# SG15_MILE / SG25_MILE

MEDIUM VOLTAGE SWITCHGEAR

## MAINTENANCE MANUAL


ISO 9001:2015 certification
ISO 14001:2015 certification

TAVRIDA ELECTRIC

**It is absolutely necessary to read this document carefully before starting the installation or operation of SG_Mile switchgear and to adhere to the instructions and the relevant regulations contained in it.**

# SAFETY FIRST

Make sure that during installation, commissioning, maintenance and operation, the respective legal regulations (such as IEC) and appropriate national safety regulations are adhered to.

Make sure that the installation, commissioning and the operation are carried out by electrical specialists.

Only install the switchgear in closed rooms designated for electrical equipment.

Make sure that the specified data are not exceeded under the switchgear operation.

Make sure that this manual is available to all persons concerned with installation, commissioning and operation.

Pay special attention to the hazard statements throughout this manual:

**Useful Features:** Useful and helpful information

**TIPS:** Examples of calculations, hints

**Technical stuff:** Indicates important information about installation and maintenance

**WARNING:** Indicates a potentially hazardous situation that, if not avoided, could result in personal injury or equipment damage

**DANGER!** Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury

**Always follow the instruction manual and respect the rules of good engineering practice!**
**Hazardous voltage can cause electrical shocks and burns. Disconnect power, then earth and short-circuit before proceeding with any work on this equipment.**

Low voltage devices (recloser controller all types) meet the requirements of the EMC Directive 2014/30/ÅÑ, the Low Voltage Directive 2014/35/EU

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# ABBREVIATION

| | |
|---|---|
| AC | Alternating current |
| BC | Bus Coupler |
| BR | Bus Riser |
| BRES | Bus Riser with Earth Switch |
| BRM | Bus Riser with Metering Transformer |
| BT | Bus-Tie |
| CB | Circuit breaker |
| CC | Cable compartment |
| CM | Control module |
| CT | Current transformer |
| CO | Close-open (operation) |
| DC | Direct current |
| DIN | German institute for standardization |
| DOU | Draw-out unit |
| EMC | Electromagnetic compatibility |
| ES | Earthing switch |
| GOST | State standard of the Russian Federation |
| HCD | Handheld closing generator |
| HD | Heavy duty switching module |
| IAC | Internal arc classification |
| IEC | International Electrotechnical Commission |
| IF | Incoming Panel |
| IP | International protection |
| IP | Ingress protection |
| ISM | Indoor switching module |
| KD | Knocked down (panel) |
| LBS | Load break switch |
| LBSF | Load-Break Switch with Fuses |
| LD | Low duty switching module |
| LED | Light-emitting diode |
| LSC | Loss of service continuity (class) |
| LV | Low voltage |
| M | Metering panel |
| ManGen | Manual generator |
| MES | Metering panel with Earth Switch |
| MV | Medium voltage |
| OF | Outgoing Panel |
| PB | Power block |
| PCD | Pole-to-center distance |
| PD | Partial discharge |
| PM | Metallic partitions (class) |
| R&D | Research and development |
| SA | Surge arrester |
| SCADA | Supervisory control and data acquisition |
| SG_Mile | Medium-Voltage switchgear Mile series |
| Shell | Shell type switching module |
| SP | Switchgear panel |
| STP | Service Transformer Panel |
| TEE | AS Tavrida Electric Export |
| TEL | Tavrida Electric (registered TM) |
| VCB | Vacuum circuit breaker |
| VT | Voltage transformer |

# MAINTENANCE MANUAL

This manual provides information on maintenance and operation of SG_Mile series switchgear.

## 1. GENERAL

### 1.1 Presentation

The SG_Mile series switchgear is designed for primary distribution networks with rated voltages of 12kV, 17.5kV and 24kV 50/60Hz intended for indoor installation. The SG_Mile series switchgear is air insulated LSC2B-PM class, with single busbar design. The switchgear concept meets today's owner requirements such as reliability, personnel and operational safety, economy and efficiency in an optimal way.
The SG_Mile switchgear panels are successfully installed and commissioned for wide range of applications: distribution networks, industry, mining, Oil&Gas etc.
The switchgear is modular and is built by placing standardized units side by side in a coordinated way. The switchgear is easy to configure and selection of the apparatus and instruments does not imply dedicated solutions.
The functional units of the switchgear are guaranteed arc proof AFLR 31.5kA 1s in accordance with the IEC 62271-200 standard, appendix AA, class A accessibility, criteria 1 to 5. All start-up, maintenance and service operations can be carried out from the front. The switchgear and earthing switches are operated from the front with the door closed. The SG_Mile series switchgear can be configured with front access or with both front and rear access.

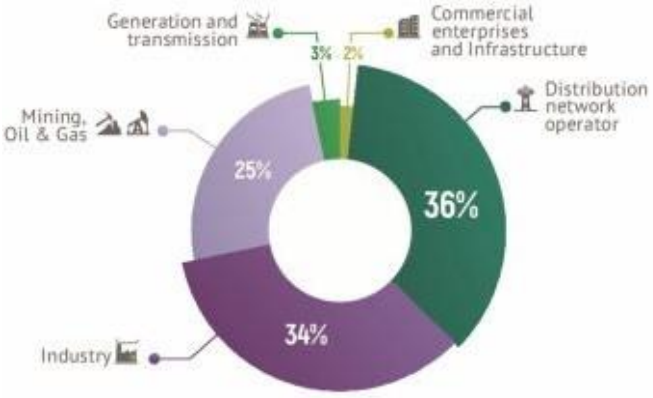



**Fig.1.1.** Installed switchgears by industry

### 1.2 Applicable standards

The switchgear and its main apparatus comply with the following standards:

**Table 1.1.** Applicable standards

| Description | Standard |
|---|---|
| High-voltage switchgear and control gear – Part 1: Common specifications | IEC 62271-1 |
| High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV | IEC 62271-200 |
| High-voltage switchgear and control gear – Part 200: High-voltage alternating current disconnectors and earthing switches | IEC 62271-102 |
| Insulation co-ordination – Part 2: Application guide | IEC 60071-2 |
| High-voltage switchgear and control gear – Part 100: High-voltage alternating current circuit-breakers | IEC 62271-100 |
| Instrument transformers - Part 2: Additional requirements for current transformers | IEC 61869-2 |
| Instrument transformers - Part 3: Additional requirements for inductive voltage transformers | IEC 61869-3 |
| High-voltage switchgear and control gear - Part 103: Switches for rated voltages above 1 kV up to and including 52 kV | IEC 62271-103 |
| Unsealed metal-enclosed switchgear and controlgear for voltages up to 10 kV. General specifications | GOST 14693-90 |
| Factory-assembled metal-enclosed switchgear for rated voltages up to and including 35 kV. General specifications | GOST R 55190-2012 |
| Alternating-current circuit-breakers for voltages from 3 to 750kV. General specifications | GOST R 52565-2006 |

### 1.3 Degrees of protection

The degrees of protection of the switchgear conforms with IEC 60529 standard. The SG_Mile series switchgear is normally supplied with the following standard degrees of protection:

- IP4X on the external housing.
- IP3X with the doors open.

**Note:** IP41 on request

### 1.4 Normal service conditions

The rated characteristics of the switchgear are guaranteed under the following ambient conditions:

**Table 1.2.**

| Parameter | Parameter value |
|---|---|
| Minimum ambient temperature | -25°C* |
| Maximum ambient temperature | +55°C** |
| Maximum altitude above sea level | 1000 m*** |
| Relative humidity | 95% |

Ambient atmosphere in accordance with IEC 60721-2-1- "Wda": non-explosive, uncontaminated and non-corrosive. Atmosphere type II according to GOST 15150-69.

* - The value is limited by instrument transformers
** - IEC 62271-200 limits the upper level of ambient temperature at +40°C
*** - For installations in altitudes above 1000 m, the external insulation is calculated as multiplication of rated insulation with Ka in accordance with IEC 62271-1

**Table 1.3.**

| Altitude above sea level, m | Air dielectric strength factor Ka |
|---|---|
| 1000 | 1,00 |
| 1200 | 0,98 |
| 1500 | 0,95 |
| 1800 | 0,92 |
| 2000 | 0,90 |
| 2500 | 0,85 |
| 3000 | 0,80 |

### 1.5 Type testing

The SG_Mile switchgear has successfully passed all the tests specified by relevant IEC (International Standard) and GOST (state standard of the Russian Federation) standards. As noted within the regulations of these standards, the tests were carried out on the switchgear units considered to be the most sensitive to stresses applied within the tests and, therefore, assigned to be valid through the whole range.

**Table 1.4.** Type tests

| Test |
|---|
| 1) Dielectric test on main and auxiliary circuits |
| 2) Temperature rise and main circuit impedance measurement |
| 3) Peak and rated short-time withstand currents test on primary and earthing circuits, including draw-out unit and earthing switch |
| 4) Making and breaking capacity of the switching devices and apparatus |
| 5) Mechanical operations of the switching devices and draw-out units |
| 6) Verification of the IP protection code |
| 7) Verification of auxiliary and control circuits |
| 8) Internal arc test (IAC classification: AFLR, 31.5(25)kA,1s) |

### 1.6 Routine tests

Routine tests are performed by the assembly factory as specified in the standard IEC 62271-200 to ensure the superior quality of each product delivered to a customer site:

**Table 1.5.** Routine tests

| Test |
|---|
| Dielectric test on the main circuits |
| Tests on auxiliary and control circuits, and verification of conformity to the circuit diagrams |
| Functional tests |
| Verification of protection against electrical shock |
| Dielectric tests on the auxiliary circuits |
| Measurement of the resistance of the main circuit |
| Design and visual checks |
| Mechanical operation tests |
| Tests of auxiliary electrical devices (interlock) |
| Voltage and current transformers ratios, polarity check |
| Primary current injection test (CT-Protection-VCB check) |
| Voltage injection test for protection and metering |

## 1.7 Internal arc proof

The personnel safety factor was a primary goal when SG_Mile switchgear was designed. Thus, the SG_Mile switchgear has been designed and tested to withstand an internal arc due to a short-circuit current of the same levels as the panel rated breaking currents. These tests ensure that the metal construction of the SG_Mile switchgear is able to protect personnel operating near the switchgear subjected to an internal arc fault. The internal arc is treated to be the most unlikely event from all type of faults, however, a small percentage of occurrence still exists due to many factors including improper connection of incoming cables and tightening contact connections, intrusion of animals, deterioration of insulation over time, severe atmospheric conditions and human factors. The proven characteristics of the SG_Mile switchgear drastically reduce the incidence of these causes in generation of faults, but not all can be fully eliminated.

An internal arc event produces a large amount of energy which instantly transforms into phenomena such as rapid increase of internal pressure and temperature, visual and sound effects, which consequently result in high mechanical stresses on the switchgear structure, and/or in melting and evaporation of the materials.

Such significant stresses, unless properly controlled, may cause a serious threat to the service personnel due to harmful effects (shock-wave, flying parts, doors opening, emission of hot gases, open flame).

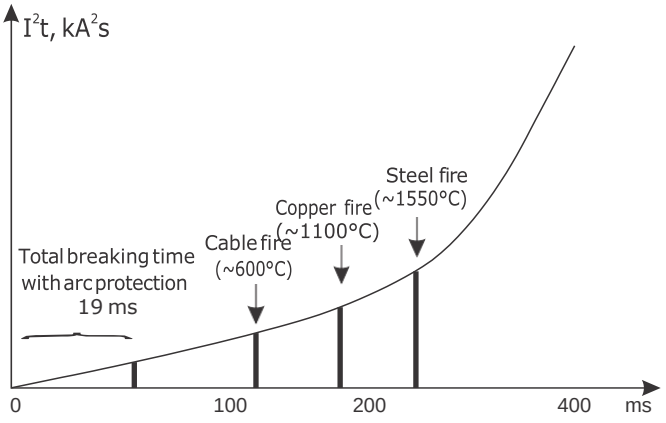
The IEC 62271-200 standard describes the test-methods required. The SG_Mile switchgear conforms to all criteria stated in Annex A of the standard:

- The doors of the switchgear must remain closed and no opening of the cover panels must occur.
- No part of the switchgear, which may be hazardous for personnel, may be ejected.
- Arcing does not cause holes in the accessible sides up to a height of 2 m.
- Vertically and horizontally arranged fabric indicators placed outside the switchgear may not get burnt.
- All the switchgear earthing connections must remain effective.

