

**General Specification for Wind in  
tower Medium Voltage Switchgears**

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Modular, gas-insulated, single busbar scheme 36kV  
(20kA short circuit withstand)

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## **1. - SCOPE**

According to Customer requirements

## 2. - DESCRIPTION – REQUIREMENTS

### General

The aim of this document is to describe gas insulated, medium voltage switchgears, designed to equip indoor HV/MV, indoor down tower substation.

The switchgear shall meet the criteria for indoor A.C. metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV, in compliance with the IEC 62271-200.

In principle, the arrangement shall follow the latest modern engineering practice, in order to ensure optimum continuity and reliability of supply, as well as the safety of the operating staff.

Design shall consider minimum space requirements as well as minimized maintenance.

The switchgear shall be of modular design and minimized dimension gas insulated type (SF6). It is sent in a compact frame, and the switchgear is prepared for a field test.

The switchgear shall be designed for continuous operation under all system operating conditions including sudden change of load and voltage and short circuits within its ratings. The equipment shall be designed to withstand normal operating voltage even if the isolating gas pressure decreases to atmospheric pressure.

All switchgears and material provided with them shall be the standard products of the manufacturer, which are regularly designed, manufactured, tested and serviced.

### System parameters:

|  |             |
|--|-------------|
| Rated Voltage (System Highest Voltage) | 36kV        |
| Frequency                              | 50Hz / 60Hz |
| Type of earthing system                | Any         |
| Nº of Phases                           | 3           |
| System Fault Current (Sym.)            | 20 kA       |

### Service conditions:

Switchgear shall meet the operating conditions, for wind turbine in tower applications, according to the IEC 62271-1 standard where the environment:

- Minimum temperature: -25°C
- Maximum temperature: +40°C
- Altitude: 2000 m
- Maximum relative humidity: 95% (over 24h)

Specific service conditions apart from the ones stated in the above mentioned point must be indicated at tendering stage for specific projects.

### 3. - INTERNATIONAL STANDARDS

The switchgear shall meet the recommendations given in the latest editions of the following standards:

|   |                      |
|---|----------------------|
| Common clauses for HV switchgear standards  | <b>IEC 62271-1</b>   |
| A.C. metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV.                               | <b>IEC 62271-200</b> |
| High Voltage A.C. circuit Breakers  | <b>IEC 62271-100</b> |
| High Voltage A.C. Disconnectors and Earthing switches   | <b>IEC 62271-102</b> |
| Technical grade sulfur hexafluoride (SF6) for use in electrical equipment   | <b>IEC 60376</b>     |
| Guidelines for the checking and treatment of sulfur hexafluoride (SF6) taken from electrical equipment and specification for its re-use | <b>IEC 60480</b>     |
| Degrees of protection for enclosures (IP Code)  | <b>IEC 60529</b>     |
| High Voltage circuit breakers<br>Part 1: Circuit-breakers for voltages above 1 kV and under 52 kV                                       | <b>IEC 60265-1</b>   |

The material and equipment provided by the manufacturer shall be their standard products, which are regularly designed, manufactured, tested and serviced.

## 4. - GENERAL AND FUNCTIONAL UNITS

The switchgear shall be single busbar system. Each cubicle shall have the next compartments:

1. CB compartment – SF6 Gas Insulated Containing:
  - SF6 Circuit Breaker
  - Three position disconnecter (Closed-Open-Ready to earth)
  - MV cable connection bushings
2. MV cable compartment – in open air (all MV parts must be insulated in technologies other than air and/or SF6)
  - MV cables connection points

The switchgear shall be modular type. The shipment of the switchgear must be compact, it is not necessary to connect anything, just plug in. The switchgear must be composed by lineal functions to facilitate the gating.

Gas insulated compartments must be segregated in each cubicle and from cubicle to cubicle by ONYX. The busbar shall be insulated with single phase solid insulators, screwed and earthed through all the switchboard. Making impossible any phase to phase fault and having the same advantages as the Gas insulated busbars systems.

