Breakers

4.2.1 Circuit-breakers shall meet all of the requirements of IEC 56 and the other relevant IEC (BS) Standards referenced in this document for the ratings detailed in NGTS 1 and NGTS 2.2 documentation with the following additional requirements.

4.2.2 The short-circuit ratings specified apply to three phase and single phase fault conditions including arc durations.

4.2.3 The maximum short-circuit break time required to meet Clause 4.4 of NGTS 1 is 50 ms for 420 kV, 60 ms for 300 kV and 70 ms for 145 kV circuit-breakers.

This rated break time shall be determined as described in IEC 56 (BS 5311) Clause 4.113.1 but with due regard to Clause 4.1.1 above.

4.2.4 The Supplier shall declare the circuit-breaker opening and closing times at 125%, 114%, 100%, 80% and 70% of the rated voltage of the opening and closing devices, and measured at the terminals when operating (as IEC 694 Clause 4.8).

4.2.5 The maximum Make-Break time when closing onto a prepared trip circuit shall be 80 ms for 420 kV, 100 ms for 300 kV and 120 ms for 145 kV circuit-breakers to conform with Clause 3.1.3.

4.2.6 The Supplier shall state the minimum Make-Break time at rated conditions.

4.2.7 Circuit-breakers for application to Series Reactor circuits shall satisfy the test duty requirements stated in Clause 5.

4.3 Performance Requirements of Switches

4.3.1 Switches for Shunt Reactor, Overhead Line and Cable Switching duties are required to be Special-purpose switches with the capability of performing an increased number of operating cycles and as such shall be capable of 10,000 operations.

4.3.2 The switches defined in 4.3.1 shall be capable of the circuit-breaker switching performance for the appropriate Switching Duty.

5 TEST REQUIREMENTS

5.1 Test Requirements Common to Circuit-breakers and Switches

5.1.1 Control system testing shall be in accordance with the requirements of NGTS 2.13

5.2 Type Test Requirements for Circuit-Breakers

5.2.1 With reference to IEC 56 Clause 6.102.2, the minimum operating pressure at which the short-circuit tests are demonstrated shall be the lockout (block) pressure appropriate to the commencement of the duty, ie C, O or O-0.3-CO.

5.2.2 In addition to the transient recovery voltage requirements of IEC 56 (BS 5311) the following Test Duty 2 characteristics shall be met by 145 kV and 300 kV circuit-breakers.

Rated Voltage	Current (kA)	U_c (kV_p)	t_3 (us)	t_d (us)	U_1 (kV_p)	t_1 (us)	U_c/t (kV/us)
145 kV	6 to 9.5	285	38	7.6	89	19.5	7.5
300 kV	9.5 to 12	415	42	6.0	138	20	10

5.2.3 Capacitive current switching tests shall preferably be performed using full pole, direct test methods. Where synthetic test methods are used, either full or part pole, the test parameters shall be in accordance with IEC 427. NGC require supplementary tests to be performed using the preferred test circuit, as Figure 1, at a current of between 50 A and 75 A and at a frequency of 50 Hz (±5%). The supplementary test programme shall be performed at both rated and lockout conditions. In all other respects the supplementary test conditions shall comply with IEC 427.

The number of test operations for both the IEC 427 tests and the supplementary tests shall be 24 operations at 15° intervals followed by a further 24 operations at the minimum arc duration ±1 ms. If tests are carried out on a part pole additional testing may be required in order to demonstrate insensitivity to polarity effects.

The prime aim of the tests is to confirm restrike free performance and provide a high degree of confidence for service use. Where doubt exists NGC may specify further tests.

5.2.4 300 kV and 420 kV circuit-breakers for application to Series Reactor circuits shall satisfy the following additional test duties as appropriate.

5.2.4.1 300 kV Reactor side transient recovery voltage.

Current (kA)	U_c (kV_p)	t_3 (us)	t_d (us)	U_c/t_3 (kV/us)
12.5	310	25	3.5	12.4

Supply (busbar) side transient recovery voltage to be as IEC 56 (BS 5311) Standard Rated values (Test Duty 4).

5.2.4.2 420 kV Reactor side transient recovery voltage.