The SG_Mile switchgear is IAC classified: AFLR 31.5kA, 1s. For the installation of the SG_Mile switchgear the following factors are obligatory to be considered:

- Level of the fault current (16. 31.5 kA).
- Duration of the fault current (0.1. 1s).
- Hot gases evacuation routes.
- Dimensions of the switchboard room, with special attention to the height.


TEE has developed various solutions providing effective control and protection over the arc initiation at earlier stages as well as passive type protection based on construction.




**Arcing time minimization**

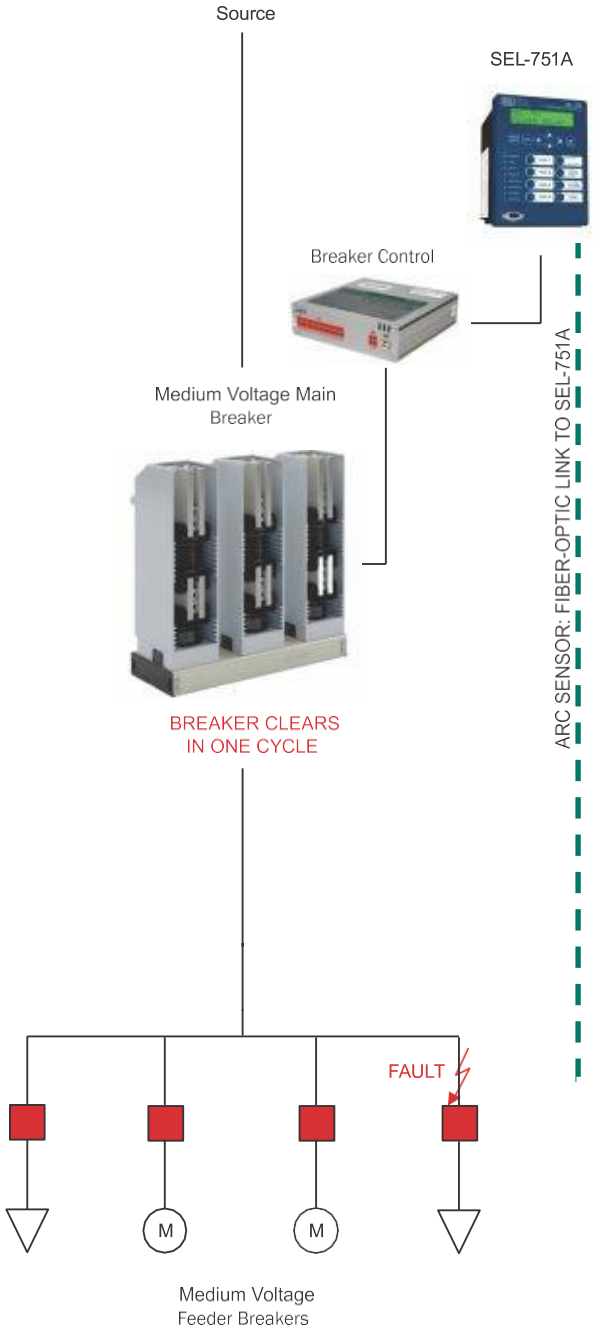
The energy released in an arc flash is directly proportional to the arcing time (V x I x t), where V is voltage, I - current, t - time. As V x I are given by the service conditions, only the arcing time (t) is changeable. The less arcing time, the less destruction can result from the arc flash. The circuit breaker operation time consist of:
1. Arc Flash relay operation time. Normally - 7ms.
2. Circuit breaker breaking time (opening time of circuit breaker and arcing time). Normally 100ms for motor spring charged drive circuit breakers.

The application of modern Arc Flash Relays with optical sensors makes it possible to minimize relay response times up to 2ms.

Tavrida circuit breakers are designed with this concept in mind – optimizing the vacuum interrupter, insulation, magnetic actuator and control modules. This has resulted in the fastest circuit breaker, the one cycle interrupter - a breakthrough for fast switching and arc flash protection technology. The reaction time of the CM16 control module series is minimized to 4ms (special version). The opening time of the fastest circuit breaker - 7ms (special version), the average arcing time - 8ms, which results in ultra-fast arc flash interruption of 20ms, that is equal to a period with frequency 50Hz, while other manufacturers advertise 5 cycles.

**Table 1.6.** Arc flash mitigation with Tavrida circuit breaker

| | |
|---|---|
| Arc flash relay reaction time | 2ms |
| CM 16 reaction time | 4ms |
| Shell FT type VCB opening time | 7ms |
| Arcing time | 7ms |
| **Totally:** | **20ms** |

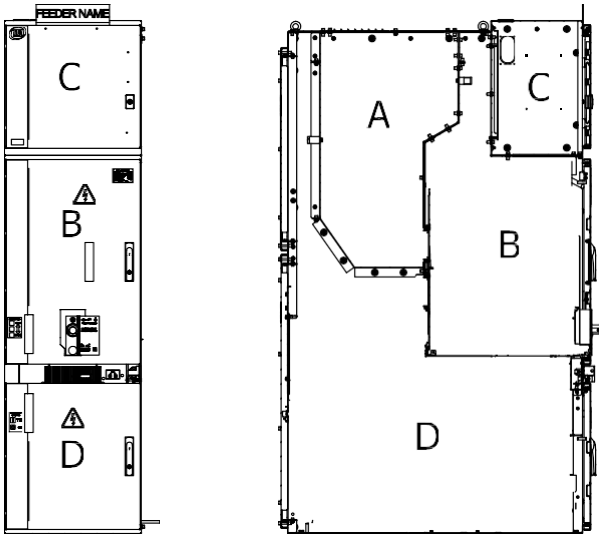




# 2. DESIGNE

## 2.1 Compartments

The SG_Mile switchgear panel is assembled with standard, pre-fabricated, hot-dip zinc galvanized sheet steel units forming a rigid, free standing structure. The switchgear consists of four compartments which are separated from each other by means of earthed metal partitions. The switchgear is supplied with cassette type draw-out unit. Within the aspects of IEC 62271-200 related to the definition of Loss of Service Continuity, the design category of SG_Mile series switchgear is defined as LSC2B-PM. Compartments of the SG_Mile series switchgear are presented below.




A - Busbar compartment
B - Circuit Breaker compartment
C - Low-voltage compartment
D - Cable compartment

**Fig.2.1.** SG_Mile cassette type

### 2.1.1 Busbar compartment

The busbar compartment houses the main busbar system connected to the fixed upper isolating contacts of the circuit breaker by means of branch connections. The main busbars are made of electrolytic copper. The busbar compartment of each panel is segregated from the busbar compartments of the neighboring panels with bushing insulators. The bushing insulators were tested with electrodynamic forces load withstand during the flow of fault current.
Optionally the busbars can be covered with heat shrinkable insulation sleeves. It is possible for maintenance personnel to access the busbar compartment from the front (through the circuit breaker compartment), as well as from the rear (removable partition of busbar compartment) of the switchgear.

### 2.1.2 Cable compartment

The cable compartment houses the branch connections, earthing busbar, earthing switch, power cables, surge arresters, instrument transformers (current transformers, voltage transformers, zero-current transformers). The cable compartment design allows up to 4 cables per phase connections (in case of the withdrawable voltage transformer truck present) or 7 cables per phase (in case of the voltage transformer truck absent). Cable fixing plate is suitable for any kind of cable. Optionally, insulation partitions can be situated in the cable compartment between phases. Insulation partitions are made from non-flammable material. Panel openings for control cables can be made in the bottom of the switchgear if they enter from the cable tunnel.

### 2.1.3 Circuit breaker compartment

The circuit breaker compartment houses the circuit breaker, bushing insulators and contains fixed contacts for connection of the circuit breaker to the busbars, to the cable compartment and the shutter mechanism. The metallic shutters operate automatically during movement of the circuit breaker from the test position to the service position or vice versa. The position of the circuit breaker can be seen from the front of the panel through an inspection window. All necessary interlocks for safety operation according to IEC 62271-200 and others can be added on request. The bushings are single-pole type and are made of cast resin. Access to live parts is prevented with movable metal shutters.


### 2.1.4 Low voltage compartment

The low-voltage compartment is designed to mount all secondary circuit connections within the single panel as well as interconnections between adjacent panels and transit connections. Special holes are provided for transit cables. The spacious compartment allows the installation of multi-functional microprocessor protection relay, energy meters, lighting, heating and many other devices. The sensors, indicators, microprocessor protection relay management blocks, mimic diagram, and control buttons are placed on the front panel.


## 2.2 Draw-out units

The following types of draw-out units are available:

- Draw-out unit with Vacuum Circuit Breaker cassette type.
- Draw-out unit with Isolating truck cassette type.
- Draw-out unit with Voltage Transformers cassette type (for CB/CC).
- Draw-out unit for Cable Service cassette type.
- Draw-out unit for Cable Testing cassette type.

**Draw-out unit with VACUUM CIRCUIT BREAKER (cassette type)**

The main purpose of a draw-out unit with circuit breaker:
- switching of load and short-circuit currents;
- to make a visible break between the busbar and the cable compartment. It is needed for maintenance purposes in the cable compartment to guarantee personal safety. The Draw- out unit is equipped with all necessary interlocks for safe operation with the panel in any condition.

**Draw-out unit with ISOLATING TRUCK (cassette type)**

Draw-out unit with Isolation truck is used for:
- conducting rated load currents;
- making a visible break between sections of switchboard during maintenance procedures.

**Draw-out unit with VOLTAGE TRANSFORMERS**

A draw-out unit with voltage transformers is used for:
- voltage metering for protection or/and commercial energy metering.

It can be placed in the circuit breaker or in the cable compartment. All voltage transformers are equipped with fuses to protect transformers against fault current. Blown fuse indication is available as an optional feature.

**CABLE SERVICE draw-out unit cassette type**

Cable Service draw-out unit is used for safe cable insulation testing, without disconnecting the power cables.

**CABLE TESTING draw-out unit cassette type**

Cable Testing draw-out unit is used for safe and convenient cable insulation testing as well as primary current injection test on power cables without disconnecting them.

**Fig.2.2.** Draw-out unit with VCB, cassette type

**Fig.2.3.** Draw-out unit with Isolating truck, cassette type

**Fig.2.4.** Draw-out unit with VT, cassette type (cable compartment)

**Fig.2.5.** Draw-out unit with VT, cassette type (circuit breaker compartment)

**Fig.2.6.** CABLE SERVICE draw-out unit cassette type

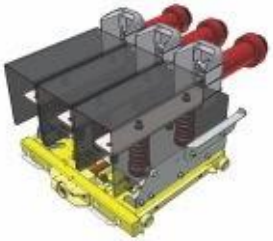


**Fig.2.7.** CABLE TESTING draw-out unit cassette type

## 2.3 Main busbars

The busbar compartment contains the main busbar system connected to the fixed upper contacts of the circuit breaker compartment by means of branch connections. The main busbars are made of electrolytic copper. The maximum rating of busbar system with natural cooling is 3150A. With compulsory cooling the busbar's nominal rating can exceed 4000A. The busbars are normally covered with heat shrinkable sleeves for voltage ratings exceeding 12kV. Each busbar compartment within the panel is segregated from the others by means of partitions and supported by pass through insulators. The through insulators have been tested for their capability to withstand stresses due to electro-dynamic forces at the rated breaking currents.

## 2.4 Branch connections

The cable compartment contains the branch system for connecting power cables to the fixed, lower contacts of the circuit breaker compartment. The branch connections are made of electrolytic copper.