The general degree of protection must be IP-65 for all MV parts and IP3X for the enclosure.

The relative filling pressure must not be higher than 0.3 bar gauge filled. All the cubicles must be factory filled and tested to assure a gas leakage of less than 0.1% per year, sealed pressure system.

SF6 gas used for insulation must comply with IEC 60376 and / or IEC 60480.

The design of the switchgear shall be such as to enable extensions to be added at either right or left side, with the minimum of disturbance to the installed equipment.

Every current-carrying part of the switchgear including isolating switches, busbars, connections and joints shall be capable of carrying its specified rated normal current continuously and in no part shall the temperature rise exceed the values specified in relevant IEC Standards.

Every part of the switchgear shall also withstand without mechanical or thermal damage the instantaneous peak currents and rated short-time currents pertaining to the rated breaking capacity of the switchgear.

### Functional units

Each functional unit shall contain all the elements needed to perform its function.

Each functional unit shall be identified by a label which clearly indicates its functional and electrical characteristics.

The functional units shall be the following:

- Outgoing feeder function. (0 cable raiser recommended, also it could be achieved with I or T functions)
- Incoming feeder function (I load break switch recommended)
- Protection of the LV/MV transformer – D function

## 5. - RATINGS

The busbar shall be fully current rated on the entire length of the GIS.

Ratings of the switchgear must be the next ones

|  |               |
|--|---------------|
| <b>Busbar System</b>                             | Single Busbar |
| <b>Rated Voltage</b>                             | 36kV          |
| <b>N° of phases</b>                              | 3             |
| <b>Power Frequency Withstand Voltage</b>         | 70kV/1min     |
| <b>Lightning impulse withstand Voltage (BIL)</b> | 170kV         |
| <b>Frequency</b>                                 | 50 Hz / 60 Hz |



## 6. - CONSTRUCTION / ARCHITECTURE

### Modular Functions

Considering the special characteristics of the MV collecting networks most commonly used in wind farms, the units that are going to be installed must provide the following functions:

- 0 Outgoing line to the following wind generator (\*)
- I Incoming line from the preceding wind generator (\*\*)
- D Transformer protection

Depending on the number of entrances or exits in each wind turbine, they will be necessary different functional groups.

### Recommended functional groups

The following configurations are based on safety, cost optimisation and space saving.

- End of line turbine: D0
- Intermediate turbine: ID0
- Confluence turbine: IID0

### 0L-Rising Function

Outgoing line to the following wind generator . A rigid riser of cables is recommended for the outgoing line to the following wind generator (0).

The modular switchgear DE-0 can also be used as an outgoing line using two, three or more MV cables per phase.

Every modular switchgear with outgoing line function 0, consists of:

- Metal base frame
- Voltage presence indicator
- MV cable compartment
- bushings for cable connection
- clamps for MV cable fastening.

For safe access to MV cables in the 0 function, the earthing-switch of the following wind generator must be previously earthed.

### Protection function D

DVCAS switchgears are provided with are supplied with a vacuum circuit breaker which complies with the requirements of IEC 62271-100 standard and it also includes a three position disconnecter, which meets the requirements of IEC 62271-102 standard for disconnectors and earthing switches

There are two options, depending on the possibility of riser to busbars through bushings.

Vacuum circuit breaker is placed inside the tank. The three position disconnecter (ON – OFF - EARTHED) is actuated manually by means of a handle to be inserted in the frontal cover (dependent manual operation).

Earthing switch making capacity is assured by the circuit breaker.

Operating mechanism is placed outside the SF6 tank, being easily accessible for its maintenance and checking after removing the cubicle frontal cover.

Any connection of functional units, type I or T, is always performed on the left. In case of no connection on the left of function D, the inner cones must be provided with insulating caps

## Switch-disconnector function I

A modular DVCAS switchgear with a three position switch-disconnector is recommended for the incoming line function from the preceding wind generator in MV networks of wind farms I, because of:

- reduces breakdown time caused by faults
- helps fault detection
- reduces interruptions due to maintenance work
- improves energization works.

