



Exploration & Production

GENERAL SPECIFICATION

ELECTRICAL

GS ELE 131

High voltage switchgear

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1. Scope

This specification covers the minimum requirements for the design, manufacture, and supply of high voltage switchgear above 1 kV and up to and including 36 kV.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Design and engineering shall conform as a minimum requirement to the current edition of the following in order of preference:

- Applicable laws, rules and regulations of the country in which the system will be operated. In cases where no "local" regulations exist, the French laws and legislation shall be used
- COMPANY Particular Specifications (if any)
- COMPANY General Specifications
- Applicable International Electro-technical Commission (IEC) Standards
- Applicable CENELEC Standards
- Applicable recognised standards and codes (e.g. UTE-NFC, BSI, VDE, etc.) where IEC publications have not yet been issued.

Standards

Reference	Title
IEC 60050-441	International Electro-technical Vocabulary. Switchgear, control gear and fuses
IEC 62271-100	High voltage alternating current circuit breakers
IEC 62271-102	Alternating current disconnectors and earthing switches
IEC 60044-1	Current transformers
IEC 60044-2	Voltage transformers
IEC 60255	Electrical relays
IEC 60265	High voltage switches
IEC 60282	High voltage fuses
IEC 60298	AC metal enclosed switchgear and controlgear for rated voltage above 1 kV and up to and including 72.5 kV
IEC 60376	Specification and acceptance of SF6
IEC 60420	High voltage alternating current fuse switch combinations
IEC 60427	Synthetic testing of high voltage alternating current circuit breakers
IEC 60466	AC insulated enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 38 kV

Reference	Title
IEC 60470	High voltage AC contactors and contactor based motor starters
IEC 60529	Classification of degrees of protection provided by enclosures
IEC 60644	Specifications for high voltage fuse-links for motor circuit applications
IEC 60694	Common clauses for high voltage switchgear and controlgear standards
IEC 60787	Application guide for the solution of fuse-links of high voltage fuses for transformer applications
IEC 60932	Additional requirements for enclosed switchgear and controlgear from 1 kV to 72.5 kV to be used in severe climatic conditions
IEC 61166	High voltage alternating current circuit breakers - Guide for seismic qualification of high voltage alternating circuit breakers
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
Not applicable	

3. Service conditions

The equipment shall be suitable in all aspects for continuous operation at full load service.

The equipment will be installed in an air-conditioned electrical room with an average ambient air temperature of 25°C but shall be able to operate in unusual conditions as defined in project data sheets.

The equipment shall be suitable for operation, without deleterious effect, with variations of voltage and frequencies as follows:

- High voltage supply: $\pm 10\%$
- Frequency: $\pm 5\%$

4. General characteristics

4.1 General electrical characteristics

The general electrical characteristics shall be in compliance with the values indicated in [IEC 60694](#) - paragraph 4 (Table 1a) and as follows:

System	3 phases/3 wires			
Rated frequency	50 Hz			
Nominal system voltage	33 kV	22 kV	11 kV	≤ 6.6 kV
Rated voltage kV (r.m.s)	36 kV	24 kV	12 kV	7.2 kV
Rated one minute power-frequency withstand voltage kV (r.m.s)	70 kV	50 kV	28 kV	20 kV
Rated lightning impulse withstand voltage kV (peak)	170 kV	125 kV	75 kV	60 kV
Neutral system	Earthed through an impedance			
	200 A	150 A	30 to 50 A	20 to 50 A

4.2 Breaking technology

The breaking technology shall be from the following types:

- Vacuum
- Gas (SF₆).

Air, Oil or pneumatic breaking technology is prohibited.

In case of use of vacuum technology, special care must be taken to limit switching overvoltages.

The SUPPLIER shall clearly indicate in his proposal which provisions have been taken (eg: RC filters, surge arrestors, ferrites...).