Current (kA)	U_c (kV_p)	t_3 (us)	t_d (us)	U_c/t_3 (kV/us)
10	700	25	3.5	28

Supply (busbar) side transient recovery voltage to be as IEC 56 (BS 5311) Standard Rated values (Test Duty 4).

5.2.5 Operation of circuit-breakers applied to shunt reactor circuits shall not produce overvoltages in excess of 2 pu at the reactor terminals and the circuit-breaker shall not suffer damage as a result of such an operation. In order to verify adequate performance circuit-breakers for application to shunt reactor circuits shall be tested according to the recommendations of the IEC Technical Report covering Shunt Reactor Switching (currently available as 17A(Secretariat)337).

5.3 Type Test Requirements for Switches for Use on Shunt Reactor, Overhead Line and Cable Circuits

5.3.1 Switches for applications to Shunt Reactor, Overhead Line and Cable Switching Duties shall satisfy the general requirements of IEC 265 for Special-purpose switches with the capability of an increased number of operating cycles.

Unless otherwise specified by NGC a 10,000 operation mechanical test shall be demonstrated to the general requirements of IEC 56. The test sequence to remain as IEC 56 for the first 2,000 operations and for subsequent operations as agreed with NGC prior to the tests. Regular performance monitoring is required during the tests.

5.3.2 Switches shall satisfy Clause 5.2.3 above for Overhead Line and Cable applications.

5.3.3 Switches for application to Shunt Reactor circuits shall satisfy Clause 5.2.5

5.4 Audible Noise Tests for Circuit-Breakers and Switches

The measurement shall be made at a height of 1.2 m above ground level. A pressure transducer shall be used in conjunction with a precision sound level meter which is set to its fastest response and linear scale. This will allow direct determination of the overall sound pressure level. Because of its short duration the noise is to be recorded on tape so as to enable detailed harmonic analysis and a check on the instrument reading to be made. The recorded noise is to be successively played back through a 1/3 octave band analyser to determine maximum rms sound pressure levels for each 1/3 octave wave band.

Since 90 dB measured by the above technique can be achieved with varying frequency spectra the maximum rms sound pressure level in any 1/3 octave wave band below a frequency of 1 kHz shall not exceed the maximum rms value in any 1/3 octave wave band above 1 kHz.

5.5 Routine and Site Commissioning Tests for Circuit-Breakers and Switches

5.5.1 In addition to the requirements of NGTS 1, NGTS 2.2 and NGTS 2.13 the Routine Test shall conform to IEC 56 for circuit-breakers and IEC 265 for switches.

5.5.2 A programme of site commissioning tests for both circuit-breakers and switches shall be agreed with NGC based on the example given in Appendix HH of IEC 56.

6 APPROVAL PROCEDURE

6.1 The approval procedure for circuit-breakers and switches is as detailed in NGTS 2.2. An accredited Testing Laboratory (Station) is one that is a member of the Short-Circuit Testing Liaison (STL) or has been separately approved by NGC for the purpose of circuit-breaker or switch testing.

6.2 In addition to the requirements of NGTS 2.2 the Supplier shall complete a copy of the NGC data sheets attached to this level 3 document as Appendix A and B. The completed document shall form part of the overall Approved Data Pack and be used to identify the equipment approved. Any change to the details contained in the data sheet shall invalidate the approval unless NGC has approved the change.

6.3 Where a manufacturer is tendering for the supply of equipment that does not have NGC approval, then the following documentation shall be supplied in relation to the control system:

6.3.1 Functional description of the equipment in sufficient detail to enable the performance characteristics and interface requirements to be evaluated by NGC.