### 2.4.1 Branch insulation

SG15_Mile switchboard with rated voltage up to 12kV - only central upper and lower branch busbars L2 are covered with heat-shrink insulation. Also, side isolating barriers are fixed to segregate L1 and L3 busbars from earthed metal parts in cable compartment. A complete heat-shrink insulation (including joints covers) can be offered under a customer request.
SG15_Mile and SG25_Mile switchboards with rated voltages 17.5kV and 24kV are delivered with fully insulated busbars.
The L, T, I type joint insulation covers are used for insulation of corresponding busbar connections.

The normal load / cross-section dependency of main and branch busbars are presented in the table.

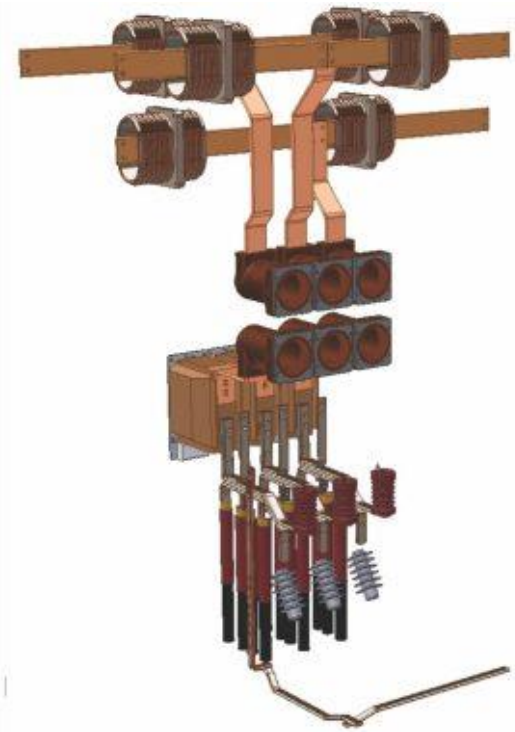


**Table 2.1.** Main busbars

| Main busbars rated current, A | Busbar, mm x mm |
|---|---|
| 1250 | 1x10x80 |
| 1600 | 2x10x60 |
| 2000 | 2x10x80 |
| 2500 | 3x10x80 |
| 3150 | 3x10x100 |

**Table 2.2.** Branch busbars

| Branch busbars rated current, A | Busbar, mm x mm |
|---|---|
| 630 | 1x10x40 |
| 1250 | 1x10x80; 2x10x40 |
| 1600 | 2x10x60 |
| 2000 | 2x10x80 |
| 2500 | 3x10x80 |
| 3150 | 3x10x100 |

### 2.5 Earthing busbar

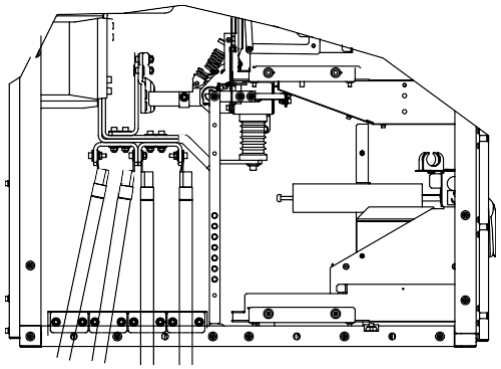
The earthing busbar is made of electrolytic copper. It runs along all adjacent panels and connects to a main substation earthing bar. All current carrying parts are interconnected with each other to equipotential bonding to guarantee personal safety against electric shock. The earthing busbars are capable of peak withstand current 31.5kA and peak value 82kA for 3 seconds.

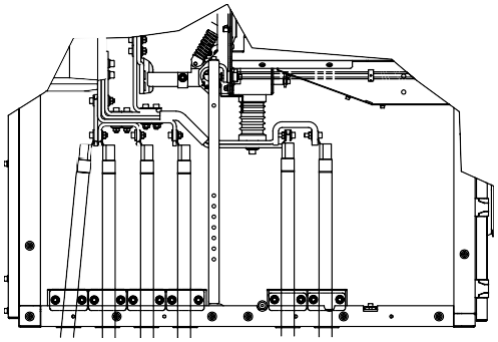
### 2.6 Bushing insulators and shutters

The bushing insulators are located in the circuit breaker compartment to hold fixed contacts. They are also used for connection of the withdrawable unit to the busbar compartment and the cable compartment respectively. The bushing insulators are single-pole type and are made of cast resin. The shutters are made of metal and activated automatically during movement of the withdrawable unit from the test position to the service position or vice versa.


### 2.7 Cables

Single and three-core cables (up to a maximum of 6 per phase or up to 4 cables with voltage transformers) can be used. The construction of SG_Mile provides simple access to the cable from the front side of the switchgear and gives the opportunity of placing SG_Mile close to the wall.





## 2.8 Auxiliary wiring

Electrical wiring diagrams are the part of switchgear documentation delivered with each order.
A complete set of wiring diagrams developed by TEE for a typical substation is available with Protection Relays from other manufacturers.
The following options are available:

- Auxiliary supply voltage: 24 .. 240V DC/AC.
- Any type of a microprocessor protection relay can be adopted.
- Solenoid and electromagnet interlocks for earthing switch, draw-out units, sectional earthing switch.
- Heating for every compartment, lighting.
- SCADA different options.
- Arc protection variety selection.
- Commercial metering.
- Motor-driven draw-out unit and earthing switch.


## 2.9 Pressure relief flaps and gas exhaust duct

Pressure relief flaps allow hot gases to be released from the compartment in the event of internal arc. A pressure relief flap is mounted at the top of each power compartment of a panel. TEE has designed different versions of the flaps depending on required IP level, nominal currents and rated breaking currents.

The gas exhaust duct is presumed to evacuate hot gases into dedicated areas. The evacuation of hot gases and other harmful particles can be diverted to:

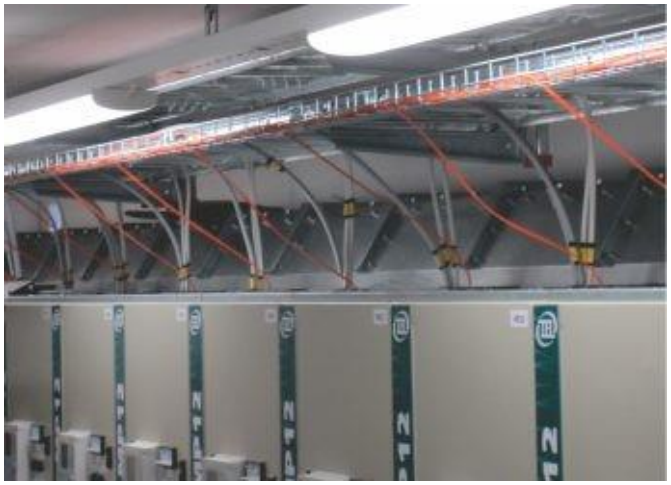
- Neighboring rooms.
- Outside to restricted areas.
- Dedicated panel with extinguishing compartment equipped with special filters.
- Upstream (special attention to the ceiling height).

The gas exhaust duct is fitted to SG_Mile at the top of each panel and runs along the entire length of the switchboard. The pressure generated by the internal arc opens pressure relief flaps thus allowing hot gases to be evacuated to dedicated areas. A complete solution for every installation is to be specified separately.

Pressure relief flaps design samples

≤ 1250 A rated current
Flat single sheet

>1250 A rated current
Louvre + mesh

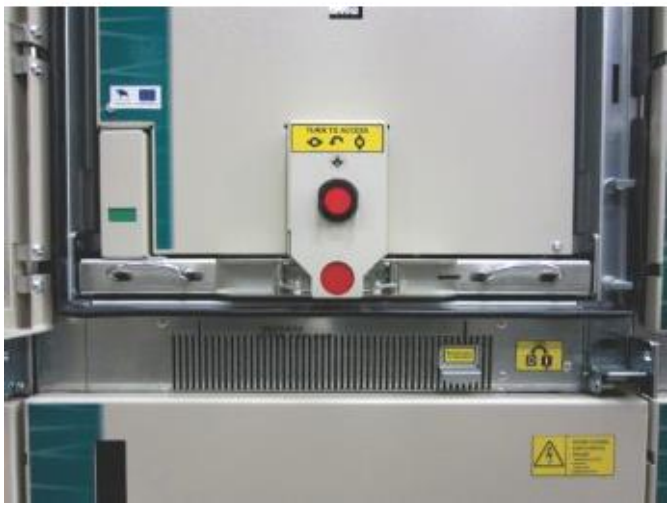


## 2.10 Doors

The SG_Mile powder coated doors are made of galvanized steel sheets, it provides a rigid structure and is resistant to mechanical stresses. Robust hinges and handles provide for convenient and safe closing.
Inspection windows are made of explosion-proof glass, providing maximum safety for personal.

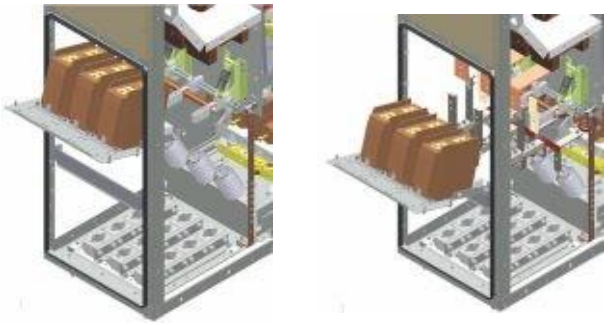
## 2.11 Natural ventilation circuit

There is a natural ventilation circuit arranged around the circuit breaker to provide dissipation of heat due to circuit breaker operating at high currents or at high ambient temperatures. The cool air is sucked into the circuit, passing underneath the circuit breaker and primary contacts and withdrawn from the panel through the gas exhaust channel. In case of internal arc blast, the reverse air current boosted by a high pressure instantly closes the special valve inside the intermediate plate, thus preventing personnel injuries due to the escape of hot gases. If the pressure relief flaps type - louvres applied, it is used as part of ventilation circuit.



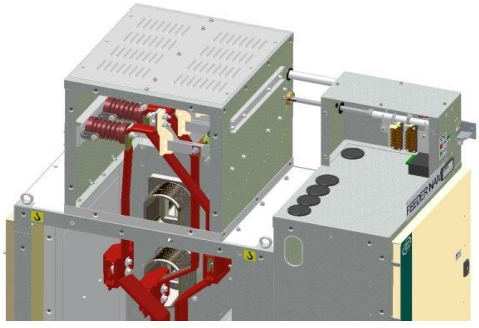
## 2.12 Current transformers

For convenient access to the current transformers, inside cable compartment, a rotating CT mounting plate design is employed.
The CT mounting plate may be opened:
- using central mounting bolts in case of CT assembly;
- using lower mounting bolts in case of CT replacement.



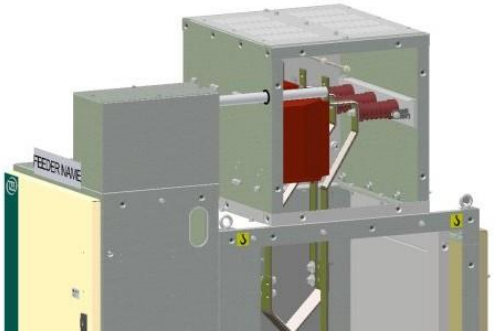
## 2.13 Top installation (earthing switch)

Depending on panel requirements and structure, the busbar earthing switch or voltage transformers can be installed over the top of any panel.
A top installed earthing switch can be equipped with support insulators, with capacitive sensors, electromagnet for providing necessary interlocks and signalling.