4.3 Particular characteristics for breakers

4.3.1 Rated short-circuit breaking current

The making and the breaking capacities shall be as a minimum rated to the peak current values and the short time withstand current in compliance with [IEC 62271-100](#)

However, when a switchgear is close to a generator, it shall be capable of breaking a short circuit current with a higher percentage d.c. component than the value given in figure 9 page 99 of [IEC 62271-100](#).

In this case the percentage d.c. component shall be calculated and specified in the project particular specification.

4.3.2 Rated out-of-phase breaking current

The requirements of [IEC 62271-100](#) are applicable to circuit breakers (incomers and ties) which are close to generators.

4.3.3 Power-frequency Short time Overvoltage

Circuit breakers intended for use in synchronizing operation, when a substantial switching surge may simultaneously occur, shall withstand 1.4 times the nominal system voltage indicated in paragraph 4.1 for a minimum of 10 s.

4.3.4 Rated cable-charging breaking current

Circuit breakers shall have a minimum rated cable-charging breaking current in accordance with the values in Table VIII of § 4.108 of [IEC 62271-100](#).

4.3.5 Operating control

Circuit breakers shall have electrical closing and opening devices with a manual and motor charged stored energy mechanism release.

Closing and tripping supplies will be from a secure 48 V d.c. + 10% - 15% power source.

The spring charging motors shall be ac supplied.

4.4 Particular characteristics for contactors

4.4.1 General requirement for operation - Temperature rise

The contactors used for motor supply shall have rated characteristics according to the performance of the motor and the starting sequence.

The contactors shall be capable of withstanding three consecutive normal starts, corresponding to a thermal constraint equal to three times the starting time.

4.4.2 Breaking current - Coordination with HRC fuses

To protect the contactor, the associated HRC fuses shall break the presumed fault currents which could be higher than the rated breaking current of the contactor in less than 50 ms.

4.4.3 Rated operating sequence

In normal conditions, the contactors shall have a utilisation category AC-3, a mechanical endurance of 300,000 no-load operating cycles and an electrical endurance of 30,000 on-load operating cycles.

4.4.4 Control supply

Control supply shall be from a secure 48 V d.c. + 10% - 15% power source.

4.5 Current and voltage transformers

4.5.1 Voltage transformers

Voltage transformers shall be of the encapsulated type.

Three voltage transformers shall be planned with star connection.

They shall be withdrawable type or disconnectable by live-fuse isolation and protected by adequate fuses:

- Measurement: accuracy class 1 (minimum)
- Protection: accuracy class 3P.

The secondary rated voltage shall be 100 V or 110 V as required in the data sheet.

Transformers with a star connection and neutral earthed shall be designed with a rated voltage factor of 1.9 $U_n/30$ s as a minimum and 8 hours when the neutral earthing system is totally isolated.

Transformers connected between primary phases shall be designed with a rated voltage factor of 1.2 U_n continuous.

4.5.2 Current transformers

Current transformers shall be of the encapsulated type installed in an air-insulated chamber.

Current transformers shall be:

- Accuracy class 0.5 for measuring circuits when a high level accuracy is required (metering, regulation, power measuring)
- Accuracy class 1 for current measuring
- Accuracy class 5P for protective relays when required by the SUPPLIER
- Accuracy class 10P for other cases (over current relay).

The secondary current rating shall be either 1A or 5A. However, where remote metering is required, the current rating shall be 1A. For differential protection the current rating shall be 1A 5P20 or class X.

Current transformers shall be rated to withstand the thermal and magnetic stresses resulting from the switchgear rated fault level.

Measurement of earth fault current shall be provided by core balance CTs. Use of residual current from connection of 3 CTs is not allowed due to the low accuracy of this arrangement.

4.6 Metering, protection, control and indication

Metering, protection, control and indication shall be in accordance with the single line diagrams, typical protection diagrams and data sheets.

Meters and relays shall be capable of withstanding without damage the secondary currents associated with the switchgear rated fault current flowing in the primary of current transformers.

Multiple test blocks shall be provided.

Current transformers shall be wired to shorting type terminal blocks.

Protection relays shall be microprocessor based and programmable type units.