For the incoming line from the preceding wind generators, a three position switchdisconnector is advised (I), which is better for the maintenance and the commissioning of wind farms

DVCAS switchgears are provided with a three position switch-disconnector, which meets the requirements of IEC 60265-1 (IEC 62271-103) standard for switches and IEC 62271-102 standard for disconnectors and earthing switches

The architecture of the switch-disconnectors used in DVCAS switchgears is of the 3 position type (closed/opened/ready to earthed), which, by design, avoids the possibility of maloperation.

Any connection to functional units type D is always performed on the right

## Dimensions

All different functional units of the same rated current shall be of the same dimensions. The switchgear dimensions shall not be greater than the following:

| Approx. Dimensions of each cubicle (mm) | WIDTH | HEIGHT | DEPTH |
|---|-------|--------|-------|
| DO                                      | 859   | 1800   | 980   |
| IDO                                     | 1426  | 1800   | 980   |
| IIDO                                    | 1993  | 1800   | 980   |
| ID                                      | 1164  | 1800   | 980   |
| IID                                     | 1731  | 1800   | 980   |
| IIID                                    | 2298  | 1800   | 980   |
| DOO                                     | 1091  | 1800   | 980   |
| DOOO                                    | 1323  | 1800   | 980   |
| IDOO                                    | 1658  | 1800   | 980   |

## 7. - COMPONENTS

### 7.1- Circuit breaker

### 7.2- Disconnecter

### 7.3- Load break switch disconnecter

#### 7.1. - Circuit Breaker

Circuit breakers should be SF6 type. These should use the SF6 gas confirming to IEC for arc quenching.

Electrical characteristics:

- Short-circuit breaking current: 20 kA
- Short-circuit making current: 50 kA

They should be according to IEC 62271-100 standard.

Rated operating sequence must be O-0.3sg-CO-3min-CO. Operating time for opening, breaking and closing, less than 100 ms.

Circuit breaker should be E2 type (electrical, mechanical endurance and capacitor breaking/making ability) according to relevant standard.

Circuit breaker operating mechanism will be outside the SF6 tank and electrically operated. The operating mechanism should consist in the next items.

- Spring system that stores the necessary energy for opening and closing operation.
- Spring charging system (motor operated) that automatically recharges the springs after the main contacts of the CB have closed. (Optional)
- Mechanical “charged-discharged” position indicator for open and close springs.
- Manually operated spring charging system (in case of auxiliary voltage fault).
- Electrical system including: (Optional)
  - Closing coil
  - Tripping coil
  - Anti pumping relay
- Mechanical emergency trip pushbutton.
- Operation counter
- Spring charging indication contact. (motorized optional)
- An “end of spring charging” indication contact.
- Mechanical indicator for Open / Closed position

#### 7.2. - Disconnecter

The disconnecter is a mechanical device which provides, in the open position, an isolating distance. This device is used as a safety element when performing a cable testing or for circuit maintenance purposes because it isolates the circuit from busbar system. The disconnecter is not a manoeuvring device but a safety device, consequently, the disconnecter is always operated with NO LOAD (zero current).

The disconnecter will be placed in between the CB and the busbar system in order to isolate the busbar system from the circuit side.

The disconnecter shall be a three position type, **Closed-Open-Ready to earth**, in order to provide maximum safety and durability:

- Maximum safety because with this technology it is not possible to have the disconnecter in close position (connected to the busbar) and ready to earth position (connected to the earthing system) at the same time. This technology avoids the needs of interlocks between the busbar disconnecter and earthing switch.
- Maximum durability because the making capacity when earthing the line is given by the circuit breaker and not by the disconnecter (refer to “**Earthing the incoming circuits**”). The earthing disconnecter will operate always OFF-LOAD and the making capacity is reached by the breaker, which is designed for these purposes.

