



HELLENIC ELECTRICITY DISTRIBUTION
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20kV METALCLAD SWITCHGEAR PANELS WITH VACUUM POWER CIRCUIT BREAKERS

1. Object, aim and regulations

The present specification concerns the technical characteristics, the constructional characteristics, the testing and packing of 20 kV metalclad switchgear panels with air insulation (AIS), with drawn-out carriages, with external metallic enclosure and internal metallic compartments, in full correspondence with the category "LSC2B-PM", as this is defined in §3.6.107 and 3.6.104 of IEC 62271-200/2021. The panels shall provide adequate human protection against internal faults (Internal Arc Classification, IAC: AFLR), according to the §7.105 and as defined in department A.A of the above-mentioned standard.

The offered power circuit breakers will be of vacuum type, manufactured and tested in accordance with the last revision of IEC-62271-100. The power circuit breakers will be installed on drawn out carriage, in full correspondence with the term "withdrawable part", as this is defined in §3.5.120 of the IEC 62271-200/2021 standard.

The construction and testing of the panels will be in accordance with this hereby specification and the latest version of the IEC 62271-200 standard. All other components of the panel shall be constructed and tested in accordance with any mentioned HEDNO specifications and relevant IEC standards.

If the requirements of this hereby specification conflict with the requirements of the IEC 62271-200/2021 standard or any other listed standard, the requirements of the present specification shall always prevail.

2. 20 kV System Characteristics

1. Operating Voltage	: 20KV
2. Maximum Operating Voltage	: 24KV
3. Three phase system, Nominal frequency	: 50Hz
4. Method of earthing (grounding)	: through a 12Ω resistor
5. Basic Impulse Insulation Level	: 125KV
6. Power frequency withstand voltage level	: 50Hz, 1min
7. Short-circuit level at the 20kV busbars	: 16kA
8. Auxiliary voltages	: 110V DC, 230V AC

3. Operating conditions

The metalclad switchgear panels shall be suitable for indoor installation and for operation in normal ambient conditions, i.e.:

1. Ambient temperature fluctuation between -5° and $+40^{\circ}\text{C}$, with the mean temperature over 24 hours period not exceeding 35°C .
2. Altitude up to 1000 m.
3. The mean 24-hour humidity does not exceed 95%.

As for the rest, the conditions will be in accordance with the ones defined in §4.1.2 of IEC 62271-1.

4. Panel Types

The metalclad 20kV switchgear panels shall consist of the following panel types:

- TM : Incoming panels from transformers (as described in §8.1)
- BRM : Bus section-Bus Rise panels (as described in §8.2)
- BRMM: Bus section-Bus Rise panels with voltage transformers (as described in §8.2)
- BSM : Bus section panels (as described in §8.2)
- ULM : Underground feeder panels (see §8.3)
- OLM : Overhead feeder panels (see §8.4)
- CM : Capacitor bank feeder panels (see §8.5)
- MM : Voltage metering panels of the bus-bar sections (see §8.6).
- IPPM : Independent Power Producer connection panels (see §8.7)

5. Packing, connections, transportation

- 5.1 The panels should be packed individually, and they will be connected at the site of their installation.
- 5.2 Each panel should be independent of any other and it should be capable for connection with any of the other panels.
- 5.3 Each panel should be self-standing and completely assembled. All the panel components (devices, wiring, etc) should be fastened in the panel in their normal position. HEDNO will be responsible for the materials and the installation work for all outside cabling and connections.
- 5.4 The panels should have undergone complete routine and functional tests before their delivery. In addition, if requested by HEDNO they shall have undergone type testing.
- 5.5 The packing, which will consist of a plastic wrapping and of a wooden frame, should be to provide external protection to the panels, and to all the devices and apparatus inside the panel from corrosion, moisture, damaging, crushing, vibrations or from any other stresses which could be developed during transportation.

6. General Requirements

- 6.1 Each panel should be equipped with metallic cover, covering all its components, protecting humans against accidental contact with live components or moving parts of the panel with IP31D degree of protection as per IEC 60529. An operator, who stands in front of the panel while the door of the panel remains closed, must be able to carry out the tasks mentioned below.

- 6.1.1 Switching operation of the power circuit breaker (ON-OFF) (electrically).
- 6.1.2 Emergency mechanical opening of the circuit breaker, regardless of the position of its carriage.
- 6.1.3 Moving of the circuit breaker carriage from the position of isolation to the operational position and vice versa.
- 6.1.4 Grounding Switch operation.
- 6.1.5 Checking of voltage presence at the cables ends.
- 6.1.6 Verification of the grounding switch position with reliable means.
- 6.1.7 Moving the Voltage Transformer carriage from the position of isolation to the operational position and vice versa.

In the event of human entrance to the inner compartment of the circuit breaker or to the cable area, IP20 protection shall be provided with respect to the other compartments of the panel.

- 6.2 The metallic partitions among the panels must extend to all the depth and height of the panel except from the busbars compartment, which could be uniform per panel block.
- 6.3 The panel should consist of a firm section and of one or two draw out elements inside the metalclad compartments, in complete accordance with the term "withdrawable part" as this is defined in §3.5.120 of IEC 62271-200/2021. One of the withdrawable parts will contain the circuit breaker and the other will contain the voltage transformer (where necessary).

The panels will be accessible from the front (Front accessible) and from the back (Back accessible), free standing and/or wall standing.

- 6.4 The firm section shall be divided to the following metalclad compartments (Partition Class PM, §3.6.107 of IEC 62271-200/2021 standard):

Busbars compartment

Access to the busbars compartment will be achieved by removing the cover with the use of a tool (*«Tool-based accessible compartment» according to §3.5.112 of IEC 62271-200/2021*)

Cable compartment

The compartment includes (apart from the rest) current transformers and the grounding switch, where necessary.

The access is achieved from the back side or the front side of the panel, after mandatory closing of the grounding switch, so as to override the relative mechanical interlocking (*«Interlock-controlled accessible compartment» according to §3.5.110 of IEC 62271-200/2021*).

Power circuit breaker compartment

The access to this compartment is achieved after mandatory withdrawal of the circuit breaker carriage in the position of isolation, to override the relative mechanical interlock (*Interlock-controlled accessible compartment»*).

For the indication of the carriage's position should be provided at least 3 NC and 3 NO auxiliary, free of voltage contacts.

Voltage transformer compartment

The access to this compartment is achieved after mandatory withdrawal of the voltage transformer carriage in the position of isolation, to override the relative mechanical interlock (*Interlock-controlled accessible compartment»*).

For the indication of the carriage's position should be provided at least 3 NC and 3 NO auxiliary, free of voltage contacts.

Low voltage compartment (L.V.)

The compartment contains terminal blocks, metering instruments and Control & Protection Digital Units (CPDUs). Access is possible from the front side of the panel. The area of the auxiliary circuits will have lighting, activated by the opening of the door.

The construction of these panels and of the above-mentioned metalclad compartments should be such so that it will allow access to any M.V. compartment of any panel (except that of the busbars), while the rest of the panels of the group are under voltage (live) and in normal operation.

- 6.5 Access to the busbar area shall be achieved, using simple means, from the front after the removal of the circuit breaker carriage or also the voltage transformers carriage.

The back cover of the panels will be removable and divisible via unbolting, so that independent access to the busbars and cables areas to be possible.

The removal of the back cover of the panel will not require the removal of the air duct and will not uncover the area of the horizontal busbars, which shall have a separate rear, inner or external, cover.

- 6.6 The moving of the carriage from the position of isolation to the operational position and vice versa, will be performed with the door of the corresponding metalclad compartment closed.

- 6.7 Provisions should be made for the convenient coupling and uncoupling of the auxiliary circuits of the firm section of each panel to the auxiliary circuits of the draw-out element (with proper multi-pin connector). When the carriage of the circuit breaker or of the voltage transformer is in position of isolation, their removal from the panel should be possible without any disconnections except that of the multi-pin connector. During maintenance works, a cable extension for the multi-pin connector should be provided.

- 6.8 A handle, and not any bolts, must be used for the closing of the door of the circuit breaker, as well as the low voltage and voltage transformer compartment.

- 6.9 The current transformers (CTs) in OLM, ULM, CM and IPPM panels must be connected between the circuit breaker and the cables side, while in the TM panel they will be connected between the circuit breaker and the 20 kV incoming cables. The secondary windings of all above CTs should be accessible either from back side or the front side.

- 6.10 VTs and CTs will be constructed and tested in accordance with the latest revision of IEC Regulation 61869.

- 6.11 The aforementioned burden values of the included CTs and VTs are indicative. In any case, the Contractor must submit the relevant adequacy study of the VTs and CTs. If different burden values arise from this study, the Contractor must fully comply with the relevant results and supply VTs or CTs with the required burden. Regarding the ratios of the CTs and VTs, any differentiation should be documented by the relevant adequacy study, and it is at the discretion of HEDNO to be accepted.

- 6.12 The busbars must be constructed from hard electrolytic copper. The busbars should be suitable for extension from both sides so that connection is possible with adjacent panels. All necessary materials for the above-mentioned connections should be provided. Inside the busbars area, no element or component that would require any maintenance shall exist. Air would be the insulation medium for the busbars. Vent outlets are allowed only if they do not,

in any way, decrease the protection in the inner panel area or the safety of the personnel.