These relays shall communicate with an (ECS) Electrical Control System (when required) through a serial link (Modbus protocol preferred).

All the relays shall be able to be synchronised with an external clock.

Interlock and intertrip circuits shall use hardwired auxiliary contacts without repeat relays.

Assemblies shall be provided with durable single line mimic diagram, clearly indicating the specific function of relevant compartment.

All indicators shall be made of multi LED only.

As a minimum, the following colour code shall be used:

Status:

On / closed / Running:	RED
Off / Open / Stopped:	GREEN
Fault / Trip:	YELLOW
Voltage presence:	WHITE

Push button:

On / Close / Start:	GREEN
Off / Open / Stop:	RED

5. Construction requirements

The construction requirements are generally applicable to withdrawable or fixed switchgear, however specific parts require particular requirements.

5.1 General

5.1.1 Degree of protection

The degree of protection of the enclosure shall be as a minimum IP 31 as specified in [IEC 60529](#).

5.1.2 Internal fault

The switchgear shall withstand arcing due to an internal fault at the same value that the short-circuit current for a duration of 1s minimum.

The switchgear shall be type-tested in accordance with the procedure described in [IEC 60298](#) and shall comply with the criteria 1 to 6 of the Annex AA with the accessibility type A.

5.1.3 Door locking device

Unless otherwise specified, no key or locking device to open enclosure and doors is required. Only door handles shall be provided.

5.2 Structure

5.2.1 Withdrawable type switchgear

The switchgear cubicles shall be of prefabricated metal clad type as defined in [IEC 60298](#) publication, section 3, paragraph 3.102.1, free standing, floor mounting, flush fronted construction. Appropriate base frames to provide a substantial foundation for the switchgear installation, together with holding down bolts, nuts and washers, rails, etc. shall be included.

The switchgear shall be complete with eyebolts/lifting eyes, etc., to facilitate installation.

Switchgear shall be self-ventilating and have facilities for extension with panels of similar construction to the panels previously forming the end.

Switchgear shall be designed and constructed to facilitate inspection, site installation, cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance.

Similar parts and components shall be normally interchangeable.

5.2.2 Fixed type switchgear

The switchgear cubicles shall be of prefabricated metal enclosed type, as defined in [IEC 60298](#) publication, section 3, paragraph 3.102.2, free standing, floor mounting, flush fronted construction. Appropriate base frames to provide a substantial foundation for the switchgear installation, together with holding down bolts, nuts and washers, rails, etc. shall be included.

The switchgear shall be complete with eyebolts/lifting eyes, etc., to facilitate installation.

Switchgear shall be arranged to form a single structure with a common busbar assembly.

Switchgear structures shall be self-ventilating.

Switchgear shall be designed and constructed to facilitate inspection site installation cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance.

Similar parts and components shall be normally interchangeable.

5.3 Busbars

Busbars shall be installed in compartments separate from the switchgear and without transverse partitions at the level of each cell except at bus section(s). Bolted panels shall be provided to allow periodic checking of busbar mechanical fasteners.

Busbars shall be of the same cross-sectional area through out the switchgear and made of hard drawn bare copper.

When the atmosphere is highly corrosive, busbars shall be insulated with heat shrinkable sleeves or similar.

Busbars and connections shall be adequately sized, braced and supported to withstand the mechanical forces and thermal effects resulting from the switchgear rated short circuit current.

5.4 Earthing switches

5.4.1 Withdrawable type switchgear

Earthing switches shall be manually operated from the front of the switchgear.

Earthing switches shall include the following locking and safety functions:

- Prevent closing the earthing switch if the switching device is closed, in the service position
- Prevent inserting the mobile part of both upstream and local circuit breakers to service position while the earthing switch is closed
- Facility to lock the outside earthing switch device in open or closed position, positions identified with nameplates of the incorruptible type
- Mechanical key interlocks shall be provided between the earth systems and all incoming circuit breakers including possible backfeeds.