The disconnecter must be according to the latest edition of the IEC 62271-102 and shall meet requirements as specified in paragraph 5- RATINGS.

The indication of the position of the disconnecter must be mechanical. This mechanical link must be kinematic chain tested.

The Operating mechanism must be outside the SF6 atmosphere and accessible from the front.

As the disconnecter is a safety device and not for manoeuvring purposes, the local manual operation by the operator is advisable against the remote-electrical one. That is why manual operation will be requested.

The disconnecter must be of single rotation-driving axis both for the disconnecter and the earthing switch. It is mandatory that the operation from "closed to busbar" to "ready to earth" is made in two separate operations, closed – open and open – ready to earth. These are completely independent operations, with two separated operating access.

Spare contacts must be available for the customer for disconnecter position indication; 3NO+3NC must be available.

### ***Earthing of the incoming Circuits***

For a safer earthing of the incoming circuits the next procedure shall be used.

Earthing of the incoming circuits will always be made by means of the 3 position disconnecter and the circuit breaker.

First, the three position disconnecter must be placed in the "ready to earth position". This is an OFF-LOAD operation, in which, the circuit breaker is in open position.

Finally, the incoming line is earthed when the Circuit Breaker is closed. The breaker guaranties the making capacity of the earthing system.

## **7.3. – Load Break Switch Disconnecter**

In the cases where no protection is need and ratings are low, Load Break Disconnecter can be used. The ratings of the Load break switch disconnecter are the next:

- Breaking current: 630A
- Short time withstand current: 20kA/3s

The disconnecter shall be a three position type, **Closed-Open-Ready to earth**, in order to provide maximum safety and durability:

- Maximum safety because with this technology it is not possible to have the disconnecter in close position (connected to the busbar) and ready to earth position (connected to the earthing system) at the same time.

This technology avoids the needs of interlocks between the busbar disconnecter and earthing switch.

Maximum durability because the making capacity when earthing the line is given by the circuit breaker and not by the disconnecter (refer to "***Earthing the incoming circuits***").

## 8. - OPERATION AND INTERLOCKS

Common operations in a substation must be available combining different functional units, such as:

- Connect line to busbar.
- Isolate line from busbar.
- Earth the line.

The interlock system shall prevent any incorrect operation of the circuit breaker, switches and disconnectors.

Mechanical and electromechanical interlocks are preferred over other type of interlocks.

There shall be some interlocks related to the switchgear itself and some other related to all the switchgears in the substation, in order to maintain safety in all operations.

Interlocks related to the switchgear itself:

- DISCONNECTOR
  - Operating handle of the disconnectors can only be removed or inserted once the operation has been completely finished.
  - It is not possible to go from “close” position (disconnecter connected to busbar) to “ready to earth” position (disconnecter connected to earth system) in one operation.
- DISCONNECTOR + CIRCUIT BREAKER
  - Disconnecter only to be operated with the Circuit breaker in open position.
  - Circuit breaker to be maintained in open position while disconnecter is being operated or operating handle is in inserted position.
- EARTHING THE CIRCUIT
  - Line earthed position (disconnecter in earth position and Circuit breaker closed) can never be electrically removed. Circuit breaker can only be opened by means of mechanical pushbutton.
  - Line earthed position must have a key lock to assure earth position in all moments.
  - Access to the cable compartment will only be possible when the circuit is in earthed position.
- ACCESS TO MV CABLE COMPARTMENT
  - It will be impossible to access the MV cable compartment unless the current is conveniently earthed.

## 9. - INSPECTION AND TESTS

Customer has the right to perform checks during manufacturing process, always in accordance with the manufacturer.

### 9.1. - Type Tests.

The switchgear must be type tested according to latest relevant IEC standards. The next type tests might be required during tendering process according to the IEC 62271-200 standards.