6.13 Each individual metalclad compartment of the panel (except of the low voltage compartment) must have vent outlets for extinguishing ionized gases. The vent outlets must be located at the top part of the panel.

6.14 Provisions should be made so that the metalclad compartment of the power cables, the 20 kV busbars, the circuit breaker and the voltage transformers (wherever present) of each panel type, possess a light sensor for the detection of internal arcs. The details of these light sensors for the protection of the panels, through detection of electric arcs, are described below in detail in §8.8 of this specification.

6.15 The power cable compartment shall be equipped with a grounding switch, wherever necessary. The cable and grounding switch compartment shall be accessible through a metallic cover, with mechanical locking, to ensure mandatory grounding, before accessing the cable area.

Following access, there should be a capability for operation of the grounding switch, to enable the testing of the cables.

The checking of the position of the grounding switch will be secured externally from the panel with mechanical labelling of high reliability, before accessing the cables area and visually will be achieved by appropriate inspection windows, which shall be installed on the above-mentioned metallic cover. Also, the control of the position of the earthing switch will be ensured through the mimic diagram on the CPDU of the metal-clad panel.

6.16 Every panel will be equipped with all the moving metallic covers, galvanically connected with the rest of the grounded iron construction, which will cover automatically every three-phase group of firm disconnecting contacts, when the draw-out part of the panel is withdrawn. The covers shall be secured in their closed position, without the possibility of a random, or by mistake, partial opening, and would open only during the entrance of the carriage for the reestablishment of the coupling. These covers ensure that all components under live voltage, such as busbars and their branches towards the power circuit breakers, power cable sealing ends (terminations) and their connections towards the corresponding power circuit breakers, shall be inaccessible.

For maintenance purposes, it should be possible to intentionally open the covers after the removal of the corresponding carriage from the area, as well as capability for securing the covers in the closed position.

6.17 All inner metallic partitions, shutters and inspection windows shall be in accordance with the requirements of IEC 62271-200.

6.18 For all the alarms mentioned below, the following shall be foreseen:

- a. A local visual alarm on the CPDU of the metalclad panel.
- b. A remote alarm to the RTU and the Distribution Control Centre (DCC).

6.19 All power circuit breakers shall be controlled remotely, however they could be electrically operated locally, and they shall be equipped with mechanical control switches ON and OFF and mechanical position indicators for "ON" and "OFF" positions, and with an operations counter. There should also be two (2) remote indications for charging-discharging the springs of the power circuit breaker, through two (2) free of voltage contacts, as well as a local visual indication at the CPDU, but only for the discharged springs. For verifying the expiration of the

time required for charging of CB springs, an auxiliary time-relay (OFF-delay-ON) will be provided for Byer's use. The auxiliary relay contacts will change position giving an alarm after a time (t) greater than the time required for charging. Alternatively, the above function can be implemented by the CPDU, without the use of auxiliary relay.

For these operations, there should be foreseen and the relevant indications as defined in §6.18.

For maintenance reasons, the manual opening and closing of the breaker would be possible without the presence of an auxiliary voltage.

In addition, all CBs will be equipped with a coupling prohibition coil or equivalent device.

6.20 The selection of local control - remote control (local-remote) of the CB will be made through the CPDU.

6.21 Each panel will have a circuit health indication for the arming and stopping circuits via the CPDU. In the event of an anomaly in any of these circuits, there will be a corresponding indication on the CPDU and sending a relevant alarm signal to the RTU and the Distribution Control Centre.

6.22 Each panel should be equipped with test sockets of ENTRELEC or CEE make, ESSAILEC type, for the voltage and current circuits, so that short circuiting and isolation of all the secondary winding of the current and voltage transformers and of instruments (where necessary) of the corresponding panel is possible, as well as with test sockets for the protection circuits (current and trip) so that the testing of the CPDUs, with isolation of the current and tripping circuits, is possible. The test sockets will be equipped with suitable covers having metallic safety links.

6.23 All panels should be equipped with terminal blocks for the reception of external "trip" commands for the power circuit breakers, which may originate from external protection systems. In case that the carriage is in the "isolation" position, the external trip commands should be interrupted.

6.24 All auxiliary circuits and whatever motors may be used should be supplied by the following available by HEDNO auxiliary sources.

The control circuits, the circuits for charging the springs of the power circuit breaker, the indication circuits and the circuits for feeding the motor of the circuit breaker:

- Rectifier Batteries system 110V DC
- The available of the Substation, DC voltage will be 110V with fluctuation of $\pm 20\%$.

Heating resistances (if needed)

- From 230/400V supply, 50Hz

6.25 Provisions should be made for an indication whether the end of the cable is under voltage, through capacitive voltage dividers, which will be present in each panel, and will turn on the corresponding indicating lamps of high life expectancy (e.g. LED). For personnel security reasons, there should be full galvanic isolation between any accessible point of the indication lamps from the front side, and the voltage signals to the indicating lamps. In addition, the indicator should provide a way to ensure its proper operation. There will also be contacts for remote indications for "live" cable (§6.18). For these remote telesignals, the absence of even one phase is considered as voltage absence. The voltage absence will be signalized using an auxiliary relay. If one end of the cable is live, it will not be possible to operate the earthing switch.

6.26 Provisions should be made so that all operating levers are locked in the positions CLOSED-OPENED or GROUNDED. Similar provisions should be also made for the draw-out elements. The holes in which the safety locks will be placed must have a diameter of at least 6 mm.

6.27 All non-current carrying metallic parts of the panels must be electrically connected to a copper ground strip of rectangular shape, appropriate for earth fault current of 1 kA.

The strip should be painted green or copper strip with earthing indication in its middle, it should be in an easily accessible area of the panels, and it should be suitable for extension in order to be connected with adjacent panels.

Proper arrangement should exist so that the draw-out elements (circuit breaker or voltage transformers carriage) shall be continuously connected to the ground strip in the operating, isolation and any other in between position, as defined in §6.3.103 of IEC 62271-200/2021.

The shielding of the power cables, the grounding (earthing) of the metering transformers, etc, will be connected to the main grounding bus (strip) directly or through other strips or through flexible copper strips.

The bolted connections of non-current carrying sections within each panel must ensure the electrical continuity. The revolving doors and covers of low voltage areas must be connected with the firm metallic parts by a flexible copper strip of an at least 25mm² cross section.

6.28 All instructions and indicating plates in the panels must be in the Greek language. All text plates must be submitted for HEDNO approval immediately after signing the contract.

The name plates shall contain at least the following elements:

- Name or trademark of the manufacturer
- Type of the panel
- Serial number of the plate
- HEDNO contract number
- Nominal voltage
- Nominal bus current and nominal current of the main circuits
- Nominal current and short circuit withstand level
- Protection class in case of internal fault
- Year of manufacturing

On the front side of the firm section of each panel a removable plate should be placed, on which the Purchaser will mark the characteristics of the bay.

6.29 The identification of the phases (three-phased feeders) of all the elements of the circuits should be distinct with brown, black (or red) and gray colors for the phases, blue of the neutral and green-yellow for the grounding. The above-mentioned sequence shows the sequence of the phases. The corresponding wiring must have corresponding colours and in addition their ends should be equipped with indicating rings or tags according to the wiring drawings.

6.30 All non-current carrying sections of the panel must bear proper metallic plating for anti-rusting protection. The protection of the doors and the covers of the panels should be done after proper preparations with electrostatic paint, of beige colour (RAL 7032) or other color after HEDNO's approval.

6.31 The bolts, nuts and the rest of the fastening components shall be of stainless steel or protected with proper metallic plating.

6.32 The panels must be accompanied by all necessary components and tools for their installation, operation and maintenance.

- 6.33 The auxiliary cables will pass (interconnect) between the panels from their top. All panel's power cables are driven to the back side of the panels, via suitable holes in the floor.
- 6.34 In all panels there will be heating resistors in the LV compartment and in the MV cable compartment due to the humidity present in the area where they will be installed. The heating resistors will be of a suitable type to heat the space evenly and there is no risk of overheating of the equipment (e.g. horizontally placed resistors in a cage or more than one resistor evenly distributed in the same space). Also, the heating resistors will be activated by a thermostat and a hygostat.
- 6.35 Regarding the opening operation of the CB in the event of a fault in the CPDU, an emergency button will be provided, which will give opening commands to the CB without taking into account the hierarchical control levels. This button will be installed on the front of the panel, near the CPDU, and will be covered by an appropriate protective cover to avoid unwanted operations. It will also have a rotary type reset system. Any activation of the "emergency button" will be appropriately indicated on the RTU.
- 6.36 At the bottom of the panels, at the cables' exit, there will be a metal floor cover made of aluminum. This cover in the cable area will be constructed in such a way that it can be placed from the bottom of the panel and covers the entire cables' exit opening. The cover will be divided into two sections along the common axis of the 3 cables, easily removable, and will have holes with a diameter slightly larger than the diameter of the cables. On the edges of each hole there will be a protective plastic reinforced conical lining to prevent the cable from being damaged. Similarly, for panels with six cables, the cover will be divided into three sections with a similar construction. Inside the panel there will be support ("support collars") for adjusting the cables before the terminal boxes.
- 6.37 The strength and robustness of the fastening of all switchboard equipment marking plates should be ensured.