5.4.2 Fixed type switchgear

Earthing switches shall be manually operated from the front of the switchgear.

Earthing switches shall include the following locking and safety functions:

- Prevent closing the earthing switch if the switching device is closed, in the service position
- Facility to lock the outside earthing switch control in open or closed position; positions identified with nameplates of incorruptible type.

5.5 Switching device compartment

5.5.1 Withdrawable switchgear

Interlocks, lockable busbars shutters, covers, etc., shall be provided to prevent incorrect or unsafe operation and to prevent access to live parts.

Shutters shall be automatically and mechanically operated by the mobile part and cover the openings of the HV contacts when mobile unit is withdrawn, providing physical separation of energised parts. When the mobile unit is inserted, shutters shall be automatically raised to release the openings of the HV contacts.

5.5.2 Fixed type switchgear

Interlocks, covers, etc., shall be provided to prevent incorrect or unsafe operation and to prevent access to live parts.

5.6 Switching devices

5.6.1 Withdrawable type switchgear

5.6.1.1 General

The type of switching device to be selected shall depend on the circuit protection requirements:

- Circuit breakers shall be used for incomers and bus-ties, power transformer feeders, motor feeders above 1 MW, secondary switchboard feeders
- Contactors shall be used for motor feeders above 150 kW up to 1000 kW and may be used for transformer feeders up to 630 kVA.

Switching devices shall be fitted in withdrawable trays or trucks with the following positions:

- Inserted
- Withdrawn, in test (isolated) position
- Removed for maintenance.

In the test position, auxiliary circuits shall be connected but power contacts shall be disconnected.

Each cubicle shall be equipped with voltage presence indicators (neon lamp indicator, one per phase).

A mechanical full proof system shall prevent insertion of a mobile part with a lower rating or a different design than normally assigned to the compartment. All switching devices shall be lockable in the withdrawn position.

Mechanical closing facilities (push-button) shall be locked off in the service position.

5.6.1.2 Circuit breakers

Circuit breakers of similar rating shall be interchangeable.

Circuit breakers shall be electrically operated and fitted with manual operating devices.

Circuit breakers shall be provided with anti-pumping facilities.

Withdrawable circuit breakers shall be interlocked to prevent:

- Breakers being inserted into the service position unless open
- Breakers being withdrawn from the service position unless open
- Breakers being closed unless fully in the service, withdrawn/test or earthing position.

5.6.1.3 Fused contactors

Fuse links shall have high rupturing capacity and shall be fitted with blown indicators and striker pins to prevent single phase operating.

Fuses for motor starters shall have a time-current characteristic suitable for direct on-line motor starting.

Current discrimination shall be provided between fuse characteristics and contactor breaking capacities. This shall ensure that overload and fault currents are safely interrupted, by the appropriate devices avoiding any risk of welding or other damage to contactors.

5.6.2 Fixed type switchgear

The type of switching device to be selected shall depend on the circuit protection requirements:

- Circuit breakers for incomers
- Fused switch combination for transformer feeders
- Fused contactors for motor feeders.

In loop distribution systems, fixed type switchgear shall be used.

5.6.3 Secondary wiring

Secondary wiring shall be self-extinguishable, insulated with black PVC 1000 V grade with the following minimum cross-sections:

- 2.5 sqmm for current circuits
- 1 sqmm for voltage circuits.

Secondary wiring within the switchgear shall be securely held in position (either loomed or run in conduit/trunking).

Identification shall refer to the related wiring diagram.

Flexible loomed cables shall be used for connections on door mounted equipment.

5.6.4 Cable terminations

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

Positioning of cable termination facilities shall avoid obstruction of other cable terminations, removable covers, etc. and provide easy access for terminating cables.

20% spare terminals shall be provided.

Spare auxiliary contacts shall be wired to the cable terminations.

Cable compartment with more than one core cable per phase, shall have termination facilities arranged to avoid crossing of phase core.

Cable supports shall be provided to avoid undue strain on cable terminations.