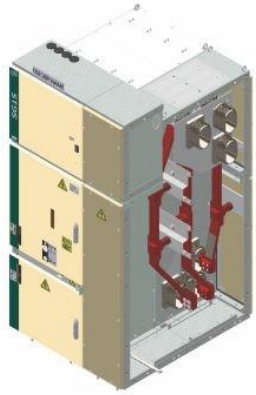
## 2.14 Top installation (voltage transformer)

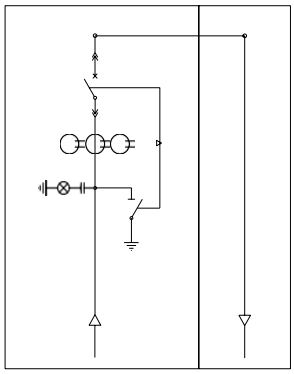
Depending on panel requirements and structure, the busbar earthing switch or voltage transformers can be installed over the top of any panel.
A top installed earthing switch can be equipped with support insulators, with capacitive sensors, electromagnet for providing necessary interlocks and signalling.

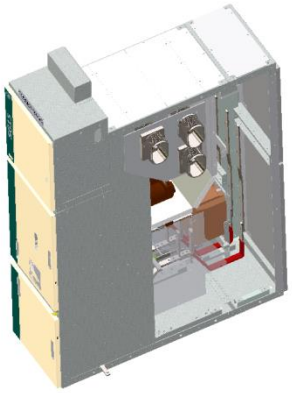


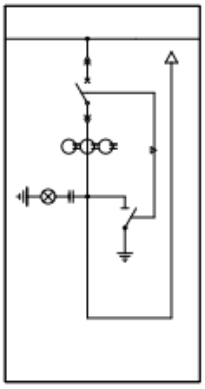

## 2.15 Panel attachment

The following solutions are available for non-standard installations such as rear or side input, cable or busbar input:
- rear attachment for cable or busbar input;
- left side attachment for cable or busbar input;
- right side attachment for cable or busbar input.



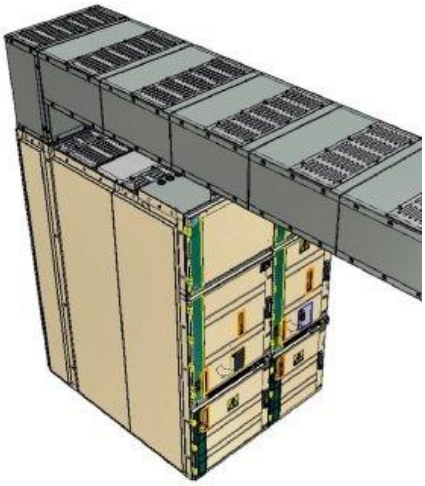


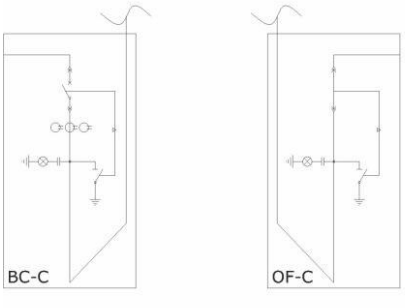




## 2.16 Busbar bridge

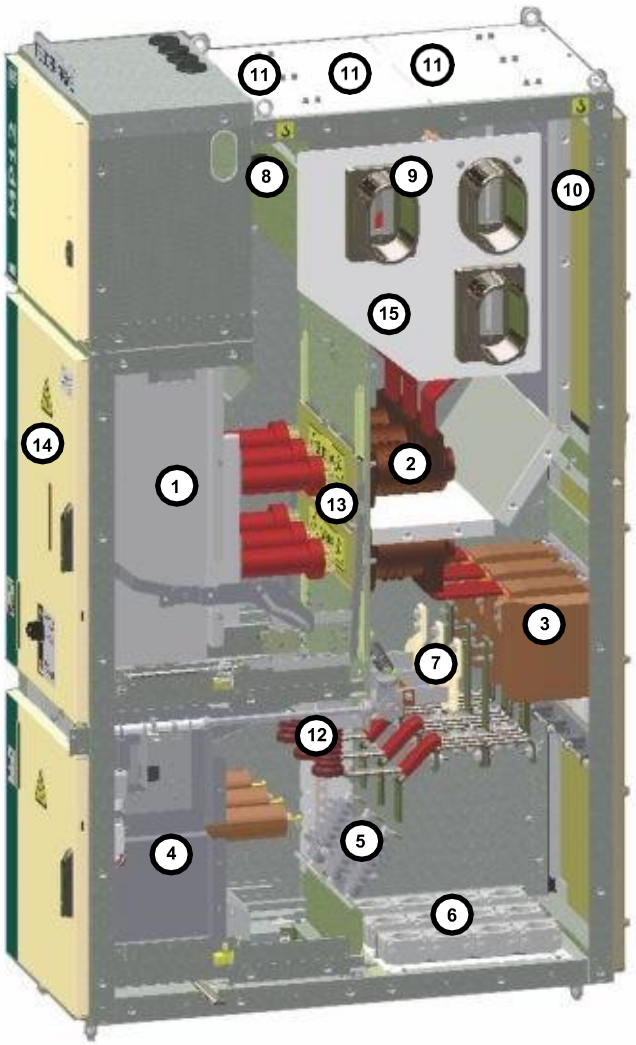
Section coupling can be also done with a busbar bridge (bus duct). Normally the connection of the busbar bridge is done with the help of rear attachments of the panels at the opposite sides. The busbar bridge is designed per project requirements.





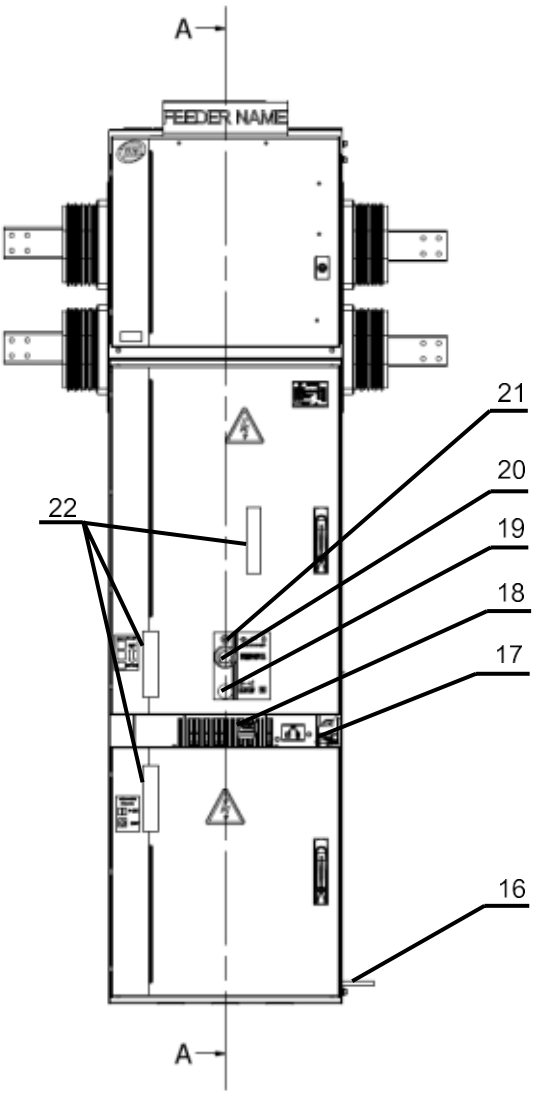
## 3. BASIC STRUCTURE

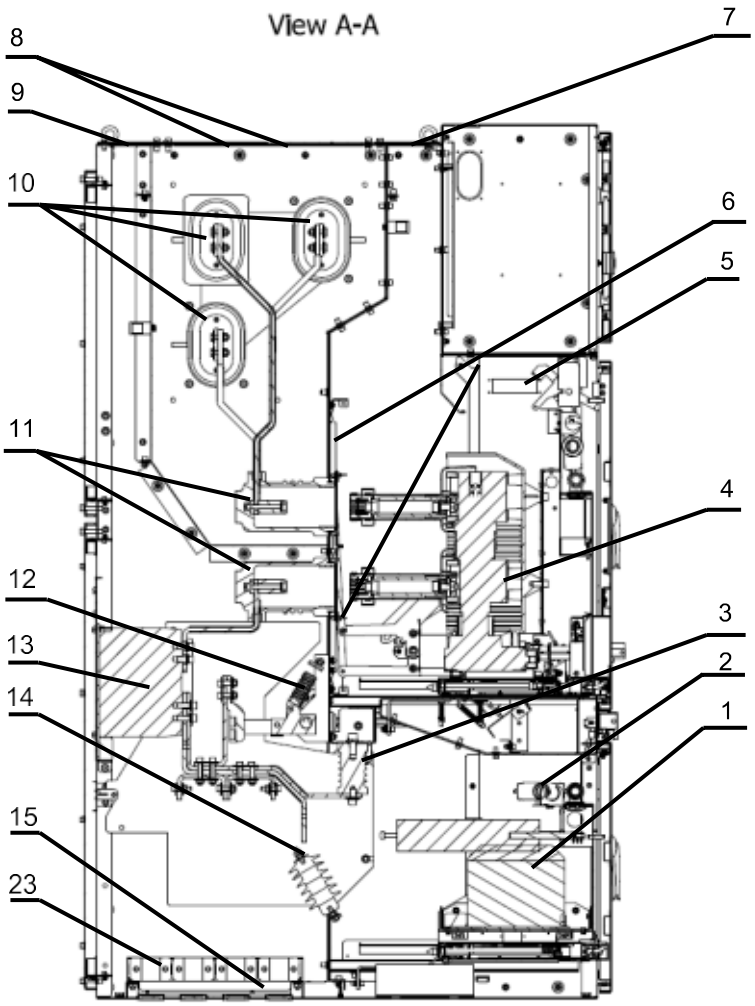
An indoor substation switchboard consists of different numbers and types of SG panels with switching devices, control and protection relays, signaling and metering devices and other auxiliary equipment, which are interconnected by control cabling. The base structure of the typical SG panel is given below.




1. Vacuum circuit breaker
2. Primary contacts insulators
3. Current transformers
4. Draw-out unit with voltage transformers
5. Surge arresters
6. Sealed cable entries
7. Earthing switch
8. Gas exhaust channel of the circuit breaker compartment
9. Gas exhaust channel of the busbar compartment
10. Gas exhaust channel of the cable compartment
11. Pressure relief flaps
12. Support insulators with voltage indicator
13. Shutter mechanism
14. Circuit breaker door with inspection window
15. Through insulators

Cross - section: cassette type




1. Voltage transformer
2. Voltage transformer auxiliary connector
3. Support insulator with capacitive sensors
4. Draw-out unit with circuit breaker
5. Circuit breaker auxiliary connector
6. Shutter mechanism
7. Circuit breaker compartment pressure relief flap
8. Busbar compartment pressure relief flap
9. Cable compartment pressure relief flap
10. Through insulators
11. Bushing insulators
12. Earthing switch (make type)
13. Current transformers
14. Surge arresters
15. Bottom with sealed cable entries
16. Main earthing bar
17. Earthing switch operation slot
18. Ventilation provision
19. Draw-out unit operation slot
20. Circuit breaker manual trip button
21. Circuit breaker / draw-out unit interlock interface
22. Inspection windows
23. Cable clamps

# 4. MAINTENANCE

Only authorized persons who have the required knowledge regarding handling of SG15_MILE and SG25_MILE type panels are allowed to provide maintenance and cleaning work.

Routine maintenance will depend on the conditions to which the switchgear is subjected to, and to the local relevant codes and practice (i.e. BS6626 for UK switchgear rated 1kV-36kV).
The recommended maintenance schedules stated in table 4.1 assume typical standard environmental and operating conditions as outlined below.

Standard Conditions:

- Humidity below 60%.
- Unit may be indoors or outdoors (within suitable enclosures), but must not be subjected to regular extremes of weather, i.e. dust storms, flooding, temperature cycles greater than 40°C or less than minus 5°C, dense coastal fog or acid rain.
- No regular or thick covering of debris.
- No contact with any chemical agents (e.g. salt).
- No infestation of animal or plant life.
- No earth movements.
- No mechanical damage to the unit of any kind.
- No mal-operation of any kind.
- No abnormally high number of operations (>2,000 per year)
- No abnormally high number of fault currents.
- No over-voltage or over-current (above switchgear rating).