7. Interlocking

The design of the panels should be such to secure the internal mechanical interlockings that will prohibit the following operations, regardless of if they are carried out by mechanical or electrical means:

- 7.1 Moving of the carriage of the circuit breaker from the isolation position or the operating position when the circuit breaker is closed.
- 7.2 Closing the circuit breaker when the carriage is not correctly placed in the terminal position (operation position or isolation position). The closing or opening of the circuiting breaker will be possible when it is placed in the isolating position or has been completely removed from the panel for testing or for maintenance reasons.
- 7.3 Closing of the circuit breaker in the operating position, in case all the auxiliary circuits between the moving and the fixed part are not connected, as well as the disconnection of the auxiliary circuits when the circuit breaker is closed in operating condition (secured for example, by multi-pin connector).
- 7.4 Entrance of the carriage in the operating position when the grounding switch is closed.

- 7.5 Closing of the grounding switch when the movable element has not been removed completely from the isolation position or being outside the panel.
- 7.6 The removal of the metallic cover of the grounding switch area is not permitted to access this area, if the grounding switch is not closed. Operating capability of the grounding switch should exist after the intentional removal of the metallic cover.
- 7.7 Moving of the carriage of the circuit breaker if the door of the circuit breaker compartment is not completely closed.
Note: There shall exist capability for deliberate removal of this interlock.
- 7.8 Opening of the door of the circuit breaker compartment if the carriage is not withdrawn to its isolation position.
Note: There shall exist capability for deliberate removal of this interlock.

It is noted that accessibility to the area of the busbars or in the exit circuits which do not contain sealing ends, is not included in the usual interventions to the interior of the panel and for that reason not secured with interlocks. The access must be possible either externally or from the top part of the panel, with deliberate removing of external or internal parts, by unbolting of their fastening bolts, or also with deliberate removal and relocation (with the use of tools) of internal partitions, which in all other cases of intervention in the interior of the panel provides protection from non-deliberate touch with the live circuits. The danger from the access to the busbars must be specially noted on the corresponding covers or partitions (i.e. Yellow Signal or with the sign "CAUTION BUSBARS").

8. Special requirements for the particular panels.

The required common technical characteristics for all panel types are the following:

- Nominal maximum voltage : 24KV
- Nominal frequency : 50Hz
- Phases : Three (3)
- Power frequency dielectric strength : 50KV for 1min
- Lightning impulse dielectric strength : 125KV peak value
- Nominal busbars current : 1600A
- Busbars short time current : 16kA, 1sec
- Internal Arc Category (IAC) : AFLR
- Peak and duration of internal arc : 16kA, 1sec
- Protection degree according to IEC 60529 : IP31D

The equipment of each panel will be as follows:

8.1. Transformer Incoming Panel (TM)

This panel will include:

a. Busbars

Simple busbars of nominal current of 1600A, with air insulation.

b. Power Circuit Breaker

One (1) three-pole circuit breaker of vacuum, draw-out type, constructed and tested in accordance with IEC 62271-100 standard, the requirements of this hereby specification and with the following technical characteristics:

- Nominal voltage : 24KV
- Nominal frequency : 50Hz

- Nominal current : 1600A
- Nominal insulation level:
 - i) Power frequency withstand voltage 50Hz, 1min
 - Between phases and earth : 50KV
 - Between phases : 50KV
 - Along the circuit breaker's open contacts : 50KV
 - ii) Nominal lightning impulse voltage strength
 - Between phases and earth : 125KV
 - Between phases : 125KV
 - Along the circuit breaker's open contacts : 125KV
- Nominal breaking short circuit current (rms value at 24KV) : 16kA
- Nominal making short circuit current ($2,5 \times I_{\text{short-circuit breaking}}$) : 40kA
- Nominal operating cycle : O-0,3sec-CO-3min-CO
- Nominal short circuit duration : 1sec
- Nominal short circuit current strength (rms value at 24KV) : 16kA
- First pole clearing factor : 1,5
- Nominal peak short circuit current (peak value) : 40kA
- Nominal breaking current of a capacitor bank : 400A
- Mechanical strength category, according to IEC-62271-100 standard: M2
- Electrical strength category, according to IEC-62271-100 standard: E2
- Restrike category for breaking capacitive current according to IEC-62271-100 standard : C2
- Total breaking time : ≤ 4 cycles

Except from the necessary auxiliary contacts for the control and operation circuits and the contacts mentioned in paragraph 6.19, the power circuit breaker will be equipped with at least three (3) spare contacts of "normal closed" type and three (3) spare contacts of "normal open" type for the auxiliary circuits which the Buyer will install.

- ☞ This power circuit breaker will accept tripping commands from the TM Panel's CPDU, from the Transformer's Differential Protection and limited zone relay (through the 30XB relay), any existing Large Earth Faults relays and Small Earth Faults relays, the mechanical protections of the transformer (the 30XA relay) of the transformer's Control and Protection Panel, the Arc Protection, the HV CB in case of its opening (intertrip), etc.

c. Current transformers

Three (3) one-phase current transformers (winding type) with three (3) secondary windings for the supply of the Transformer's Differential Protection and limited zone relay and of the TM Panel's CPDU (for the overcurrent protection and measurements) and the Automatic Voltage Regulator (AVR-APT) of the transformer.

The current transformers must have the following characteristics:

- Transformer ratio : 1500/1-5-5A
- Primary winding nominal thermal current for continuous operation : $1,2 \times I_N = 1800A$
- Nominal short time thermal current : 16kA 1sec
- Nominal dynamic current : 40kA peak value

The first winding 1A will be of class 5P20, burden 15VA and will supply the differential protection relay, the second winding 5A will be class 5P10, burden 15 VA and will supply the CPDU for the needs of overcurrent protection. The third 5A winding will be of class 0,5, FS5 and burden 15VA and will provide measurements to the AVR.

These apply in the case where the TM Panel is to be installed in a substation with a differential protection scheme for the transformer. In the case where the TM Panel is to be installed in a substation with an extended differential scheme for the transformer, then the above 1A winding is not required.

In the case where the TM Panel is to be installed in a substation with distinct differential and Limited Zone relays, then the CTs must also have a fourth 1A winding, class 5P10 and power 15 VA.

All the above secondary windings of the CTs will be of star connection.

d. CPDU

A Control & Protection Digital Unit / Multifunctional Relay (CPDU), according to TD NMID-417.

The feeding of the CPDU will be via independent mcb including auxiliary contact.

e. Grounding arrangement

One (1) grounding switch on the cable's side, according to IEC-62271-102 standard. The grounding switch will have nominal making short circuit current of 16 kA for 1 sec. Except from the necessary auxiliary contacts for the control and operation circuits, each grounding switch shall be equipped with at least three (3) spare "NC" contacts and three (3) "NO" contacts for the auxiliary circuits that the Buyer will install. It will also have, except from the above-mentioned contacts, two (2) "NO" leading contacts, which will close after the switching action, but before the grounding is achieved, so as a trip command for 150KV CB to be produced.

The grounding switch will also have a 110V DC blocking coil. When this coil is not under voltage, it will not allow the closing of the grounding switch. Provisions should be made for the possibility of deliberate removal of this interlock from the outside of the panel.

f. Sealing ends (cable terminations)

Nine (9) single-pole sealing ends for cables (3 per phase), complete with all their components, suitable for the termination of 24kV, single phase, copper, 500mm² cross-section, XLPE insulation cables.

g. Voltage transformers

Three (3) single-phase VTs 20/√3:0.1/√3-0.1/√3-0.1/3 kV.

The first and second windings will be of accuracy class 0.5 and rated power 15 VA and will be connected to the CPDU for measurements as well as to the AVR of the transformer respectively. The third winding will be an open delta winding, will have protection class 3P and rated power 15VA.

It is noted that appropriate schemes will be provided to protect the VTs from ferroresonance phenomena.

The transformers will be of case resin, indoor type, according to IEC 61869-3 standard and with rated continuous overvoltage factor U=1.2.

The voltage transformers will be placed on a carriage, inside a separate metalclad compartment and their primary windings will be protected with

fuses of high melting power. These fuses will be placed in such a position that will guarantee the easy replacement of their cartridges.

The secondary windings of the voltage transformers will also be protected by a three phase 2A micro-switch with "NO" position contacts, as mentioned in §6.18.

The removal of the carriage of the VTs and the change of the fuses will be possible, without interrupting the voltage of the busbars (busbars are supplied by the incoming panel), or the voltage of the incoming cables or de-energisation of any other M.V. element of the panel.

There will be at least three NO and three NC contacts for indications of the voltage transformer's carriage (in-out).

The operation of removal of the voltage transformers, as well as the replacement of the fuses should be performed after securing the following safety conditions:

- Secure their isolation from the M.V. circuit
- In case of human entrance to the inner compartment of the voltage transformers, this space shall be metalcladed and provide protection against accidental contact with under voltage elements of class IP20.

8.2. Busbars section panels (BSM+BRM or BRMM)

For the 20 kV busbars section, two (2) panels will be foreseen. One of the panels will be BSM type and the other will be BRM or BRMM type.