5.7 Miscellaneous

5.7.1 Earthing

An earth busbar shall be provided along the full length of the switchgear structure with provision for earth cable connections at each end. Earthing busbar shall be made of hard drawn copper.

All metallic non-current carrying parts of the switchgear including hinged doors shall be bonded together and connected to the earth busbar.

Withdrawable parts (e.g circuit breakers) shall be effectively earthed until completely withdrawn with all power and control connections disconnected.

Provision shall be made, adjacent to the cable termination, for earthing cable armour and screen to the earth busbar.

Each wiring circuit shall be identified by green/yellow strips.



5.7.2 Anti-condensation heaters

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

Anti-condensation heaters shall be installed at the bottom of each vertical section and shall be individually protected by miniature circuit breakers. Heaters shall be controlled by hygrometers. A dedicated feeder breaker shall be provided with alarm contacts.

5.7.3 Labels

Cubicles, compartments, withdrawable starters, circuit breakers and components shall be identified by labels with circuit numbers. Cubicle label designations (at front and rear of panel) shall be in accordance with the switchgear single line diagram and associated data sheets.

Nameplates shall bear all identification in accordance with the reference standards. Language used for labelling shall be stated in the data sheets.

Nameplates shall be laminated engraved plastic with black letters on a white background.

5.7.4 Special tools and accessories

Handles, tools, and service trucks for operation and maintenance of switchgear shall be provided in the electrical room or building where it is installed.

5.8 Maintainability

Provisions shall be made for installation of windows for preventive inspection of internal areas of protected cells by using IR camera.

6. Interface with Electrical Control System (ECS) (Optional)

When specified, switchgear assembly may be connected to an Electrical Control System dedicated to control the general electrical system.

In this case a Programmable Logic Controller (PLC) or dedicated Remote Control Unit (RCU) from the Electrical Control System (ECS) may be installed within each switchgear assembly by the MANUFACTURER.

The MANUFACTURER shall be responsible for the co-ordination with ECS SUPPLIER to ensure the proper data transmission between the switchgear assembly and the ECS.

It shall be possible to isolate all incoming ECS controls for maintenance and manual operation.

7. Inspection and testing

7.1 General

All equipment covered by this specification shall be subject to inspection and testing by COMPANY at the SUPPLIER works during manufacture. In certain cases these activities may extend to the SUPPLIER's SUBCONTRACTORS.

Inspection and tests shall be performed in accordance with IEC standards.

7.2 Type tests

Type tests in accordance with the referenced standards shall have been carried out on SUPPLIER's similar equipment and the type test certificates shall be provided with the quotation. When appropriate type test certificates do not exist, tests shall be made at the time of manufacture of the equipment to which this specification refers, subject to agreement by COMPANY.

7.3 Factory acceptance tests

Factory acceptance tests shall be performed by SUPPLIER in the presence of COMPANY representative.

At least the following tests shall be performed:

- Visual check (aspect, painting, finish, welding, sheet metal, lifting ring, assembly bolt torque, busbar bolt torque, conformity of torque values for main connections, lining up of measuring apparatus, handling devices, remote control and signalling, labels)
- Dimension controls (terminals, busbar and wires, leakage path and insulation distance, fixation axis, overall dimensions, weight)
- Check for conformity and existence of name plates, marking labels, notice boards for danger, marking of miscellaneous switchgear, wire marking, terminal marking, earth marking, phase marking with colours and all extra markings depending on specification requirements
- Auxiliary device test
- Check for interchangeability of equipment
- Quality and quantity check for wearable parts and spare parts according to the specification concerned
- Control of protective devices by primary current injection corresponding to the protection setting values (Secondary injection is acceptable when the appropriate relevant certificates of CTs are provided)
- Power-frequency voltage tests on the main circuit
- Dielectric test of main circuits
- Dielectric test of auxiliary circuits
- Mechanical test
- Switchgear electrical operation test
- Insulation resistance measurement
- Check for validation of the interface link with the ECS. The tests will be carried out in accordance with the tools and support (meeting, procedure and documentation) proposed by the ECS MANUFACTURER
- Participation in the Factory Acceptance Tests of the ECS in order to test all the protection and Measurement Management Units (MMU), and the specific functions (restarting, automatic transfer, load-shedding, etc.).