Note:
Local legislation may dictate maintenance schedules to be conducted with greater frequency, irrespective of site conditions.
Operation outside of typical standard conditions may require the recommended maintenance schedule to be adapted accordingly

**Table 4.1.** Maintenance schedule

| Maintenance intervals | General sequence of operations to be carried out |
|---|---|
| Annual | • determination of substation environment and non-invasive inspection |
| Every 3 years from the date of panel installation | • Visual inspection of all switchgear compartments (low-voltage, circuit-breaker, cable)<br>• Functional tests<br>• Greasing of moving (as required) and accessible current conducting parts |
| Every 10 years from the date of panel installation | • Insulation resistance tests<br>• Measurement of the resistance of the main conducting circuits<br>• Power frequency test<br>• Busbar chamber inspection |

### 4.1 Visual inspection of all switchgear compartments ( low-voltage, circuit-breaker, cable, busbar)

Periodic inspection of the substation and equipment (annual non-invasive) will be necessary to establish the environmental conditions to which the units are subjected, to allow a suitable maintenance schedule to be determined. Consideration should be given to:

- Humidity/condensation
- Dust/air circulation
- Ambient temperature
- Contact with any chemical agents (e.g. salt)
- No infestation of any animal life (e.g. insects)
- No contact with any plant life (e.g. mould)
- No earth (seismic) movements
- Potential for mechanical damage

During the determination of the environmental conditions, the opportunity should be taken to conduct the following non-invasive checks;

- Check all covers/fixings in situ
- Check all appropriate labelling (front and rear, if applicable) is attached
- Check all mimic (if fitted) LED's are functioning
- Check all thermostats (if fitted) are set correctly
- Check all meters (if fitted) are reading correctly
- Check display on all protective devices for correct indication
- Check for undue noise/vibration
- Check all safety padlocks fitted, where appropriate
- Check condition of any ancillary equipment (manual generator, lanyard, service trolleys, cable testing trucks)

**Table 4.1.1** Visual inspection taken every 3 years

| Switchgear compartments | Actions to be taken every 3 years |
|---|---|
| Low-Voltage compartment | • Check closing/tripping circuits<br>• Visual inspection for contamination, damage and condensation inside compartment |
| Circuit-breaker compartment | • Visual inspection for contamination, damage and condensation inside compartment<br>• Check of draw-out unit isolating contact condition<br>• Check for abnormal visible signs (i.e. pd activity) |
| Cable compartment | • Visual inspection for contamination, damage and condensation inside compartment<br>• Check of HV power cable and LV cable sealing facility<br>• Check for abnormal visible signs (i.e. pd activity) |

### 4.2 Functional tests

**Table 4.2.1** Functional tests taken every 3 years

| Actions to be taken every 3 years |
|---|
| Checking ON/OFF operation of VCB in TEST position |
| Checking rack IN/OUT (Test/Service position) operation of VCB |
| Checking for correct operation of circuit breaker mechanical indication |
| Checking rack IN/OUT (Test/Service position) operation of VT |
| Checking ON/OFF operation of earth switch. |
| Checking for correct operation of earthing switch mechanical indication. |
| Checking of mechanical interlock between VCB & earth switch. |
| Checking of bushing insulator shutter mechanism |
| Checking of mechanical interlock between CB compt. door & VCB. |
| Checking of mechanical interlock between CC compt. door & earth switch. |
| Checking operation of cable shutters. |
| Checking of safety padlocks facilities. |
| Checking door handles/locks. |
| Spot check of bolted connections of accessible current conducting parts. |
| Checking of doors proper operation. |
| Checking of lamp test circuit |
| Checking of panel space heater circuit |

### 4.3 Greasing of moving and current conducting parts

Three types of recommended grease & lubricant are used during SG15_MILE and SG25_MILE assembly and allowed to be used during maintenance period:

- Ensto SR1, HHS 2000 – for covering contact surfaces;
- HHS Adhesive Lubricant 5000 Wurth – For greasing machinery parts (liquid)
- Klüber-Isoflex Topas L32 – for greasing machinery parts.

**NB! Usage of WD4/WD40 grease and its equivalents is prohibited.**

Table 4.3.1 Lubrication of components taken every 3 years

| Switchgear compartment & DOU | Actions to be taken every 3 years |
|---|---|
| Low-voltage compartment | • Greasing of compartment door hinges and locks (if necessary) |
| Circuit-breaker compartment | • Greasing of compartment door hinges and locks (if necessary)<br>• Apply contact lubricant on draw-out unit earthing contact<br>• Greasing of bushing insulator protective shutter mechanism (if necessary)<br>• Greasing of earthing switch flexible indication cable (if necessary) |
| Cable compartment | • Greasing of compartment door hinges and locks (if necessary)<br>• Apply contact lubricant on earthing switch fixed contacts<br>• Apply contact lubricant on voltage transformer earthing contacts<br>• Greasing of earthing switch operation socket |
| Draw-out unit | • Apply contact lubricant on isolating contacts<br>• Greasing of worm gear mechanism |

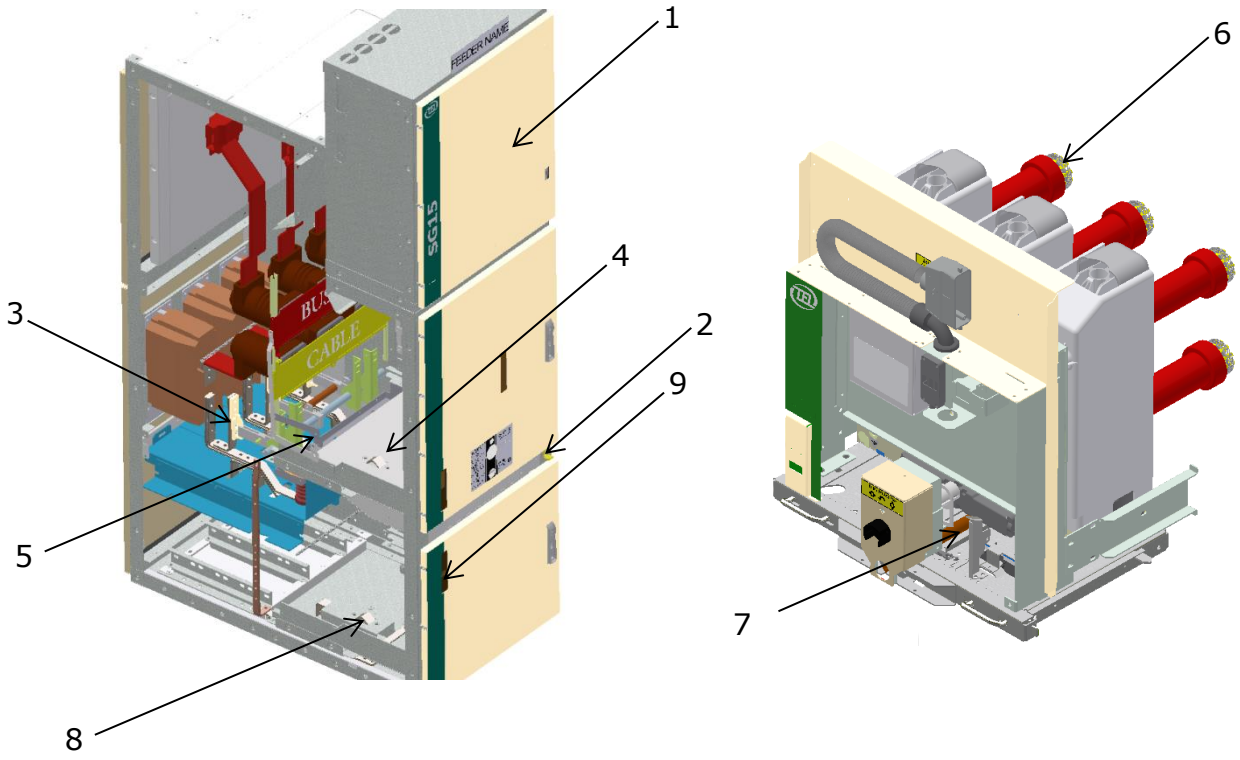
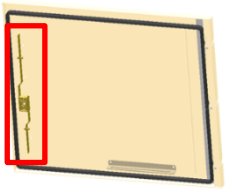
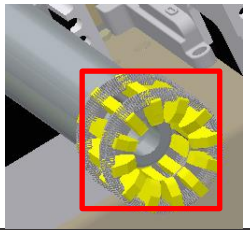
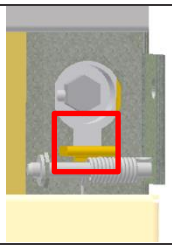
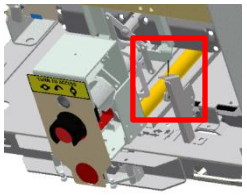
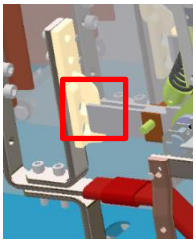
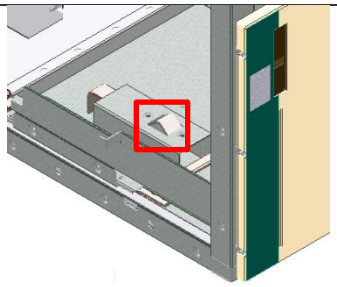
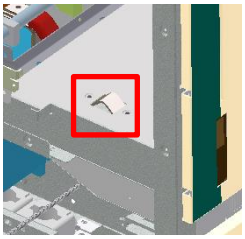
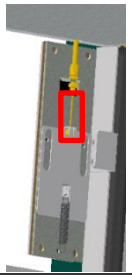
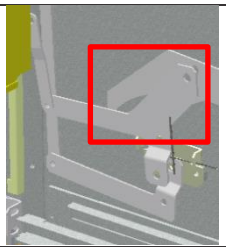



Fig.4.3.1. Grease & lubricant location on switchgear and DOU

**Table 4.3.2** Detailed grease & lubricant location

| Switchgear compartment & DOU | Detailed grease & lubricant location ( marked by red rectangle) | Switchgear compartment & DOU | Detailed grease & lubricant location ( marked by red rectangle) |
|---|---|---|---|
| Number 1 |  | Number 6 |  |
| Number 2 |  | Number 7 |  |
| Number 3 |  | Number 8 |  |
| Number 4 |  | Number 9 |  |
| Number 5 |  | | |

### 4.4 Insulation resistance tests

Test procedure shall be followed as detailed below:

- The switchboard shall be cleaned properly. Any dust/foreign particle on insulation bushing are not allowed.
- Test leads shall be connected from the back of the switchgear panel through opened rear covers.
- VCB shall be in service position and CLOSED.
- Front doors shall be closed.
- Sufficient space shall be maintained around the switchboard.
- Earth switch shall be OPEN.
- The switchboard under test shall be properly encircled with warning tape. Unauthorized personnel shall not enter the test area.
- All relevant control circuits shall be isolated, CTs shall be shorted.
- 5kV valid calibrated instrument shall be used for insulation resistance test.

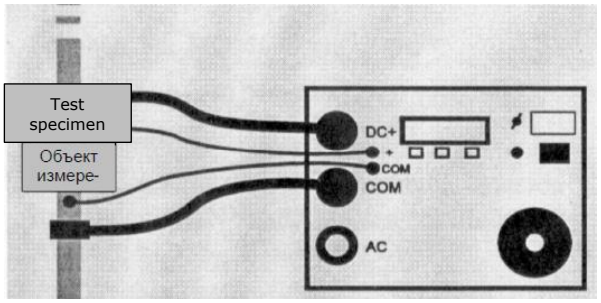
- The IR value shall be recorded for Ph-E, Ph-Ph measurements would be done as per customer requirements.
- Test voltage shall be applied for 1 minute.