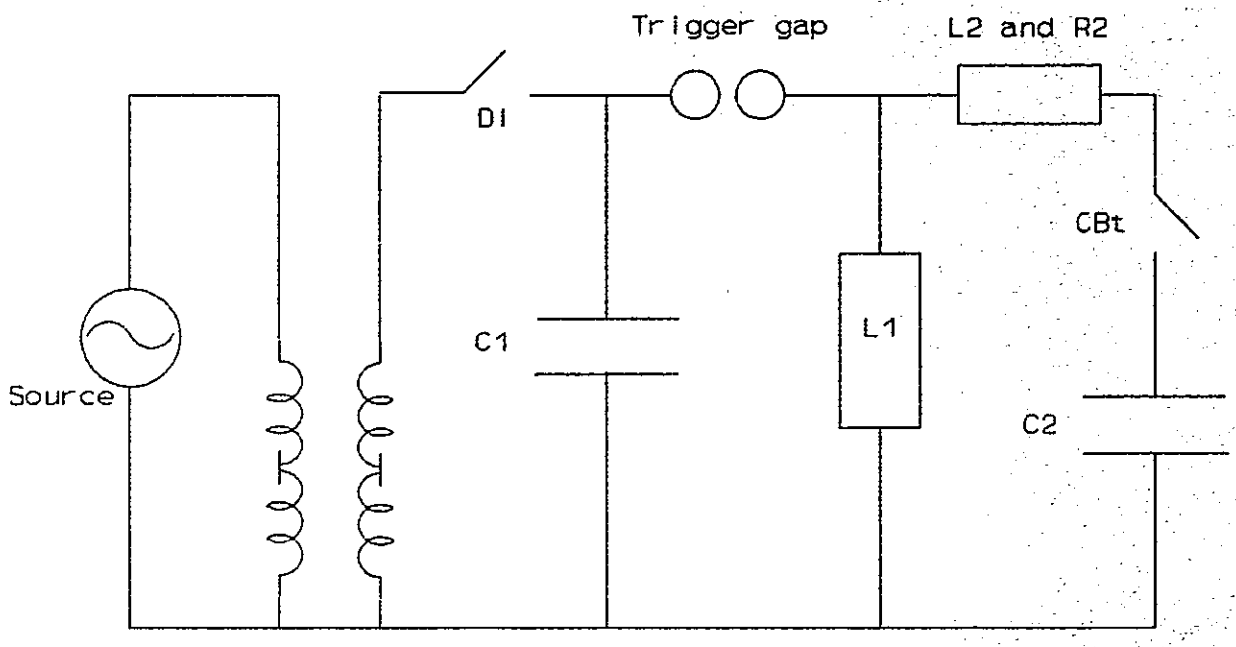
6.3.2 Type test results that record the equipment performance and compliance with the required environmental conditions.

6.3.3 Type test results that record the equipment functional performance and compliance with the functional requirements.

6.3.4 Any other information that may be required for the perpose of giving approval.

6.4 When approved the Supplier need only quote the NGC approval register reference of the equipment being offered.

6.5 If non-approved equipment is offered the Supplier shall provide the above documentation at the time of tendering.



C1/L1 : Oscillatory supply circuit
C2 : Load capacitance
CBt : Circuit-breaker under test
DI : Source disconnector
L2/R2 : Additional load current shaping circuit

Figure 1 : Schematic of test circuit for additional capacitive switching tests

NGC TYPE APPROVAL DATA SHEET: CIRCUIT-BREAKERS (FORMING APPENDIX A TO NGTS 3.2.1)

A1 MANUFACTURER, DESIGNATION, PRODUCTION PERIOD AND RATING

1	MANUFACTURER		
2	CIRCUIT-BREAKER DESIGNATION (eg GIS or OT self-blast puffer)		
3	CIRCUIT-BREAKER TYPE REFERENCE Year Production Commenced Year Production Ceased (NGC use only)		
4	CIRCUIT-BREAKER RATING		
	Normal Voltage	kV	
	Normal Current	A	
	Fault Current 3/1 Phase	kA	/
	RRRV on 100% duty 3/1 Phase	kV / µs	/
	D.C. Component at Contact Separation (following 10 ms relay time and open time as A3 Cl. 3.9)	%	
	Capacitive Current Switching Ability	A	
	Voltage Factor for Capacitor Bank Duty	p.u.	
	Shunt Reactor Switching Ability	A	
	Series Reactor Switching Ability	kA	
	RRRV on Series Reactor Duty 3 Phase	kV / µs	
	Out of Phase Switching Ability	kA	
	RRRV Out of Phase Duty	kV / µs	
	Dielectric Withstand		
	Lightning Impulse (1/50) Switching Impulse (250/2500) Power Frequency (wet and dry)	kVp kVp kVrms	
	Bending moment at base of support porcelain (see Appendix B)	kN-m	
	3-phase arrangement drawing No		
	Single-phase arrangement drawing No		
	Control schematic drawing No		
	Type Approved List Number (NGC use only)		