I. The **BSM panel will include:**

a. Busbars

Simple busbars of 1600 A nominal current, with air insulation.

b. Power Circuit Breaker

One (1) three phase power circuit breaker of vacuum, withdrawable type, manufactured and tested according to IEC-62271-100, the requirements of this hereby specification and the following technical characteristics:

- Nominal voltage : 24KV
- Nominal frequency : 50Hz
- Nominal current : 1600A
- Nominal insulation levels:
 - i) Power frequency voltage withstand 50Hz, 1min
 - Between phases and earth : 50KV
 - Between phases : 50KV
 - Along the circuit breaker's open contacts : 50KV
 - ii) Nominal lightning impulse voltage withstand
 - Between phases and earth : 125KV
 - Between phases : 125KV
 - Along the circuit breaker's open contacts : 125KV
- Nominal breaking short circuit current (rms value at 24KV) : 16kA
- Nominal making short circuit current ($2,5 \times I_{\text{short-circuit breaking}}$) : 40kA
- Nominal operating cycle : O-0,3sec-CO-3min-CO
- Nominal short circuit duration : 1sec
- Nominal short circuit short duration current strength (rms value at 24KV) : 16kA
- First pole clearing factor : 1,5
- Nominal peak short circuit current (peak value) : 40kA

- Nominal breaking current of a capacitor bank : 400A
- Mechanical strength category, according to IEC-62271-100 standard: M2
- Electrical strength category, according to IEC-62271-100 standard: E2
- Restrike category at the breaking of capacitive current according to IEC-62271-100 standard : C2
- Total breaking time : ≤ 4 cycles

➤ This CB will accept tripping commands from the Panel's CPDU, from the Earth Fault Low relay (EFL), from the Arc Protection as well as from the extended and limited-zone differential protection of the transformer.

Except from the necessary auxiliary contacts used in the control and the operation circuits and the contacts which are mentioned in paragraph 6.19, the circuit breaker will be equipped with at least three (3) spare contacts of "NO" type and three (3) spare contacts of "NC" type for the auxiliary circuits which shall be installed by the Buyer.

c. Current transformers

The BSM panel will have three (3) single phase CTs of ratio 1500 / 5A, class 5P10 and burden 15 VA to supply the CPDU of the panel to perform the overcurrent function and take measurements, with the following characteristics.

- Continuous operation primary winding nominal thermal current : $I/I_p = 1,2$ continuously
- Nominal short time thermal current : 16kA 1sec
- Nominal dynamic current : 40kA peak value

In case the BSM Panel is to be installed in a substation with an extended differential protection scheme for the transformer, two additional 1500/1.25A, 5P20, 15VA windings are required to supply the differential protection relays of the two transformers on either side.

d. CPDU

A Control & Protection Digital Unit / Multifunctional Relay (CPDU), according to TD NMID-417/October 2021.

The feeding of the CPDU will be via independent mcb including auxiliary contact.

- e. An auxiliary time relay will be provided with a time delay of 1÷5min used for giving local and also a remote alarm, in case that the power circuit breaker of BSM panel and the power circuit breakers of the two (2) TM panels connected in its both sides are closed simultaneously for a corresponding period of time.

It should be considered that the carriage of the CBs will be in operating position.

II. The BRM panel will include:

a. Busbars

Simple busbars of 1600A nominal current, with air insulation for the rising of the busbars and their connection with the busbars of the adjacent panel.

b. One withdrawable carriage.

A locking coil should be provided to prevent the carriage from being disconnected when the CB of the corresponding BSM is connected to the busbars and closed.

III. The BRMM panel will include:

a. Busbars

Simple busbars of 1600A nominal current, with air insulation for the rising of the busbars and their connection with the busbars of the adjacent panel.

b. One withdrawable carriage.

A locking coil should be provided to prevent the carriage from being disconnected when the CB of the corresponding BSM is connected to the busbars and closed.

c. Voltage transformers

Three (3) single-phase VTs $20/\sqrt{3}:0.1/\sqrt{3}-0.1/3$ kV. The first winding, that will be used for measurements, will be of accuracy class 0,5 and rated burden 15 VA. The second winding will be an open triangle winding, of protection class 3P and rated burden 15VA.

It is noted that appropriate schemes will be provided to protect the VTs from ferroresonance phenomena.

The transformers will be of case resin, indoor type, according to IEC 61869-3 standard and with rated continuous overvoltage factor $U=1.2$.

The voltage transformers will be placed on a carriage, inside a separate metalclad compartment and their primary windings will be protected with fuses of high melting power. These fuses will be placed on such a position that will guarantee the easy replacement of their cartridges.

The secondary windings of the voltage transformers will also be protected by a three phase 2A micro-switch with "NO" position contacts, as mentioned in §6.18.

The removal of the carriage of the VTs and the change of the fuses will be possible, without interrupting the voltage of the busbars (busbars are supplied by the incoming panel), or the voltage of the incoming cables or de-energisation of any other M.V. element of the panel.

There will be at least three NO and three NC contacts for indications of the voltage transformer's carriage (in-out).

The operation of removal of the voltage transformers, as well as the replacement of the fuses, should be performed after securing the following safety conditions:

- Secure their isolation from the M.V. circuit
- In case of human entrance to the inner compartment of the voltage transformers, this space shall be metalcladed and provide protection against accidental contact with under voltage elements of class IP20.

In case the BSM Panel is interconnected with the BRM or BRMM Panel via a cable, then both types of Panels will additionally have the following:

a. Earthing device

One (1) earthing switch on the cable side, in accordance with the applicable IEC 62271-102 regulations. The earthing switch will have a rated short-circuit making current of 16kA for 1s. In addition to the necessary auxiliary contacts for the control and operating circuits, each earthing switch shall be equipped with at least 3 spare contacts of the "NC" type and 3 "NO" type for auxiliary circuits to be installed by the Purchaser. It shall also have, in addition to the

above, two (2) "NO" advance contacts, which shall close after the earthing switch switching operation has begun, but before the earthing is carried out. The earthing switch shall also have a 110V DC blocking coil. When this coil is not energized, it shall not allow the earthing switch to be coupled. However, provisions shall be made for the possibility of intentionally cancelling this locking from the outside of the panel.

b. Terminal Blocks

Nine (9) single-pole cable terminal blocks (3 per phase), complete with all their accessories, suitable for terminating single-pole 24kV, copper, 500mm² cross-section cables with XLPE insulation.

8.3. Underground feeder panels (ULM)

Each panel will include:

a. Busbars

Simple busbars of 1600A nominal current, with air insulation.

b. Circuit breaker

One (1) three phase power circuit breaker of vacuum, withdrawable type, manufactured and tested according to IEC 62271-100, the requirements of this hereby specification and the following technical characteristics:

- Nominal voltage : 24KV
- Nominal frequency : 50Hz
- Nominal current : 630A
- Nominal insulation levels:
 - i) Power frequency voltage withstand 50Hz, 1min
 - Between phases and earth : 50KV
 - Between phases : 50KV
 - Along the circuit breaker's open contacts : 50KV
 - ii) Nominal lightning impulse voltage strength
 - Between phases and earth : 125KV
 - Between phases : 125KV
 - Along the circuit breaker's open contacts : 125KV
- Nominal breaking short circuit current (rms value at 24KV) : 16kA
- Nominal making short circuit current (2,5× I_{short-circuit breaking}) : 40kA
- Nominal operating cycle : O-0,3sec-CO-3min-CO
- Nominal short circuit duration : 1sec
- Nominal short circuit short duration current strength (rms value at 24KV) : 16kA
- First pole clearing factor : 1,5
- Nominal peak short circuit current (peak value) : 40kA
- Nominal breaking current of an uncharged cable : 31,5A
- Mechanical strength category, according to IEC-62271-100 standard: M2
- Electrical strength category, according to IEC-62271-100 standard: E2
- Restrike category at the breaking of capacitive current according to IEC-62271-100 standard : C1
- Total breaking time : ≤ 4 cycles

Except from the necessary auxiliary contacts, which are used for the control and operation circuits and the contacts which are mentioned in paragraph

6.19, the circuit breaker will be equipped with at least three (3) spare contacts of "NO" type and three (3) spare contacts of "NC" type for the auxiliary circuits which shall be installed by the Buyer.

- ☛ This power circuit breaker will accept tripping commands from the CPDU of the ULM panel, from the Arc Protection as well as from the extended differential and limited-zone protection of the transformer

c. Current transformers for the supply of the CPDU

Three (3) current transformers with one (1) secondary winding and with the following characteristics:

- Transformation ratio : 400-600/5A.
- Accuracy class and output power : 5P20, 15VA.
- Primary winding's nominal thermal current for continuous operation : $1,2 \times I_N$

In case the ULM Panel is to be installed in a substation with an extended differential protection scheme for the transformer, then one additional 600/0.5A, 5P20, 15VA winding is required to supply the differential protection relay of the transformer.

d. CPDU

A Control & Protection Digital Unit / Multifunctional Relay (CPDU), according to TD NMID-417.