**NB! Minimum acceptable insulation resistance value is 100 MΩ**

### 4.5 Measurement of the resistance of the main conducting circuits

Test procedure shall be followed as detailed below:

- VCB shall be closed & in service position. Earth switch shall be OPEN for VCB contact resistance test.
- Test leads shall be connected from beginning and end of vertical bus bars of each switchgear panel.
- The resistance & mV drop test leads shall be connected also connected across the tested circuit as shown on picture below:





- 200A DC current shall be injected in each test.
- Values are recorded for each phase as resistance in micro ohms.
- Test shall be conducted on each phase separately.

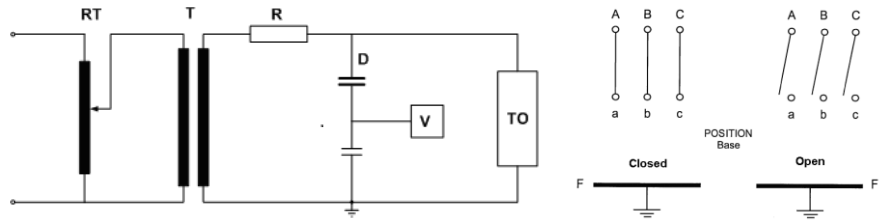
**NB! Minor deviations of contact resistance of the main conducting circuits are allowed in comparison with routine test reports. Otherwise all current conducting parts have to be tightened accordingly to recommended torque connection table 4.5.1**

### 4.6 Power frequency test

Test procedure shall be followed as detailed below:

- Please make sure that the testing specimen is earthed.
- VCB shall be in service position and CLOSED.
- Front doors shall be closed.
- Sufficient space shall be maintained around the switchboard.
- Earth switch shall be OPEN.
- The switchboard under test shall be properly encircled with warning tape. Unauthorized personnel shall not enter the test area.
- All relevant control circuits shall be isolated, CTs shall be shorted, VTs shall be withdrawn into test position or disconnected.
- Connect testing facility to the test object as per diagram below:

**Test diagram – up to 55kV, 50Hz**




| | | |
|---|---|---|
| *R – regulating transformer*<br>*T – High voltage transformer* | *TO – Tested object*<br>*R – Current suppressing resistor* | *D – Capacity divider*<br>*V – Voltage measurement* |

- Test leads shall be connected from the back of the switchgear panel through opened rear covers.
- Calibrated equipment shall be used for power frequency tests.

Test voltage must be chosen according to the table below:

| Rated voltage $U_r$ | Rated short-duration power-frequency withstand voltage $U_d$ |
|---|---|
| 3,6 | 12* |
| 7,2 | 20* |
| 12 | 28* |
| 17,5 | 38* |
| 24 | 50* |

*- Reduced to 80% test voltage for repeated testing (post routine test and commissioning)

Apply the test voltage on the tested object for 1 min with the following conditions:

- Between phases and earth;
- Across opened contacts.

**NB! There shall be no disruptive discharge (sparkover, flashover or isolation puncture) during the test**

**Table 4.5.2** Recommended tightening torques for current conducting connections

| Bolt connection size | Tightening torque without lubricant, Nm | Tightening torque with lubricant, Nm |
|---|---|---|
| M8 | 15 | 10 |
| M10 | 30 | 20 |
| M12 | 60 | 40 |
| M16 | 120 | 80 |
| M20 | 250 | 160 |

# 5. TROUBLESHOOTING

## 5.1 Switchgear troubleshooting

| Switchgear compartment & DOU | Problem | Action to be taken |
|---|---|---|
| Low-voltage compartment | • Door will not close or open | • Clean door hinges and locks from combination.<br>• Align door hinges if necessary |
| | • Secondary measurements from the voltage and current transformers are not adequate | • Check correctness of the wiring throughout all panel<br>• Remove short-circuiting connection on the secondary connections ( current transformer)<br>• Check proper connection between transformer and current conducting busbars ( voltage transformer) |
| Circuit-breaker compartment | • Door will not close or open | • Clean door hinges and locks from combination.<br>• Align door hinges if necessary |
| | • DOU rack-in/rack-out operation get stuck | • Check the position of DOU, move DOU to the TEST position<br>• Check the position of low voltage plug of DOU |
| | • Abnormal visible appearance of components | • Check that the earthing switch in the OPEN position<br>• Align and apply grease to the shutter mechanism |
| | | • Tests and further activity accordingly to customer procedure ( check substation environmental conditions, DC battery location, ventilation, moisture condensation, cooling/heating, etc) |

| | | |
|---|---|---|
| Busbar compartment | • Abnormal sound is appearing in compartment | • Check and clean compartment from any contamination and moisture if necessary<br>• Check that the busbar insulation covers are located correctly (if fitted) |
| | • Abnormal visible appearance of components | • Tests and further activity accordingly to customer procedure ( check of substation environmental conditions, DC battery location, ventilation, moisture condensation, cooling/heating, etc) |
| Cable compartment | • Door will not close or open | • Check that the earthing switch is in the EARTHED or OPENED position |
| | • Protective cover of earthing switch operating slot get stuck | • Clean cover from contamination and apply liquid lubricant inside operating slot |
| | • Abnormal visible appearance of components | • Tests and further activity accordingly to customer procedure ( check of substation environmental conditions, DC battery location, ventilation, moisture condensation, cooling/heating, etc) |

### 5.2 Draw-out unit troubleshooting

| | | |
|---|---|---|
| Draw-out unit | • DOU rack-in/rack-out operation get stuck | • Check that DOU solenoid pulled in (energized)<br>• Clean worm gear from any contamination and apply grease if necessary |
| | • Cannot close VCB | • Check the position of DOU, move DOU to the TEST/SERVICE position<br>• After VCB manual trip, rotate cam-switch/push button to OPEN position to reset Control Module operational sequence or disconnect power supply to CM for 100 seconds |

### 5.3 Control Module troubleshooting

| Control Module (Number of blinks followed by 1,5s interval) | Description | Action to be taken to reset |
|---|---|---|
| 1 | • Outage of operating voltage or voltage exceeds the prescribed value limit | • Check the auxiliary supply source, its wiring, connection, MCBs condition, value of the voltage supplied |
| 2 | • Shell type VCB failed to trip | • Check the connection and wiring integrity of the coil circuitry |
| 3 | • Shell type VCB actuator coil is open circuit | |
| 4 | • Shell type VCB actuator coil is short circuit | |
| 5 | • Shell type VCB open and locked | • Close Shell type VCB racking shutter |
| 6 | • Overheating of Control Module | • The maximum number of operations per hour exceeded<br>• Stop close/open operations<br>• Check ambient temperature |
| 7 | • Out of sequence operation | • Issue electrical trip or switch off Control Module supply MCB for 100 sec |
| Continuous glowing | • Internal failure of Control Module | • Consult with specialist of TAVRIDA ELECTRIC EXPORT |

## 6. INTERLOCKS AND LOCKING DEVICES

The SG_Mile switchgear is fitted with all interlocks needed to guarantee the highest level of safety for operators. According to IEC 62271-200 the interlocking devices prevent:

- Closing of a circuit breaker in the intermediate position
- Racking-in/out of a circuit breaker in the closed position
- Opening of the circuit breaker compartment door as long as the circuit breaker is not in the test position
- Closing of the circuit breaker compartment door, unless secondary circuits plug is connected
- Racking-in of the circuit breaker from test to service position while the compartment door is open

In addition, if a panel is equipped with an earthing switch, the interlocking devices prevent:

- Racking-in of the circuit breaker while the earthing switch is closed
- Closing of the earthing switch when the circuit breaker is closed or in the intermediate position
- Opening of the cable compartment door while the earthing switch is open
- Opening of the earthing switch while the cable compartment door is open
- Opening of the cable compartment door, unless earthing switch is closed

All doors of SG15(25)_Mile switchgear have swing-handles equipped with the key-locks.



The earthing switch close/open operations can be prevented by applying the padlocks or castell lock to the corresponding openings or slots.


The metal shutters can be locked either together or individually in open and closed positions by means of two independent padlocks.



# 7. OPERATION

## 7.1 Withdrawable parts position definitions

| |
|---|
| **Service position** |
| • Main circuits are connected |
| • Auxiliary circuits are connected |
| • The circuit breaker can be CLOSED and OPENED |
| • The circuit breaker compartment door is closed and cannot be opened |
| **Test position** |
| • Main circuits are disconnected |
| • Auxiliary circuits are connected |
| • The circuit breaker can be CLOSED and OPENED for testing purposes |
| • The circuit breaker compartment door can be opened and closed |
| **Intermediate position** |
| • The withdrawable part is between the service and the test positions |
| • Auxiliary circuits are connected |
| • The circuit breaker is OPENED and interlocked |
| • The circuit breaker compartment door is closed and cannot be opened |
| **Isolated position** |
| • Main circuits are disconnected |
| • Auxiliary circuits are disconnected |
| • The circuit breaker cannot operate |
| **Removed position** |
| • The DOU is physically removed from the panel |

## 7.2 Interlocking Conditions

Panel cassette type

| Operations | CB | | CB in | | Panel Earthing Switch with Mechanical Interlock | | Respective Busbar Earthing Switch | | Circuit breaker compartment Door with Mechanical Interlock | | Cable compartment Door with Mechanical Interlock | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Open | Closed | Test Position | Service Position | Open | Closed | Open | Closed | Open | Closed | Open | Closed |
| Test Position - CB closing | X | | X | | | | | | | | | |
| Test Position - CB opening | | X | X | | | | | | | | | |
| Service Position - CB closing | X | | | X | X* | | X | | | X* | | |
| Service Position - CB opening | | X | | X | X* | | X | | | X* | | |
| **CB Moving from** | | | | | | | | | | | | |
| Service position to Test position | X | | | | X* | | X | | | X* | | |
| Test position to Service Position | X | | | | X* | | X | | | X* | | |
| **Panel Earthing Switch** | | | | | | | | | | | | |
| Closing | X | | X | | X | | | | | | | X* |
| Opening | X | | X | | | X | | | | | | X* |
| **Bus Earthing Switch** | | | | | | | | | | | | |
| Closing | X | | X | | | | X | | | X | | |
| Opening | X | | X | | | | | X | | X | | |
| **LV Plug** | | | | | | | | | | | | |
| Disconnecting | X | | X | | | | | | X | | | |
| Connecting | X | | X | | | | | | X | | | |

X – Conditions to be met
* – Mechanical interlock

## 7.3 Interlocks

**Interlock 1**

It will not be possible to operate the circuit breaker when the circuit breaker is in the intermediate position and vice versa.
It will not be possible to rack the circuit breaker in or out, when the circuit breaker is closed.
The permission key must be turned 90° counterclockwise to access the rack-in mechanism. If the circuit breaker is in the CLOSED state during key operation, the interlock will trip the circuit breaker to prevent a dangerous situation.

**Interlock 2**
It will not be possible to rack in the draw-out unit from the isolated position to the service position when the circuit breaker compartment door is open. Upon closing the door, the door hook presses on the DOU engaging slide, which releases the DOU operating mechanism.

**Interlock 3**
It will not be possible to close the circuit breaker compartment door in the isolated position unless the low voltage control plug is connected.

**Interlock 4**
It will not be possible to open the circuit breaker compartment door when the draw-out unit is in the test position.

**Interlock 5**
It will not be possible to close the earthing switch, unless the draw-out unit is in the test position and vice versa. This ensures physical isolation between the withdrawable part and the busbar and cables.
It will not be possible to rack in the withdrawable part from the test position to the service position when the cable earthing switch is closed.