A2 GENERAL TECHNICAL DATA

2.1	Number of Main Breaks/Phase		
2.2	Shunt Capacitance/Break	pF	
2.3	Manufacturer and Type Reference of Capacitors		
2.4	Number and Type of Fixed Contacts Main / Arcing		
2.5	Number and Type of Moving Contacts Main / Arcing		
2.6	Maximum Main Circuit Resistance	μΩ	
2.7	Weight of Interrupter Module/Head	kg	
2.8	Weight of Interrupter Unit	kg	
2.9	Weight of Interrupter Porcelain	kg	
2.10	Manufacturer of Interrupter Porcelain		
2.11	Weight of Support Porcelain	kg	
2.12	Manufacturer of Support Porcelain		
2.13	Weight of Bushings (Open Terminal Dead Tank)	kg	
2.14	Weight of Barrier (Metal Enclosed GIS)	kg	
2.15	Weight of Circuit-breaker base/bases (per phase)	kg	
2.16	Weight of Local Control Cubicle	kg	
2.17	Weight of Single Phase Complete	kg	
2.18	Weight of Complete Circuit-breaker without gas and oil	kg	
2.19	Weight of Complete Circuit-breaker with gas and oil	kg	
2.20	Type of Operating Mechanism		
2.21	Manufacturer and Type reference of Operating Mechanism		
2.22	Mechanism Travel	mm	

2.23	Operating Coils - Close (i) Number and Type (ii) Type Reference (iii) Power Consumption Rating		
2.24	Power to Close (100% V and pressure/drive) Rated Voltage to be 110 V d.c. Rated Pressure (if applicable)	W V Barg	
2.25	Coil Current Characteristics when at Minimum Voltage (NGTS 2.2)	A	
2.26	Operating Coils - Open (i) Number and Type (ii) Type Reference (iii) Power Consumption Rating	W	
2.27	Power to Open (100% V and pressure/drive) Rated Voltage to be 110 V d.c. Rated Pressure (if applicable)	W V Barg	
2.28	Coil Current Characteristics when at Minimum Voltage (NGTS 2.2)	A	

A3 TECHNICAL DATA - INTERRUPTER OPERATION

3.1	Main Interrupter Travel	mm	
3.2	Close Time (initiation to contract touch at rated pressure and rated voltage of 110 V d.c. as detailed in NGTS 2.2	ms	
3.3	Maximum Spread Between Interrupters on One Phase on Closing	ms	
3.4	Maximum Spread Between Phases on Closing	ms	
3.5	Close Speed at Contact Touch	m/s	
3.6	Variation in Close Time with Control Voltage (at rated pressure)	ms	
3.7	Variation in Close Time with Pressure (at rated control voltage)	ms	
3.8	Variation in Close Time with Temperature (at rated pressure and voltage)	0 to -25°C 0 to 20°C 20 to +40°C	
3.9	Opening time (initiation to contact part at rated pressure and rated voltage of 110 V d.c. as detailed in NGTS 2.2	ms	
3.10	Maximum Spread Between Interrupters on One Phase on Opening	ms	
3.11	Maximum Spread Between Phases on Opening	ms	
3.12	Open Speed at Contact Part	m/s	
3.13	Variation in Open Time with Control Voltage (at rated pressure)	ms	
3.14	Variation in Open Time with Pressure (at rated control voltage)	ms	
3.15	Variation in Open Time with Temperature (at rated pressure and voltage)	0 to -25°C 0 to 20°C 20 to +40°C	
3.16	Live Time on Make-Break Duty (minimum)	ms	
3.17	Maximum Arc Duration - Three Phase Symmetrical - Single Phase Symmetrical - SLF (L90) as Single Phase	ms	
3.18	Noise Level at 25 Metres (NGTS 3.2.1)	dB (Lin)	