The feeding of the CPDU will be via independent mcb including an auxiliary contact.

e. Grounding arrangement

One (1) grounding switch on the cable's side, according to IEC-62271-102 standard. The grounding switch will have nominal making short circuit current of 16 kA for 1 sec. Except from the necessary auxiliary contacts for the control and operation circuits, each grounding switch shall be equipped with at least three (3) spare "NC" contacts and three (3) "NO" contacts for the auxiliary circuits, which the Buyer will install, as well as two contacts of leading "NO" type for closing the grounding switch. The earthing switch must also have a blocking coil, 110V DC. When this coil is not energized, the earthing switch will not be allowed to be connected, but provision will also be made for the possibility of intentionally undoing this locking.

f. Three (3) single pole sealing ends (cable terminations) (one per phase), complete, with all its components, suitable for the termination of 12/20kV cables, 240mm², aluminum with XPLE insulation (e.g. heat shrinkable sealing ends).

It should be noted that panels equipped with three (3) single pole sealing ends must have enough free space for future addition of three more single pole sealing ends (cable terminations).

8.4. Supplying panels of overhead feeders (OLM)

Each panel will contain:

a. Busbars

Simple busbars of 1600A nominal current, with air insulation.

b. Power Circuit Breaker

One (1) three phase power circuit breaker of vacuum, withdrawable type, manufactured and tested according to IEC 62271-100, the requirements of this hereby specification and with the following technical characteristics:

- Nominal voltage : 24KV
- Nominal frequency : 50Hz
- Nominal current : 630A
- Nominal insulation levels:
 - i) Power frequency voltage withstand 50Hz, 1min
 - Between phases and earth : 50KV
 - Between phases : 50KV
 - Along the circuit breaker's open contacts : 50KV
 - ii) Nominal lightning impulse voltage withstand
 - Between phases and earth : 125KV
 - Between phases : 125KV
 - Along the circuit breaker's open contacts : 125KV
- Nominal breaking short circuit current (rms value at 24KV) : 16kA
- Nominal making short circuit current ($2,5 \times I_{\text{short-circuit breaking}}$) : 40kA
- Nominal operating cycle : 0-0,3s-CO-15s-CO-15s-CO
- Nominal short circuit duration : 1sec
- Nominal short circuit short duration current capability (rms value at 24KV) : 16kA
- First pole clearing factor : 1,5
- Nominal peak short circuit current (peak value) : 40kA
- Nominal breaking current of uncharged line : 10A
- Mechanical strength category, according to IEC-62271-100 standard: M2
- Electrical strength category, according to IEC-62271-100 standard: E2
- Restrike category for breaking capacitive current according to IEC-62271-100 standard : C1
- Total breaking time : ≤ 4 cycles

Except from the necessary auxiliary contacts, which are used for the control and operation circuits and the contacts which are mentioned in paragraph 6.19, the circuit breaker will be equipped with at least three (3) spare contacts of "NO" type and three (3) spare contacts of "NC" type for the auxiliary circuits which shall be installed by the Buyer.

- ➡ This power circuit breaker will accept tripping commands from the CPDU of the OLM panel, from the Arc Protection, as well as from the extended differential and limited-zone protection of the transformer.

c. Current transformers for the supply of CPDU

Three (3) current transformers with one (1) secondary winding and with the following characteristics:

- Transformation ratio : 400-600/5A.
- Accuracy class and output power : 5P20, 15VA.
- Primary winding's nominal thermal current for continuous operation : $1,2 \times I_N$

In case the OLM Panel is to be installed in a substation with an extended differential protection scheme for the transformer, then one additional 600/0.5A, 5P20, 15VA winding is required to supply the differential protection relay of the transformer.

d. CPDU

A Control & Protection Digital Unit / Multifunctional Relay (CPDU), according to TD NMID-417.

The feeding of the relay will be via independent mcb including auxiliary contact.

e. Grounding arrangement

One (1) grounding switch on the cable's side, according to IEC-62271-102 standard. The grounding switch will have nominal making short circuit current of 16 kA for 1 sec. Except from the necessary auxiliary contacts for the control and operation circuits, each grounding switch shall be equipped with at least three (3) spare "NC" contacts and three (3) "NO" contacts for the auxiliary circuits, which the Buyer will install, as well as two contacts of the leading "NO" type.

The grounding switch will also have a 110V DC blocking coil. When this coil is not under voltage it will not allow the closing of the grounding switch. Provision should be made for the possibility of deliberate removal of this interlock.

f. Three (3) single pole sealing ends (cable terminations) (one per phase), complete, with all its components, suitable for the termination of 12/20kV cables, 240mm², aluminum with XPLE insulation (e.g. heat shrinkable sealing ends).

It should be noted that panels equipped with three (3) single pole sealing ends must have enough free space for future addition of three more single pole sealing ends (cable terminations).

g. Application of Sensitive Earth Fault (SEF)

Protection scheme to MV overhead lines. For the application of this scheme, special toroidal CTs (Core Balance CTs) will be used, according to the TD ND-NMID-418/October 2021, that will be placed preferably inside the department of power cable connection of OLM panel (if this is possible by the distances of OLM panel).

8.5. Panels supplying capacitors (CM)

Each capacitor panel is designated to supply three (3) three-phase capacitor banks 4,3MVar, 21KV, each connected double-wye ungrounded star (in total 12,9MVar). For the switching of each capacitor bank there will be used a capacitive load switch, as well as a series reactor of inductance of 80μH per phase, which will be used for suppressing the inrush currents of the capacitors.

Between the neutrals of each capacitor bank, a CT of ratio 40/5 A, accuracy class 5P10 and power output 15VA is installed, which is used for the protection of the bank against unbalance current. The power circuit breaker of the CM panel is used for protection against any type of short circuit, covering the distance from the entry of the cable to the capacitor banks themselves.

The CM panel will contain:

a. Busbars

Simple busbars of 1600A nominal current, with air insulation.

b. Power Circuit Breaker

One (1) three-phase power circuit breaker of vacuum type, withdrawable type, suitable for switching the capacitor banks and for fault current interruption, manufactured and tested according to IEC 62271-100, the

requirements of this hereby specification and the following technical characteristics:

- Nominal voltage : 24KV
- Nominal frequency : 50Hz
- Nominal current : 630A
- Nominal insulation levels:
 - i) Power frequency voltage withstand 50Hz, 1min
 - Between phases and earth : 50KV
 - Between phases : 50KV
 - Along the circuit breaker's contacts : 50KV
 - ii) Nominal lightning impulse voltage withstand
 - Between phases and earth : 125KV
 - Between phases : 125KV
 - Along the circuit breaker's contacts : 125KV
- Nominal short circuit breaking current (rms value at 24KV) : 16kA
- Nominal short circuit making current ($2,5 \times I_{\text{short-circuit breaking}}$) : 40kA
- Nominal operating cycle : O-0,3sec-CO-3min-CO
- Nominal short circuit duration : 1sec
- Nominal short circuit short duration current capability (rms value at 24KV) : 16kA
- First pole clearing factor : 1,5
- Nominal peak short circuit current (peak value) : 40kA
- Nominal breaking current of capacitor bank : 400A
- Mechanical strength category, according to IEC-62271-100 standard: M2
- Electrical strength category, according to IEC-62271-100 standard: E2
- Restrike category for the capacitive currents according to IEC-62271-100 standard : C2
- Total breaking time : ≤ 4 cycles

Except from the necessary auxiliary contacts, which are used for the control and operation circuits and the contacts which are mentioned in paragraph 6.19, the circuit breaker will be equipped with at least three (3) spare contacts of "NO" type and three (3) spare contacts of "NC" type for the auxiliary circuits which shall be installed by the Buyer.

This power circuit breaker will accept tripping commands the CPDU of the panel, from the capacitor bank's current unbalance relay, from the Arc Protection, as well as from the extended differential and limited-zone protection of the transformer.

c. Current transformers for the supply of the CPDU

Three (3) current transformers with one secondary winding and with the following characteristics:

- Transformation ratio : 200-400/5A.
- Accuracy class and output power : 5P20, 15VA.
- Primary winding's nominal thermal current for continuous operation : $1,2 \times I_N$

In case the CM Panel is to be installed in a substation with an extended differential protection scheme for the transformer, then an additional 600/0.5A, 5P20, 15VA winding is required to supply the differential protection relay of the transformer.

d. CPDU

A Control & Protection Digital Unit / Multifunctional Relay (CPDU), according to TD NMID-417.

The feeding of the relay will be via independent mcb including auxiliary contact.

e. Current unbalanced relays

Regarding the current unbalance protection and the control of the MV capacitor banks, this can be incorporated in the CPDU of the CM panel or can be performed by another device/CPDU that satisfies the requirements of TD-40/3 technical description, as well as of paragraph 15 (regarding the communications) of the technical description NMID-417.

The CPDU's local user interface shall have a clear graphical display of the mimic diagram and the measurements of the capacitor's banks. The CPDU will also have function keys/push buttons for navigation on the menu and push buttons for control (e.g. Vacuum Capacitor Switches OPEN & CLOSE, LOCAL & REMOTE CONTROL).

Regarding the digital inputs and outputs, the CPDU must have at least ten (10) inputs and eleven (11) outputs.