- a) Tests to verify the insulation level of the equipment
- b) Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of circuits
- c) Test to prove the capability of the main and earthing circuits to be subjected to the rated peak and the rated short time withstand currents
- d) Test to prove the making and breaking capacity of the included switching devices.
- e) Test to prove the satisfactory operation of the included switching devices (operation and mechanical endurance test)
- f) Test to verify the protection of persons against access to hazardous parts and the protection of the equipment against solid foreign objects (IP protection degree)
- g) Test to verify the strength of gas filled compartments
- h) Tightness test of gas filled compartments
- i) Internal arc test:

GIS technology is designed to reduce at a maximum the internal faults inside the switchgear, in any case, as an option at tendering stage it might be requested that the switchgear is tested against the effects of arcing due to an internal fault (This must be indicated in tendering stage).

If this option is requested the switchgear must be tested as a minimum IAC AFL for 1 sec according to IEC 62271-200.

### 9.2. - Routine Tests.

The switchgear shall be subjected to routine tests as per the latest relevant IEC standards.

The following tests shall be performed at the supplier's factory:

- Visual inspection of: dimensions (according to drawings), painting thickness and adherence, appearance, protection degree, electric devices and polarity of connections.
- Electrical tests for low voltage compartment: dielectric test and voltage drop.
- Dielectric withstand at power frequency for the entire switchgear.
- Voltages drop of main circuit.
- Gas leakage of all cubicles.
- Quality of SF6
- Dew point of the SF6
- Mechanical/electrical operation and cabling of main circuit and auxiliary circuits.

### 9.3. - Site Tests.

It is not necessary to be tested again for the voltage drop test for complete configuration because it is supplied as a compact switchgear from the factory.

The following site tests shall be carried out:

- Visual inspection
- Dielectric withstand at power frequency test for the busbar.
- Complete functional tests.

## 10. - QUALITY REQUIREMENTS

The manufacturer shall give proof of at least 30 years experience in the Medium Voltage equipment field and at least 15 years experience in manufacturing GIS type switchgears.

The manufacturer shall provide objective evidence that they operate an effective and proven quality system appropriate to the scope of supply. The evidence shall be in the form of the ISO 9000 (quality management system) certificate.

The manufacturer shall also provide objective evidence that they operate an environmental friendly manufacturing process in its factory. This evidence shall be in the form of the ISO 14000 (environmental management certificate) certificate.

## 11. - DOCUMENTATION REQUIREMENTS

All the information and documents related to the project shall comply with the latest edition of the IEC 62271-200 standard.

The manufacturer shall submit the following documents at the delivery of the equipments:

- General arrangement.
- Logic diagram, detailed schematic & wiring diagrams and bill of material for each functional unit.
- Tests certificates and test reports.
- Instruction manual including (paper copy):
  - General characteristics of switchgears
  - Civil works
  - Handling, transport and storage
  - Installation
  - Operating instructions
  - Maintenance instructions
- A "USER'S MANUAL" CD including:
  - Catalogue of the switchgears
  - Instruction manual
  - Animation based on 3D drawings and voice to explain how to perform all the operations with the switchgears.
  - Animations based on 3D drawings and voice to explain how to perform all the storage, handling and tests of the switchgears on site.

## General

The switchgear must be suitable for 36 kV rated voltage and specifically conceived for the secondary distribution substations in M.V. with either ring or radial type networks.

The switchgear must have the following general features:

- Rated voltage up to 36kV
- Rated current for single functions of 630A
- Available both in compact and modular versions, extensible or not.
- Compact design with up to 4 functions
- Capable of withstanding immersion for 24 hours.
- Availability of reduced height versions
- Easy installation and operation
- Reduced dimensions
- Internal arc containment 20kA 1s, both in live tanks and cable compartment.
- Internal arc proof classification AFL and AFLR (acc. to IEC 62271-200) as option with
  - rear or side duct
- Simplicity of inspection and maintenance
- Long operational life
- Modularity & Versatility
- Remote operation possible
- External enclosure made of stainless steel AISI 304
- Mechanical interlocks which ensure the exact sequence of operations
- Circuit breaker of vacuum type
- Direct earthing of the switchgear whole structure;
- Total segregation of the live parts, which are contained inside a stainless steel housing, hermetically sealed and filled with gas SF<sub>6</sub>;
- Availability of earthing switches with making capacity;
- Mechanical interlocks, granting the exact sequence of the operations.