A4 TECHNICAL DATA - SF_6 GAS

4.1	Design Pressure of Gas System	Barg	
4.2	Operating Pressure of Relief Device Size/Type	Barg	
4.3	Normal Pressure at 15°C Normal Pressure at 20°C	Barg	
4.4	Close Lockout Pressure	Barg	
4.5	Open (Trip) Lockout Pressure	Barg	
4.6	Minimum Close Pressure	Barg	
4.7	Minimum Open Pressure	Barg	
4.8	Quantity of Gas	kg	
4.9	Quantity of Gas	lt	
4.10	Method of Monitoring Pressure and Temperature Compensation		
4.11	Maximum Permissible Dew Point Temperature	°C	
4.12	Maximum Permissible Acidity Level (HF)		
4.13	Maximum Permissible Leak Rate (<1% per annum)	lt/s or %	
4.14	Mass of Alumina/Molecular Sieve and Type Reference	kg	
4.15	SF_6 Pipework OD Material	mm	
4.16	Type and Manufacturer of Pipe Couplings		

A5 TECHNICAL DATA - AIR SYSTEM (where applicable)

5.1	Mechanism Type Reference		
5.2	Rated Pressure at 20°C	Barg	
5.3	Local Air Receiver Volume	m^3	
5.4	Minimum Close Pressure	Barg	
5.5	Minimum Open Pressure	Barg	
5.6	Close Lockout Pressure	Barg	
5.7	Open (Trip) Lockout Pressure	Barg	
5.8	Forced Open (Trip) Setting	Barg	
5.9	Detent Alarm/Operate Setting (if applicable)	Barg	
5.10	Detent Reset Setting	Barg	
5.11	Pressure Drop on Open	Barg	
5.12	Air Consumption on Open	m^3	
5.13	Pressure Drop on Close	Barg	
5.14	Air Consumption on Close	m^3	
5.15	Method of Monitoring Pressure and Temperature Compensation		
5.16	Maximum Permissible Dew Point Temperature	°C	
5.17	Air Pipework OD Material	mm	
5.18	Type and Manufacturer of Pipe Couplings		

A6 TECHNICAL DATA - HYDRAULIC SYSTEM (where applicable)

6.1	Mechanism Type Reference/Manufacturer		
6.2	Pump Type Reference/Manufacturer		
6.3	Rated Pressure at 20°C	Barg	
6.4	Pump Cut In/Out Pressures	Barg	
6.5	Close Lockout Pressure	Barg	
6.6	Open (Trip) Lockout Pressure	Barg	
6.7	Forced Open (Trip) Setting	Barg	
6.8	Minimum Pressure for Close	Barg	
6.9	Minimum Pressure for Open (Trip)	Barg	
6.10	Relief Valve Operate/Reset Pressures	Barg	
6.11	High Oil Pressure Alarm Setting	Barg	
6.12	Pressure Drop on Close	Barg	
6.13	Oil Consumption on Close	lt	
6.14	Pressure Drop on Open	Barg	
6.15	Oil Consumption on Open	lt	
6.16	Detent Alarm Operate/Setting (if applicable)	Barg	
6.17	Detent Reset Setting	Barg	
6.18	Volume of Oil	lt	
6.19	Recommended Oil Type		
6.20	Maximum Oil Pressure Leak Rate	Barg/m	
6.21	Pumping Rate	Barg/m	
6.22	Time to Restore Normal Pressure after COCO Duty	s	
6.23	Oil Pipework OD Material	mm	
6.24	Type and Manufacturer of Pipe Couplings		

A7 TECHNICAL DATA - NITROGEN SYSTEM (where applicable)

7.1	Mechanism Type Reference		
7.2	Volume of Nitrogen	m^3	
7.3	Precharge Pressure at 20°C	Barg	
7.4	Close Lockout Pressure (if applicable)	Barg	
7.5	Open (Trip) Lockout Pressure (if applicable)	Barg	
7.6	Method of Monitoring Pressure and Temperature Compensation		
7.7	Nitrogen Pipework OD Material	mm	
7.8	Type and Manufacturer of Pipe Couplings		

A8 TECHNICAL DATA - SPRING SYSTEM (where applicable)

8.1	Mechanism Type Reference		
8.2	Method of Spring Charging		
8.3	Charging Time CO Sequence Charging Time COCO Sequence	s s	
8.4	Starting Current of Charging Motor and Voltage (where applicable)	V''	
8.5	Method of Monitoring Charging System		
8.6	Method of Damping Mechanism		

NGC TYPE APPROVAL DATA SHEET: CERAMIC HOLLOW PRESSURISED SUPPORT PORCELAIN CALCULATION SHEET: CIRCUIT-BREAKERS AND SWITCHES (FORMING APPENDIX B TO NGTS 3.2.1)

MECHANICAL STRENGTH OF SUPPORT PORCELAIN

The Supplier shall state the Cantilever Strength of the support porcelain and illustrate its ability in relation to the European Standard EN 50062 by completing the following tables. These completed tables will form part of the NGC Data Pack for the circuit-breaker/switch type approval process.