The 20 kV bank capacitor's unbalance CPDU will include phase overcurrent protections of definite and inverse time (ANSI 50/51), supporting at least two (2) stages of definite and one (1) stage of inverse time.

The current measurements will be supplied by the CTs in the common node of each capacitor bank.

In the case of stimulation of an energized protection element, the CPDU will send a trip command to the opening coil of the corresponding capacitor bank's switch. Furthermore, after programmable time delay, the CPDU will send trip command to the coil of the CB of the CM Panel.

f. Grounding arrangement

One (1) grounding switch on the cable's side, according to IEC-62271-102 standard. The grounding switch will have nominal making short circuit current of 16 kA for 1 sec. Except from the necessary auxiliary contacts for the control and operation circuits, each grounding switch shall be equipped with at least three (3) spare "NC" contacts and three (3) "NO" contacts for the auxiliary circuits, which the Buyer will install. The grounding switch should also have a 110V DC blocking coil, which will be controlled by a timing relay, so that the coupling of the grounding switch should not be allowed unless a time of 5 mins has elapsed after the opening of the power circuit breaker.

g. Three (3) single pole sealing ends (cable terminations) (one per phase), complete, with all its components, suitable for the termination of 12/20kV cables of 240mm² in cross section, aluminium with XPLE insulation (e.g. heat shrinkable sealing ends).

It should be noted that panels equipped with three (3) single pole sealing ends must have enough free space for future addition of three more single pole sealing ends (cable terminations).

8.6. Busbars Voltage Metering Panel (MM)

This panel will include:

a. Busbars

Simple busbars of 1600A nominal current, with air insulation.

b. Voltage transformers

Three (3) single-phase VTs $20/\sqrt{3}:0.1/\sqrt{3}-0.1/3$ kV. The first winding, that will be used for measurements, will be of accuracy class 0.5 and rated burden 15 VA. The second winding will be an open triangle winding, of protection class 3P and rated burden 15VA.

It is noted that appropriate schemes will be provided to protect the VTs from ferroresonance phenomena.

The transformers will be of case resin, indoor type, according to IEC 61869-3 standard and with rated continuous overvoltage factor $U=1.2$.

The voltage transformers will be placed on a sliding carriage, inside a separate metalclad compartment and their primary windings will be protected with fuses of the melting type of high power. These fuses will be placed on a position that will guarantee the easy replacement of their M.V. cartridges.

The secondary windings of the voltage transformers will also be protected by a three-phase miniature circuit breaker with "NO" contacts, for indications mentioned in §6.18.

The removal of the carriage of the VT and the replacement of its fuses will be possible, without voltage interruption of the busbars (which are supplied by the TM panel), or the voltage of the incoming cables or de-energisation of any other M.V. element of the panel.

There will be at least two contacts for remote indication of the two positions of the voltage transformer's carriage (in-out).

The operation of removing the voltage transformers, as well as the replacement of the fuses should be performed after ensuring the following safety conditions:

- Secure their isolation from the M.V. circuit
- In case of human entrance to the inner compartment of the voltage transformers, this space must be metalcladed and it should provide protection against accidental contact with under voltage elements of class IP20.

8.7. Independent Power Producer Panel (IPPM)

Each panel will include:

a. Busbars

Simple busbars of 1600A nominal current, with air insulation.

b. Power Circuit Breaker

One (1) three-phase power circuit breaker of vacuum, withdrawable type, manufactured and tested according to IEC 62271-100, the requirements of this hereby specification and the following technical characteristics:

- Nominal voltage : 24KV
- Nominal frequency : 50Hz
- Nominal current : 630A
- Nominal insulation levels:
 - i) Power frequency voltage withstand 50Hz, 1min
 - Between phases and earth : 50KV
 - Between phases : 50KV
 - Along the circuit breaker's open contacts : 50KV
 - ii) Nominal lightning impulse voltage withstand

- Between phases and earth : 125KV
- Between phases : 125KV
- Along the circuit breaker's open contacts : 125KV
- Nominal short circuit breaking current (rms value at 24KV) : 16kA
- Nominal short circuit making current ($2,5 \times I_{\text{short-circuit breaking}}$) : 40kA
- Nominal operating cycle :
O-0.3sec-CO-15sec-CO-15sec-CO for overhead line
O-0.3sec-CO-3min-CO for underground feeder
- Nominal short circuit duration : 1sec
- Nominal short circuit short duration current capability (rms value at 24KV) : 16kA
- First pole clearing factor : 1,5
- Nominal peak short circuit current (peak value) : 40kA
- Nominal breaking current of uncharged line : 10A
- Nominal breaking current of uncharged cable : 31,5A
- Mechanical strength category, according to IEC-62271-100 standard : M2
- Electrical strength category, according to IEC-62271-100 standard : E2
- Restrike category for interrupting of capacitive current, according to IEC-62271-100 standard : C1
- Total breaking time : ≤ 4 cycles

Except from the necessary auxiliary contacts, which are used for the control and operation circuits and the contacts which are mentioned in paragraph 6.19, the circuit breaker will be equipped with at least three (3) spare contacts of "NO" type and three (3) spare contacts of "NC" type for the auxiliary circuits which shall be installed by the Buyer.

- This power circuit breaker will accept tripping commands from the CPDU of the IPPM panel, from the Arc Protection as well as from the extended differential and limited-zone protection of the transformer.

c. Current transformers for supplying the CPDU and for energy clearing measurements

Three (3) current transformers manufactured and tested according to the latest revision of the IEC-61869 standard, with the following characteristics:

- Transformation ratio:
400-600/5-5-5(A).
- Accuracy class:
5P20 for overcurrent protection,
0.2s for measuring the energy exchanged - main measurement,
0.2s for measuring the energy exchanged - crosscheck
- Output power:
15VA, 15VA, 15VA

In case the IPPM Panel is to be installed in a substation with an extended differential protection scheme for the transformer, then one additional 600/0.5A, 5P20, 15VA winding is required to supply the differential protection relay of the transformer.

d. Voltage transformers

Three (3) single-phase VTs $20/\sqrt{3}:0.1/\sqrt{3}-0.1/\sqrt{3}-0.1/3$ kV. The two windings will be used for measurement, will have accuracy class 0.5 and rated burden 15 VA. The VTs of the IPPM panels will have a third winding, which will be an open triangle winding of protection class 3P and of rated burden 15 VA and appropriate schemes will be provided to protect the VTs from ferroresonance phenomena.

The voltage transformers will be manufactured and tested according to the last revision of IEC 61869 Standard.

The voltage transformers will be placed on a carriage, inside a separate metalclad compartment and their primaries will be protected with fuses of the melting type and of high power. These fuses will be placed in such a position that will guarantee the easy replacement of their M.V. cartridges.

The secondary windings of the voltage transformers will also be protected by a three-phase miniature circuit breaker with "NO" contacts, for indications mentioned in §6.18.

The removal of the carriage of the VTs and the replacement of its fuses of the primary winding will be possible, without interrupting busbars voltage (busbars are supplied by the incoming panel), or the voltage at the incoming cables or de-energisation of any other M.V. element of the panel. There will also be at least two (2) remote indication contacts for the two (2) positions of the voltage transformer's carriage (in-out).

The operation of the removal of the voltage transformers and of the replacement of the fuses should be carried out after ensuring the following safety conditions:

- The above-mentioned operations will not be possible before securing the isolation of the voltage transformers from the M.V. circuit.
- In case of human entrance to the inner compartment of the voltage transformers, this space must be metalcladed and it should provide protection against accidental contact with under voltage elements of class IP20.

e. CPDU

A Control & Protection Digital Unit / Multifunctional Relay (CPDU), according to TD NMID-417.

The feeding of the relay will be via independent mcb including auxiliary contact.

f. Grounding arrangement

One (1) grounding switch on the cable's side, according to IEC-62271-102 standard. The grounding switch will be fast and of safe with nominal making short circuit current of 16kA for 1sec.

Except from the necessary auxiliary contacts for the control and operation circuits, each grounding switch shall be equipped with at least three (3) spare "NC" contacts and three (3) "NO" contacts for the auxiliary circuits, which the Buyer will install. In addition to the above, the grounding switch will have two (2) leading contacts of "NO" type, which will close after the beginning of the making of the grounding switch, but before the grounding is achieved.

The grounding switch will be equipped with a 110V DC blocking coil. When the coil is not under voltage, the coupling of the switch shall be prohibited, but provisions will be made for the ability to deliberately undo this interlocking from the outside of the panel.

g. Sealing ends (cable terminations)

Six (6) single-pole sealing ends (cable terminations) (two per phase), complete, with all their components, suitable for the termination of 24kV aluminium cables, 240mm², with XLPE insulation. It should be noted that the panels must have enough free space for future addition of three more single-pole sealing ends.

h. Application of Sensitive Earth Fault (SEF)

In the case of IPPM Panels connected to overhead MV feeders, a protection scheme against low earth faults (Sensitive Earth Fault - SEF) will be applied. For the application of this scheme, special toroidal CTs (Core Balance CTs) will be used, according to the TD ND-NMID-418, that will be placed preferably inside the compartment of power cable connection of IPPM panel (if this is possible by the distances of IPPM panel).