The basic units which can be combined together in the modular version are:

- Incoming/outgoing unit with switch disconnecter (I)
- Incoming/outgoing unit with circuit-breaker (D)
- Direct incoming/outgoing unit (0).

It must be also be possible to further extend the configurations by externally connecting with purposed bus-bars several basic units the one to the other, provided that they were initially bought in the extensible version.



The switchgear consists of a stainless steel metal housing, suitably welded in order to assure the sealing of the gas SF6.

The switchgear must fully comply with the IEC 62271-100, IEC 62271-200 and IEC 60694 Standards.

The following Degree of protection against accidental contact and ingress of foreign objects must be assured:

- Main electric circuits IP65
- Fuses compartment IP3X

The switchgear must have the following ratings:

| General electrical/Constructive data                 |         |      |
|--|---------|------|
| Rated voltage  | kV      | 36   |
| Frequency  | Hz      | 50   |
| <b>Insulation level</b>                              |         |      |
| Power frequency withstand voltage                    | kV      | 70   |
| Lightning impulse withstand voltage                  | kV peak | 170  |
| Rated current of the main busbar                     | A       | 630  |
| Short time withstand current                         | kA/s    | 20/3 |
| Short circuit breaking current capacity              | kA      | 20   |
| Short circuit making capacity                        | kA peak | 50   |
| Internal arc withstand IAC AFL (AFLR also available) | kA/1s   | 20   |
| <b>Degree of protection</b>                          |         |      |
| HV compartment                                       | IP      | 65   |
| LV and operating mechanism compartment               | IP      | 3X   |
| SF6 gas pressure at 20°C                             | bar     | 0.3  |

## D function:

| Electrical data of circuit breakers                  |           |         |
|--|-----------|---------|
| Rated voltage  | kV        | 36      |
| Frequency  | Hz        | 50      |
| Insulation level                                     |           |         |
| Power frequency withstand voltage (50-60 Hz/1 min)   | kV        | 70      |
| Lightning impulse withstand voltage (1.2/50 $\mu$ s) | kV peak   | 170     |
| Rated current  | A         | 630     |
| Short time withstand current                         | kA/s      | 20/3    |
| Short circuit breaking current capacity              | kA        | 20      |
| Short circuit making capacity                        | kA peak   | 50      |
| Operation sequence                                   |           |         |
| Electrical endurance                                 | Class     | E2      |
| Mechanical endurance                                 | Class /Op | M1/2000 |

## I function:

| Electrical data                                      |           |         |
|--|-----------|---------|
| Rated voltage  | kV        | 36      |
| Frequency  | Hz        | 50      |
| Insulation level                                     |           |         |
| Power frequency withstand voltage (50 Hz/1 min)      | kV        | 70      |
| Lightning impulse withstand voltage (1.2/50 $\mu$ s) | kV peak   | 170     |
| Switch-disconnector                                  |           |         |
| Rated current  | A         | 630     |
| Electrical endurance                                 | Class /Op | E3/100  |
| Mechanical endurance                                 | Class /Op | M1/1000 |
| Short time withstand current                         | kA/s      | 20/3    |
| Short circuit making capacity                        | kA peak   | 50      |
| Electrical endurance                                 | Class /Op | E3/5    |
| Earthing switch                                      |           |         |
| Short time withstand current                         | kA/s      | 20/3    |
| Short circuit making capacity                        | kA peak   | 50      |
| Electrical endurance                                 | Class /Op | E2/5    |
| Mechanical endurance                                 | Class /Op | M0/1000 |