Type test withstand bending moment	kNm	

Table 1 Basic Data Used for Calculations

Design Pressure (En 50 - 062)	barg	
Design temperature (EN 50 - 062) (see Note)	°C	
Dimensions of Lower Section of Support Porcelain (EN 50062 Fig B1)	Ds(m)	
	Do(m)	
	Di(m)	
Mass of single phase of circuit-breaker/switch above base of support porcelain	kg	
Length of current path of circuit-breaker/switch interrupters	m	
Declared minimum inter-phase spacing	m	
Routine test bending moment		
Factor of Safety for Extreme Loads if in excess of minimum of 1.2 specified in En 50 - 062		

Note: For outdoor equipment it is necessary to consider the added effect of a solar gain temperature of 10°C.

Table 2 Wind Pressure on Circuit-Breaker/Switch Alone (Without Connections)

Sub-component	Area m^2	Lever Arm m	Force kN (See Note 1)	Bending Moment kN-m
Interrupter module				
Upper Support Insulator (where applicable)				
Middle Support Insulator (where applicable)				
Lower Support Insulator				
Totals				

Note: Force to be calculated in accordance with the NGC Design memorandum TDM 3/28.

NGC REQUIREMENT

The mechanical design of NGC substations is based on the maximum forces that can be expected to occur within the lifetime of the equipment under two extreme load conditions:

(i) 100% Wind load without ice + 100% Short circuit forces

(ii) 100% Wind load with ice

It is expected when applying the equipment offered within these criteria to be able to utilise the design withstand bending moment of the support column declared above subject to a safety factor of 1.2 as specified in EN 50-062. In the Table 3, suppliers should indicate the deductions from this figure as a result of the loads on the equipment and state the maximum external extreme loads that may be applied.

Table 3 Declared Bending Moments

Type test withstand bending moment ÷ 1.2	kNm	
Wind load on circuit-breaker/switch as bending moment	kNm	
Short-circuit focus on interrupter of circuit-breaker/switch as bending moment	kNm	
Load ducts circuit-breaker/switch mass restoring bending moment	kNm	
Usable withstand bending moment under extreme conditions available at the equipment terminals	kNm	

Table 4 Additional Data Related to IEC 56 Rated Terminal Loads

		Bending Moment (kN-m)
Longitudinal-static horizonal	(FthA 420 kV =1750)	
	(300 kV =1250)	
	(145 kV =1000)	
Transverse - static horizontal	(FthB 420 kV =1250)	
	(300 kV =1000)	
	(145 kV = 750)	
Distance from top of bottom flange of lower porcelain to interrupter centre-line	m	

Date 16 December 1992

Our Ref

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ENGINEERING DOCUMENT DESPATCH NOTE

Please find enclosed the document listed below for your retention:

National Grid Technical Specification NGTS 2.2
Switchgear for the National Grid System
Issue 1, September 1992

and associated Level 3 Specifications

National Grid Technical Specification NGTS 2.3
Transformers and Reactors for use on 132, 275 and 400 kV Systems
Issue 1, September 1992

and associated Level 3 Specifications

Number of copies: 10

Date of Despatch: .....

Please advise the Documentation Group of any corrections to the address shown above.

Registered Office
National Grid House
Kirby Corner Road
Coventry CV4 8JY

Registered in
England and Wales
No 2366977

despatch.bmh

NATIONAL GRID COMPANY PLC

TECHNOLOGY AND SCIENCE DIVISION

NATIONAL GRID TECHNICAL SPECIFICATION

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NATIONAL GRID TECHNICAL SPECIFICATION

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TECHNOLOGY AND SCIENCE DIVISION

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