8.8. Protection of the panels against internal arc

Each panel block composed indicatively of:

- One (1) TM panel
- Ten (10) OLM or ULM or IPPM or CM panels or a combination of them
- One (1) BSM panel
- One (1) BRM panel and one (1) MM panel or one (1) BRMM panel

will be protected by an arc detection system, whose operation is described in the present paragraph.

For the implementation of the system, the installation of light sensors is necessary in the separate metalclad compartments of each panel, as follows:

- OLM, ULM, CM panels

One sensor in the cable compartment, one sensor in the 20kV busbars compartment, and one sensor in the circuit breaker compartment.

- TM, IPPM panels

One sensor in the power cable compartment, one sensor in the 20kV busbars compartment, one sensor in the circuit breaker compartment and one sensor in the voltage transformer compartment.

- BSM and BRM/BRMM panels

BSM Panel: One (1) sensor in the upper busbar compartment, two (2) sensors on either side of the CB, one (1) sensor in the lower busbar compartment or one (1) sensor in the cable compartment, if applicable.

BRM Panel: One (1) sensor in the upper busbar compartment, one (1) sensor in the detachable carriage, one (1) sensor in the lower busbar compartment or one (1) sensor in the cable compartment, if applicable.

Panel MM: One (1) sensor in the busbar compartment and one (1) sensor in the voltage transformer compartment.

Panel BRMM: One (1) sensor in the upper busbar compartment, one (1) sensor in the disconnectable carriage, one (1) sensor in the voltage transformer compartment, one (1) sensor in the lower busbar compartment or one (1) sensor in the cable compartment, if applicable.

The above-mentioned light sensors will be suitable for sensing internal arcs produced by faults.

Arc protection can be implemented either by a separate arc protection relay, or by the MV panels' own CPDUs and using horizontal GOOSE communications.

The auxiliary supply voltage of the arc detection device, if not included in the corresponding CPDU of the panel, will be 110V DC via independent mcb with auxiliary contact. If this is not possible, the supplier must provide the

appropriate power supply for voltage adjustment. Possible absence of auxiliary voltage should not be taken as detection of internal arc and produce erroneous alarms and tripping of the circuit breaker. The sensors will be equipped with self – diagnostic function for their possible maloperation.

For reliability reasons, the arc protection will work in combination with the overcurrent protection (starting element of overcurrent protection of the CPDU in each panel).

The optical fibers of the optical arc detection sensors will have external cable sheathing shielding and if this is not possible, mechanical protection of the optical fibers must be ensured.

The excitation of the light sensors in the various compartments of the panels “lead” in the following trip commands, according to the case, provided the energization of the O/C protection of the feeder:

- Arc in the cable compartment of any OLM or ULM or CM or IPPM or VTs compartment of IPPM panel:
In this case, the excitation of the sensor, given the confirmation of O/C from its feeders (the same panel or TM or BSM or HV), will lead to an immediate trip command only to the circuit breaker of the panel where the arc was detected.
- Arc in the cable compartment or the voltage transformer compartment of the TM panel: In this case, the excitation of the sensor combined with confirmation of O/C from HV or TM or BSM, will lead to isolation only of the power transformer and not of the MV busbar.
- Arc in CB or busbar compartment of any panel:
In this case, the excitation of the sensor combined with confirmation of O/C from its feeders (TM or BSM or HV), will lead to isolation of this busbar. BRM, BRMM and MM, as well as any connected cable is considered as part of the busbar.
- Especially for arc in BSM compartment:
 - Arc in the busbar compartment with O/C confirmation from its feeders (TM or BSM or HV), will lead to isolation of this busbar.
 - Arc in BSM cable compartment, combined with O/C from its feeders, will lead to isolation of the other busbar where the cable ends.
 - Arc in CB compartment of BSM panel combined with O/C, will lead to isolation of one or/and two busbars, depending on to which feeders there is O/C.

Furthermore, regarding the operation of the arc protection scheme, it is emphasized that the energization of any zone of arc protection, will lead to the block of the closing of that zone’s CBs of that have been tripped, until there is a manual reset of arc protection.

There must be an option to deactivate the Arc Protection of every panel (e.g. for maintenance).

8.9. VT Choice System

In case the MV panel assembly does not include an MM panel on each busbar, a “VT choice” system should be implemented to ensure the correct

measurement of the busbar voltage in each case. We distinguish the following cases:

- **Single source of voltage measurements are the TMs**

A "VT choice" system should be implemented (in each TM panel), which will select as the measurement voltage of the relevant busbar the appropriate one from the available measurement voltages from the arrivals (TMs), according to the following logic: Under normal conditions, the measurement voltages of each busbar come from the measurement voltages of the relevant arrival. In case of loss of measurement voltage of the relevant TM and provided that the buses are coupled (closed BSM/BRM), the measurement voltages of the busbar come from the measurement voltages of the arrival which supplies the busbar through the BSM/BRM.

- **Existence of a BRMM (instead of an MM) on each busbar**

A "VT choice" system should be implemented, which will select as the measurement voltage of the relevant busbar the appropriate one from the available measurement voltages from the arrival (TM) and from the BRMMs on either side, according to the following logic: Under normal conditions, the measurement voltages of each busbar will come from the measurement voltages of the relevant BRMM. In the event of loss of the measurement voltage of the relevant BRMM (e.g. due to disconnection of its carriage), the measurement voltages of the busbar will come from the relevant TM if the latter is active, otherwise from the other BRMM, if there is a coupling with another busbar (the BSM CB is coupled with the busbars and closed and the BRMM carriage is coupled with the busbars).

In this way, the correct voltage measurement of each busbar will be ensured, which will be distributed to all MV panels of the corresponding busbar (except for the TM and IPPM panels which have their own voltage transformers) for the needs of measurements, underfrequency protection and undervoltage protection (in the case of CM Panels).

9. Additional data for the L.V. auxiliary circuits

9.1 The L.V. wiring must be done with multiwire, flexible, insulated copper conductors of at least 1.5mm² in cross section for the control circuits and voltage transformer circuits, while providing terminal blocks for the external interfaces, which will be suitable for the connection of at least 2.5mm² conductors. For the circuits of the current transformers (CTs), the conductors will be at least 4.0mm² in cross section. The terminals of the CTs' secondary windings will be wired to be connected in a common terminal block per phase. All the conductors will have numbered rings at their ends, which will indicate, with a code number, the circuit to which they belong.

9.2 At the incoming terminals of the 110 V DC circuits and within every compartment, miniature circuit breakers (mcb) with annunciation of operation must be installed.

It should be noted that the system of protection, control and annunciation of the substations, in which these panels will be installed, employs three (3) independent voltages, each of which has to be secured with an independent mcb.

More specifically, provisions should be made for:

1. Auxiliary voltage, $\pm I$, for feeding the circuit breaker motors
 2. Auxiliary voltage, $\pm Q$, for control and protection
 3. Auxiliary voltage, $\pm S$, for annunciation (alarm signals).
- 9.3 In case of 110V DC loss, there shall be provided local indication to the CPDU, through one (1) free of voltage contact as well as remote indication through one (1) free of voltage contact to the Distribution Control Centre (DCC) and to the RTU.
- The free of voltage contacts will be suitable for 110V DC, 1A and will close whenever the mcbs trip.
- 9.4 The auxiliary cables must be inside conduits with cover, up to their terminal connections and can be recognized and be replaced easily (use of double insulation is required for 230V AC cables).
- The route of cables through perforated supporting metal sheets is not acceptable.
- In the conduits of the auxiliary cables, a protective plastic reinforced conical lining will be placed at the tips to avoid damage to the cables. Also, if supports are required for the auxiliary cables, these will be of screw type or in case their fastening with a screw is not possible, the strength and robustness of the fastening of the supports must be ensured.
- In the routes of the auxiliary cables, which are subject to mechanical stress, an opening cable protection cover must be used.
- 9.5 The auxiliary cables that go through M.V. areas will be protected from M.V. with a metallic cover.
- 9.6 Besides the terminal blocks that are required for this specification, additional spare terminal blocks must be provided. The terminal blocks for the connection of the auxiliary voltage of 110V DC must be suitable for 10 mm² conductors.
- 9.7 The arrangement of the field elements (CB, CT's, partitions etc.) must ensure safe and convenient access to the auxiliary cables.
- 9.8 The L.V. cables from and towards the panel will terminate in terminal strips before their connections to the individual equipment of the panel.

10. Additional devices and components for the panels

The metalclad panels must be suitable for placement on concrete bases with openings. The floor levelling would be secured by HEDNO. Each group of panels must be accompanied by all required placement components, such as bolts, nuts, busbar connecting materials, panel connecting materials, compacting materials etc.

Moreover, for each group of panels the following should be provided:

- Two levers for manual charging of the circuit breaker's springs
- Two levers for operating the grounding switch
- Two levers for inserting and removing the carriage of the circuit breaker
- Two levers for inserting and removing the carriage of the voltage transformer
- Two arrangements for removing the carriage of the circuit breaker from the panel
- Two arrangements for removing the carriage of the voltage transformer from the panel
- Ducts for the collection of arc gases, if necessary.

The price of all the above will be included in the total price of the offer.