**Interlock 6**
It will not be possible to the open cable compartment door when the earthing switch is opened.

**Interlock 7**
It will not be possible to operate the earthing switch when the cable compartment door is opened.

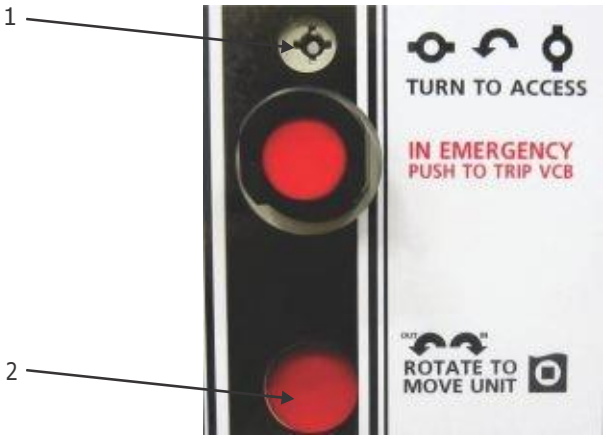
**Interlock 8**
It will not be possible to open the cable compartment door if the earthing switch operating tool is plugged into the earthing switch operating socket.

**Interlock 1**

To rack in or rack out the withdrawable unit it is necessary to turn the permission key (1) counter-clockwise 90°. It opens access to the rack-in mechanism (2). If the circuit breaker was closed when turning the key (1), the interlock trips the circuit breaker to prevent a dangerous situation.

**NB! If the circuit breaker was closed, counterclockwise rotation will trip it!**

Additional interlocking solenoid to prevent access to the permission key slot could be installed on request.

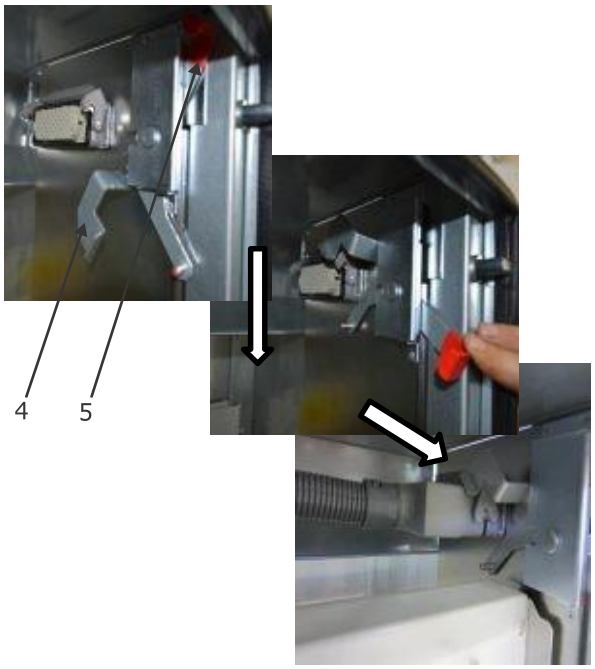



**Interlock 2**

When closing the door, the door bracket (3) presses the DOU engaging facility, which releases the DOU operating mechanism.


**Interlock 3**

If the low voltage control plug is not inserted, the lever (4) blocks the door from closing and a fluorescent red sticker is visible(5). To close the door the service personnel must push the lever down, free access to the socket and insert the plug. In cassette type panel, the same interlock is used in the cable compartment when a draw-out unit with voltage transformers is installed.

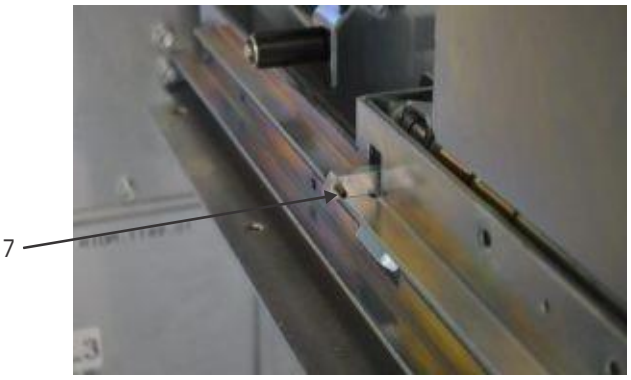


**Interlock 4**

When the DOU is racked in, the end of the bracket engaged by the shutter mechanism moves downward and blocks the circuit breaker door hook (6).

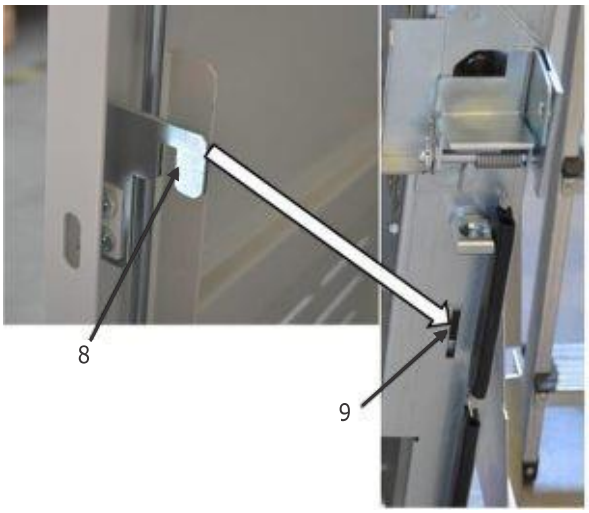

**Interlock 5**

When the earthing switch is in the closed position the locking shaft (7) withdraws to slide a joint mechanism and blocks the circuit breaker from being racked in.




**Interlock 6**

When the earthing switch is in the opened position the locking shaft fixes the door hook (8) in opening (9). To open the cable compartment door turn the operating tool clockwise and close the earthing switch. The locking shaft slides upwards and releases the hook.




**Interlock 7**

When closing the door the blade fits into an opening, releasing a locking pin (10) which allows access to the earthing switch slot. When the door is opened the locking pin is engaged.

**Interlock 8**

If the earthing switch operation tool is inserted into earthing switch operating slot, the earthing mechanism's cover (11) blocks opening of the cable compartment door. To open the cable compartment door, the earthing switch operation tool must be removed from the earthing switch slot.

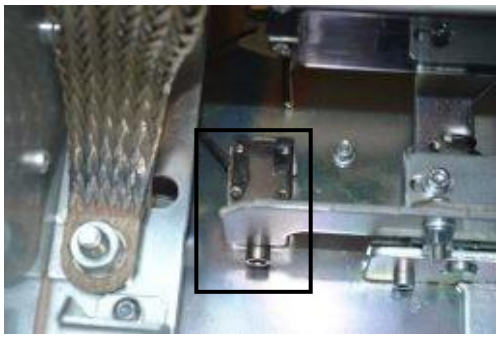

### 7.3.1 Optional interlocks

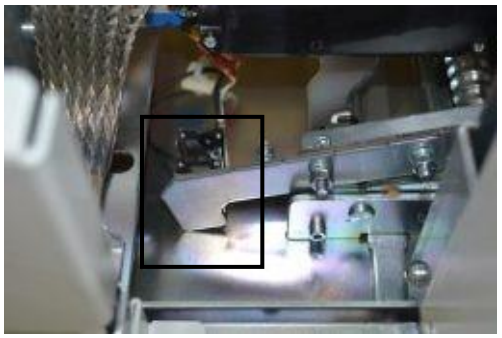
The interlocks below are supplied as optional equipment. **Draw-out unit electromagnetic interlock**

It will be not possible to operate the draw-out unit unless the control cable auxiliary connector is plugged in or permission from the auxiliary circuit is granted (voltage applied).

The electromagnetic interlock blocks rotation of the DOU operating handle and the DOU is not operable with when the control cable auxiliary connector is not plugged into panel female connector or the permission from the auxiliary circuit is not granted (voltage not applied).

The electromagnetic interlock can be added to motor-drive to prevent moving (upon requirement).


Position of activated interlock inside DOU (no voltage applied)

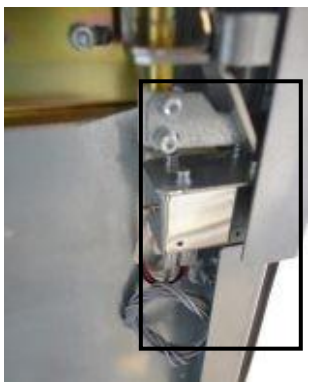

Position of not activated interlock inside DOU (voltage applied)


Control cable female connector

**Earthing switch electromagnetic interlock**

It will be not possible to operate the earthing switch unless permission from the auxiliary circuits is granted (voltage applied).

The earthing switch electromagnetic interlock blocks access to the socket for operating the earthing switch if the supply voltage of the panel is disconnected (permission is not granted).


Earthing switch electromagnetic interlock


Socket for operation with earthing switch

**Castell key interlock**

Castell key interlock is a mechanical alternative to an electromagnetic interlock of the draw-out unit and the earthing switch.

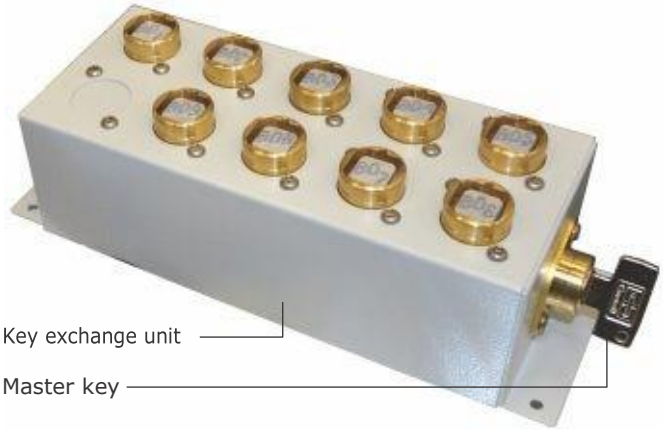
1. Castell lock blocks DOU movement from the test position to the service position.
Castell lock is located on the draw-out unit as shown on the right:

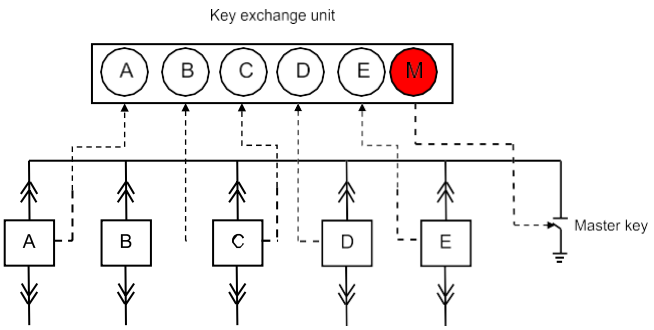
Castell lock

Castell key

In the test position VCB DOU can be blocked by the Castell lock. After blocking the truck the Castell key can be released from the lock.

2. Castell lock blocks access to socket for operation with busbar earthing switch.


All Castell keys from each VCB DOU must be put into the key exchange unit to release the master key, opening access to busbar earthing switch.

Castell key interlocking diagram (options are available).