A test report shall be made of the acceptance tests.

7.4 Field tests

Field tests shall be made before the switchgear is energised and/or place in service and include:

- Insulation measurement
- Secondary injection and adjustment of all protective devices
- Interlock and intertrip functions
- No-load operation
- Phase rotation
- Incomer transfer sequences
- ECS interface functions (if applicable).

8. Documentation

Unless otherwise specified in project particular specification, SUPPLIER shall at least provide the following documents:

- Overall arrangement drawing
- Civil work drawing
- One line diagram
- Wiring diagram
- Schematic diagram
- Maintenance and operation instructions
- Spare part list
- Detailed equipment information (technical documentation).

Appendix 1 Gas-insulated switchgear

1. Scope

This appendix covers the specific requirements for the gas-insulated switchgear (GIS) between 24 kV and 36 kV.

2. Reference documents

Paragraph 2 is applicable.

3. Service conditions

Paragraph 3 is applicable.

4. General characteristics

Paragraph 4 is applicable.

5. Construction requirements

5.1 Structure

The switchgear cubicles shall be of prefabricated metal clad, SF6 gas insulated and fixed type as defined in [IEC 60298](#) standard, free standing, floor mounting, flush fronted construction.

Appropriate base frames to provide a substantial foundation for the switchgear installation together with holding bolts, nuts and washers, rails, etc shall be included.

Each cubicle shall be divided in different gastight compartments (busbars, circuit breaker(s)).

Switchgear shall withstand arcing due to an internal fault and shall be type-tested in accordance with the procedure described in annex AA of [IEC 60298 accessibility type A and criteria 1 to 6](#).

The minimum Ingress protection for operating mechanisms (circuit breaker and three-position switches) and low voltage compartment shall be IP 31.

The minimum Ingress Protection for the gas filled enclosure shall be IP 64.

Switchgear shall be self-ventilating and have facilities for extension on both sides

Switchgear shall be designed and constructed to facilitate inspection, cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance.

5.2 Busbars

Busbars shall be installed in separate SF6 gas filled enclosure.

Busbars shall be of the same cross-sectional area through out the switchgear and made of hard drawn bare copper.

Busbars and connections shall be adequately sized, braced and supported to withstand the mechanical forces and thermal effects resulting from the switchgear rated short circuit current.

5.3 Earthing switches

An integrated three-position switch with ON/OFF/Earthed positions shall be provided.

Earthing switch shall include the following locking and safety functions:

- Prevent closing the earthing switch if the switching device is closed, in the service position
- Facility to lock the outside earthing switch control in open or closed position; positions, identified with nameplates of incorruptible type.

5.4 Switching device compartment

Interlocks, covers, etc., shall be provided to prevent incorrect or unsafe operation and to prevent access to live parts.

5.5 Switching devices

Each switching compartment shall be equipped with a vacuum or SF6 circuit breaker.

5.5.1 Secondary wiring: paragraph 5.6.3 is applicable.

5.5.2 Cable terminations: paragraph 5.6.4 is applicable.

5.6 Miscellaneous

Paragraph 5.7 is applicable.

5.7 Specific requirements for gas tightness in switchgear

- The switchgear shall be equipped of a monitoring system of the insulating gas pressure.
- Each compartment shall be equipped with a pressure relief device.
- The relative leakage rate F_{rel} per gas compartment shall be less 1% per year as specified in [IEC 60298](#) Annex GG.3.2
- The time between refilling T shall be at least 10 years as specified in [IEC 60298](#) Annex GG.3.2.

6. Interfaces with ECS

Paragraph 6 is applicable.

7. Inspection and testing

Paragraph 7 is applicable.

8. Documentation

Paragraph 8 is applicable.