Each panel must be delivered complete and wired for installation with all the required tools for its operation, control and maintenance. The offers will also include the necessary cable sealing ends (cable terminations), which will be supplied in bulk for installation by HEDNO, and two probes for cable testing per group of panels, if they are required for the checking and testing of the cables. In addition, appropriate materials should be included for sealing and protecting the MV cable compartment, both for the cable passage holes and for the rest of the compartment, if required, to prevent the ingress of moisture, dust and foreign particles.

11. Panel insulation and dimensions

The panels of this hereby specification are panels of "normal dimensions", whose main dielectric medium among their under-voltage sections is air of atmospheric pressure.

It is accepted that the panels offered may contain small areas of suitable insulation. These insulators will not retain moisture, and, over time, their insulating capacity will not decrease. It is also accepted that the busbars of the MV panels are insulated with appropriate insulation (insulated busbars). In these cases, relevant recommendations (references) and results of long-term aging tests and reliable operation of the insulators must be submitted.

The panels should have the following maximum dimensions:

- Front side width TM, BSM, BRM, BRMM: 1000mm
- Front side width OLM, ULM, CM, IPPM, MM: 800 mm
- Panel and group height: 2300mm, in addition to the height of the duct for the collection of possible arc gases, which should be easily removable and should not exceed 650mm. (One (1) meter of free distance above the panel is a minimum for extraction of are gases).

For the TM panel, fully equipped, the height of 2600mm will be acceptable.

- Group depth: 2200mm.

The whole installation will ensure the convenient operability of the panels as well as the movement of the draw-out elements for reasons of maintenance and operations. The above dimensions are mandatory unless otherwise stated in the terms of the declaration.

12. Tests

The panels should be subjected to type and routine tests, under the supervision of the manufacturer, before the delivery of the panels, as mentioned in the following paragraphs:

12.1 Type tests

The following tests should be executed according to the IEC-62271-200 and IEC-60694 standards, as well as this hereby specification.

12.1.1 Impulse Voltage dry test, 125KV peak.

12.1.2 Power Frequency Voltage dry test, 50KV 1min.

12.1.3 Partial discharge test. This test will be executed after the impulse voltage and power frequency voltage tests.

- 12.1.4 Temperature rise test, at the nominal current of the main circuit of the panel. Any existing current transformers of lower primary nominal current will be short-circuited at the primary before the test.
- 12.1.5 Short time current test on main circuits, 16kA 1sec, 40kA peak.
- 12.1.6 Short time current test on earthing circuits
Grounding switch: 16kA, 1sec, 40kA peak
- 12.1.7 Verification of making and breaking capacity of the circuit breaker. This test is necessary only if the test certificates of breaking and making of the circuit breaker have not been submitted.
- 12.1.8 Mechanical operation and robustness test. In addition to the mechanical operation test required by IEC 62271-200, the robustness of the controls and interlocks must also be checked in accordance with the requirements of paragraph 7 of this TD.
- 12.1.9 Verification of the degrees of protection of persons against hazardous approach to live and moving parts, IP31D.
- 12.1.10 Arcing due to internal fault. The goal of this test is to check the compliance with IAC AFLR 16kA 1sec category, as these are defined in §7.105 and in section A.2 of IEC 62271-200.
- 12.1.11 Measuring of the resistance of the main circuit
- 12.1.12 Tests for breaking and making of capacitive currents of BC2 test cycles for the circuit breakers of TM and CM panels, as described in §6.111.9.1.4 of IEC-62271-100.
- 12.1.13 Dielectric tests of the auxiliary and control circuits
Test voltage: 2kV
Test duration: 1 min
- 12.1.14 Verification of the protection code of the panel, according to IP.

The tests will be performed at Innovation Center Department (ICD), if necessary, and can be carried out or in a laboratory which the manufacturer will define, in the presence of a HEDNO inspector.

At the discretion of HEDNO, there is the possibility of accepting certificates issued by a recognized laboratory, for panels of the same design, type and size.

12.2 Routine tests

For each panel of the order, the manufacturers will perform the following routing tests, according to IEC 62271-200 and IEC-60649 standards and the requirements of this hereby specification.

- 12.2.1 Power frequency Voltage dry test of the main circuit, 50KV 1min.
- 12.2.2 Voltage test on auxiliary circuits, 2KV, 1min
- 12.2.3 Mechanical operation test
- 12.2.4 Auxiliary circuit testing
- 12.2.5 Verification of wiring
- 12.2.6 Verification of completeness of the auxiliary tools and equipment accompanying the switchgear.
- 12.2.7 Measuring of the resistances of the main circuit.
- 12.2.8 Functional tests of the protection scheme.
- 12.2.9 Device communication tests according to 61850 (GOOSE).

13. Sample and drawings after the assignment of the order

- 13.1 Before the beginning of construction of the panels, and if HEDNO considers it necessary, the manufacturer has the obligation to present one panel of every

type of the order as a sample which will be examined by HEDNO Inspectors. If the samples are found in accordance with the requirements of the contract, they will be subjected, if required, to type tests as per §12.1. After the successful execution of the type tests, then and only then the manufacturer can proceed with the construction and testing (routine) of the remaining panels of the order. The above-mentioned sample approval does not exempt the manufacturer from the obligation that the switchgear must operate satisfactorily during its operational life, in complete accordance with the specified operational requirements and the purpose for which it is destined. If the sample fails to pass all the tests, then the contract is denounced, however the supplier has the right to present a new sample for testing if he desires so. The supplier can present up to two samples maximum.

- 13.2 With the awarding of the order and at least one month before construction begins, the supplier must submit for approval, in digital form, detailed construction drawings, installation, wiring and connection drawings, indicating all the required electrical points and operational steps with references in a schematic form as in the case of relays contacts connections, as well as a detailed schedule of series tests for the corresponding panels.
- 13.3 The Supplier shall deliver at least one month before the application for inspection to be submitted, the final "AS-BUILT" drawings, installation drawings, as well as detailed installation, maintenance and operation instructions for the panels. Also, the "AS-BUILT" drawings (editable) must be delivered in electronic format along with all necessary libraries. Also, the Supplier shall deliver the digital files of the CPDUs and relays and the file with all the information transmitted by the digital system (SCD & CID files). The required programs for opening and editing these digital files will also be provided. The buyer's inspector will not proceed with the Inspection process before receiving the final drawings and series test program. Any delay due to the seller's fault in the above drawings, programs and instructions will be considered a delay in the delivery of the contract items.
- 13.4 The Supplier will deliver the MV Panels with the IEC 61850 network installed (switch devices, communication cables, etc.). All devices, including the CPDUs and the relays, will be delivered appropriately configured.
- 13.5 Upon delivery of the Panels, the Supplier is obliged to submit the final "AS-BUILT" drawings, enriched with all modifications that may have arisen during the Panels Inspection, as well as the final digital files of the CPDUs and relays plus the file with all the information transmitted by the digital system (SCD & CID files).

14. Participation in the bid and information to be given by Bidder.

The Supplier, along with its offer, must submit all the necessary information for the evaluation of the offers.

This information must necessarily include the following:

1. All tenderers must submit all technical data requested in the "Compliance Sheet", as well as any proposed deviations from this description, justifying the existence of such deviations. The provision of the above information is mandatory for Manufacturers. It is recommended to clearly indicate the requested data and to avoid a simple affirmative or negative answer. Failure to comply with this requirement will constitute sufficient reason for the rejection of the offer.

2. General drawings of the panels with the complete equipment (circuit breakers, earthing switches, current transformers, etc.) with external dimensions, weights and other data that may be relevant for the installation of the panels and their specific operating conditions.
3. Technical brochures for all types of panels and their accessories (circuit breakers, current and voltage transformers, auxiliary relays, CPDUs, protection relays, test boxes, etc.).
4. Detailed information on the construction characteristics of the panel, as described in paragraph 6 of this technical specification.
5. Type test certificates as specified in this specification. It is noted that the test certificates to be submitted must be tests of materials manufactured in the same factory as the manufacturing plant of the offered materials. In the event of relocation of the manufacturing plant, test certificates and letters of recommendation, copies of contracts, etc. relating to the original location of the plant in question may be accepted. The relocation of the manufacturing plant must be proven by the presentation of the appropriate documents duly validated. In this case, the prescribed tests will necessarily be repeated at the beginning of any possible contract.
6. Any available type test certificates for the following devices:
 - a) Automatic Power Circuit Breakers
 - b) Current Transformers
 - c) Voltage Transformers

15. Spare parts-components

Along with the offer for the panels, the bidders shall submit prices for a list of spare parts. The exact number and type of spare parts shall be specified in the declaration. If the supplier deems it necessary to supply other spare parts, he shall also make their unit prices known to HEDNO. In the financial evaluation of the bids, additional spare parts proposed by the supplier shall not be taken into account.

16. Training of HEDNO personnel

The supplier is obliged to train HEDNO personnel in the operation and repair of faults that may occur in the panels. He must also train HEDNO personnel in the operation and maintenance of the new protection and control equipment. After the above training, the corresponding manuals will be provided.

17. Binding force of this technical specification

Whenever the requirements of this technical specification deviate from regulations, then in that case, the requirements of this specification shall prevail.

18. Packing

The panels must be delivered covered with nylon and within a robust wooden frame.