## 7.4 Locking facilities


A standard double bit key lock can be used for locking DOU in the test and service positions

The earthing switch can be locked with a padlock

Live shutters can be securely locked in the open and closed positions with a padlock

Access to the circuit breaker or cable compartment can be restricted with the padlocks or key-locks

Access to the low voltage compartment can be restricted with the key-lock

## 7.5 Busbar earthing switch close operation conditions

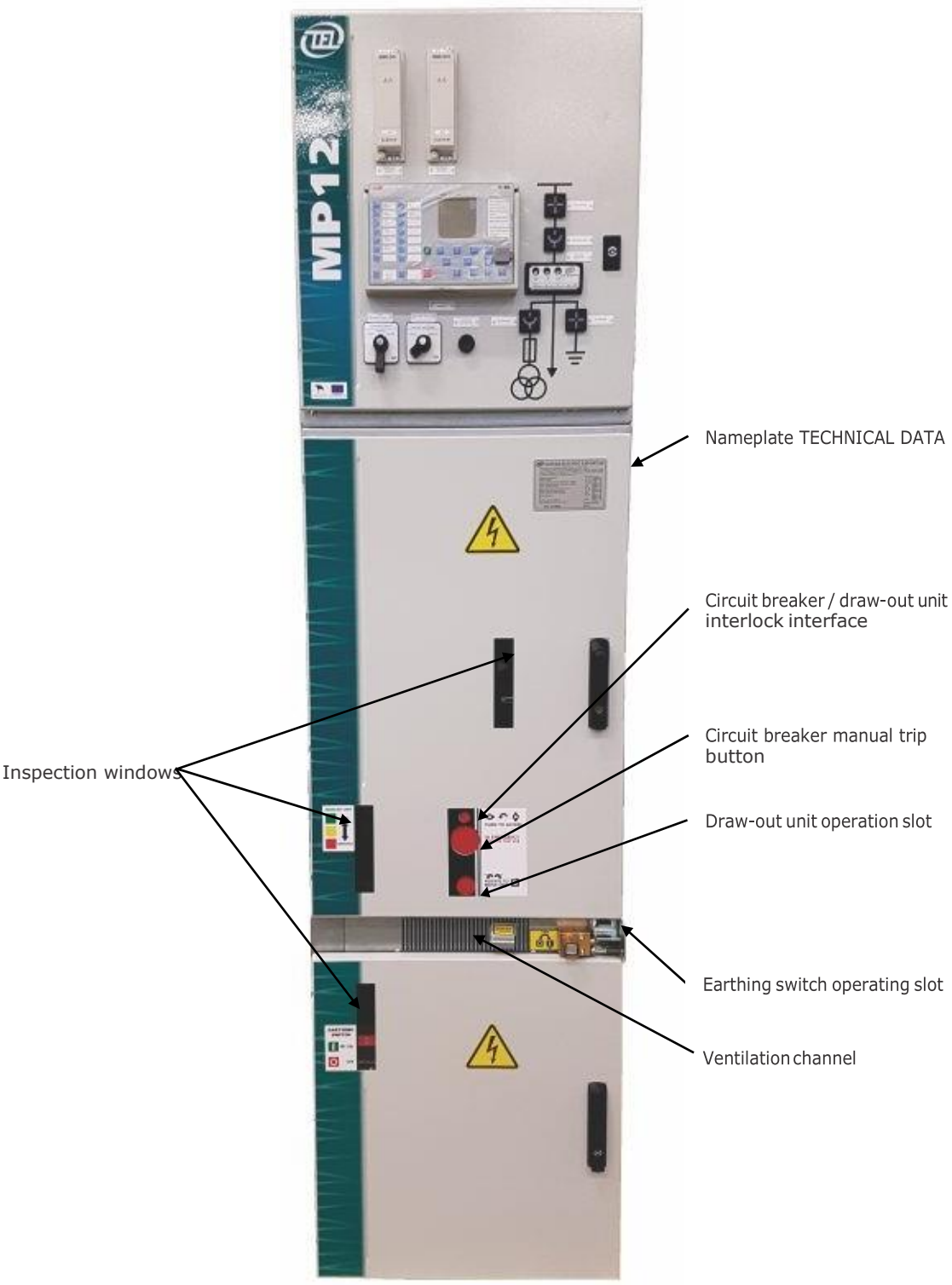
Prior to a busbar earthing switch CLOSE operation, the following conditions must be observed:

- all switching devices must be opened;
- all withdrawable parts must be racked out to the test position;
- all cable earthing switches must be closed;
- all secondary connection plugs must be connected.

If all of above mentioned points are observed, the busbar earthing switch is released for operation.

### 7.6 Appearance and interface of panel with draw-out unit with circuit breaker (IF, OF, BC, BT)

Cassette type panel with standard LV compartment



### 7.6.1 Operations with draw-out unit

Accessories:

Key 1 –
Draw-out unit interlock
SGcomp_Lever_Mile
(DoubleBit5)

Key 2 – for racking in and racking out draw-out unit
SGcomp_Lever_Mile
(DOUHandle)

**NB! DRAW-OUT UNIT MOVEMENT CAN BE DONE ONLY WHEN EARTHING SWITCH IS OPEN!**

**Draw-out unit movement from TEST to SERVICE position and switching circuit breaker.**
**Before closing the door make sure the interface position of manual disconnection on DOU is in the BLOCKED position.**

1. Close the door.
2. Push emergency disconnect button to guarantee that circuit breaker is open.
3. Socket for VCB blocking unit and manual disconnecting interface: Plug key 1 to draw-out unit interlock socket and turn to 90° counterclockwise to release access to draw-out unit operating interface.
4. Draw-out unit operating interface: Plug key 2 into the Draw-out unit operating interface and turn it clockwise until it stops (there must be clicking before the stop position).
5. Turn key 1 to 90° clockwise to permit operation with circuit breaker.
6. Take out key 1 from VCB blocking unit and manual disconnecting interface.
7. Circuit breaker is in SERVICE position.

**Draw-out unit movement from SERVICE to TEST position**

1. Switch off the circuit breaker with key 1, using the emergency disconnect push button.
2. VCB blocking unit and manual disconnecting interface: Plug key 1 to VCB blocking unit and manual disconnecting interface and turn to 90° counterclockwise to release access to draw-out unit operating interface.
3. Draw-out unit operating interface: Plug key 2 to draw-out unit operation socket and turn it counterclockwise until it stops (there must be clicking before the stop position).
4. Draw-out unit is in TEST position. Door can be opened.

**NB! IF CIRCUIT BREAKER IS CLOSED, TURNING KEY 1 TO 90˚ COUNTERCLOCKWISE WILL LEAD TO EMERGENCY TRIPPING OF CIRCUIT BREAKER.**

### 7.6.2 Operations with earthing switch

Accessories:

Key 3 – Earthing switch operating tool -
SGcomp_Lever_Mile(ESHandle)

**NB! FOR OPERATION WITH EARTHING SWITCH DRAW-OUT UNIT MUST BE IN TEST POSITION!**

**Switching ON**

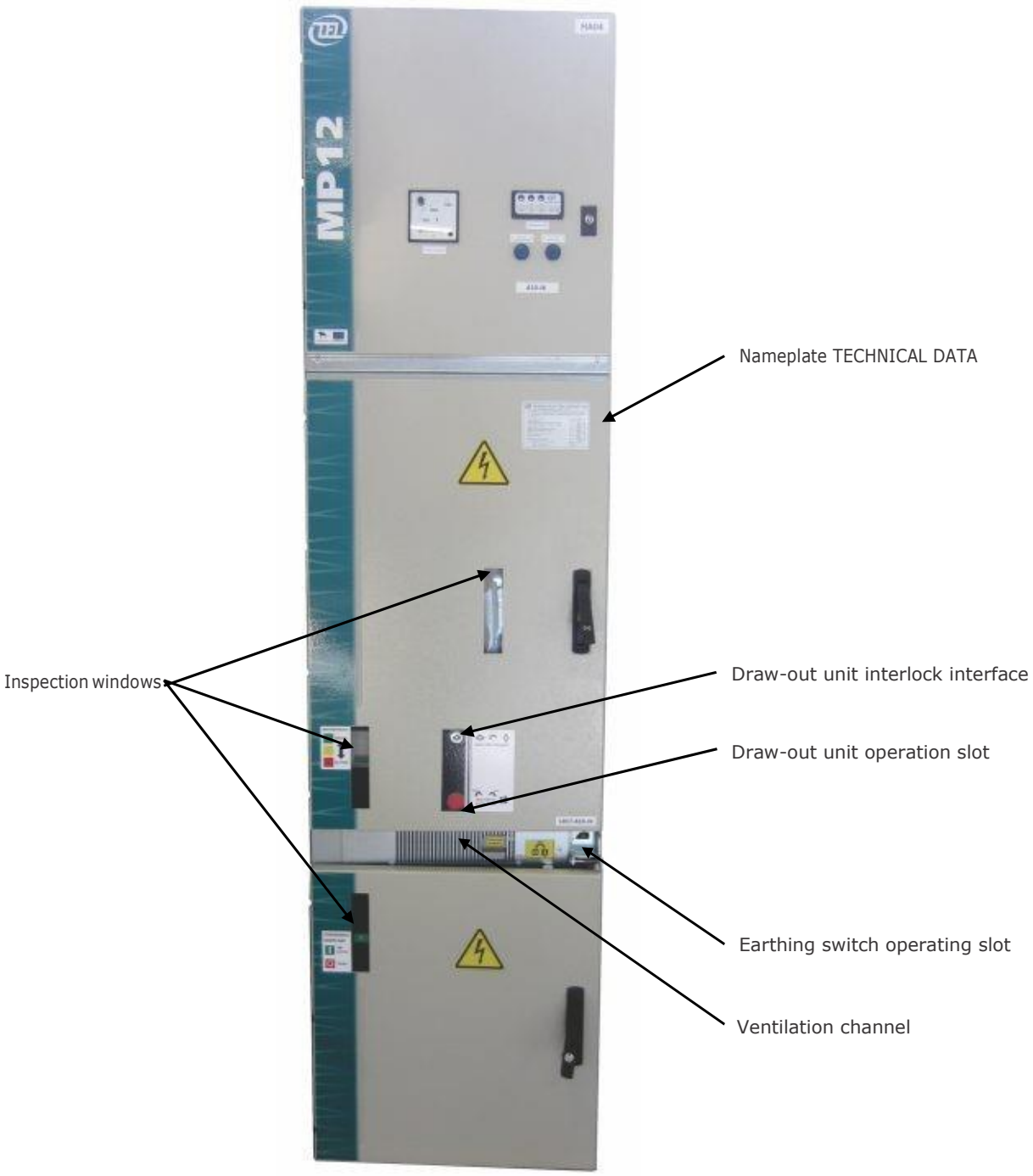
1. Open earthing mechanism cover.
2. Push the tag downward and insert earthing switch tool (3).
3. Turn tool to 180° clockwise to CLOSE earthing switch.
4. Remove the earthing switch tool to open cable compartment door.

**Switching OFF**

1. Close the cable compartment door.
2. Open earthing mechanism cover.
3. Push the tag downward and insert earthing switch tool (3).
4. Turn tool to 180° counterclockwise to OPEN earthing switch.
5. Remove the earthing tool.

### 7.7 Appearance and interface of panel with DOU and without circuit breaker (MES, M, BRES, BR, BRM)

Cassette type panel with standard LV compartment



### 7.7.1 Operations of switchgear with DOU and without circuit breaker

Accessories:

Key 1 –
Draw-out unit interlock
SGcomp_Lever_Mile
(DoubleBit5)

Key 2 – for racking in and racking out the draw-out unit - SGcomp_Lever_Mile (DOUHandle)

**NB! DRAW-OUT UNIT MOVEMENT CAN BE DONE ONLY WHEN EARTHING SWITCH IS OPEN!**

**Draw-out unit with VT movement from TEST to SERVICE position**

1. Close the door.
2. Socket for draw-out unit interlock: Plug key 1 into the draw-out unit interlock socket and turn 90° counterclockwise to release access to the draw-out unit operation socket.
3. Socket for draw-out unit operation: Plug key 2 into draw-out unit operation socket and turn it clockwise until it stops (there must be clicking before the stop position).
4. Turn key 1 to 90° clockwise to permit operation with circuit breaker.
5. Take out key 1 from draw-out unit interlock socket.

**Draw-out unit with VT movement from SERVICE to TEST position**

**ATTENTION! Ensure no voltage is present on either side before racking-out draw-out unit with insolation truck!**

1. Socket for draw-out unit interlock: Plug key 1 into the draw-out unit interlock socket and turn to 90° clockwise to release access to draw-out unit operation socket.
2. Socket for draw out unit operation: Plug key 2 into the draw-out unit operation socket and turn it counterclockwise until it stops (there must be clicking before the stop position).
3. Draw-out unit is in the TEST position. The door can be opened.

### 7.7.2 Operations with busbar earthing switch

Accessories:

Key 3 – Earthing switch operating tool- SGcomp_Lever_Mile(ESHandle)

**NB! FOR OPERATION WITH EARTHING SWITCH DRAW-OUT UNIT MUST BE IN TEST POSITION!**

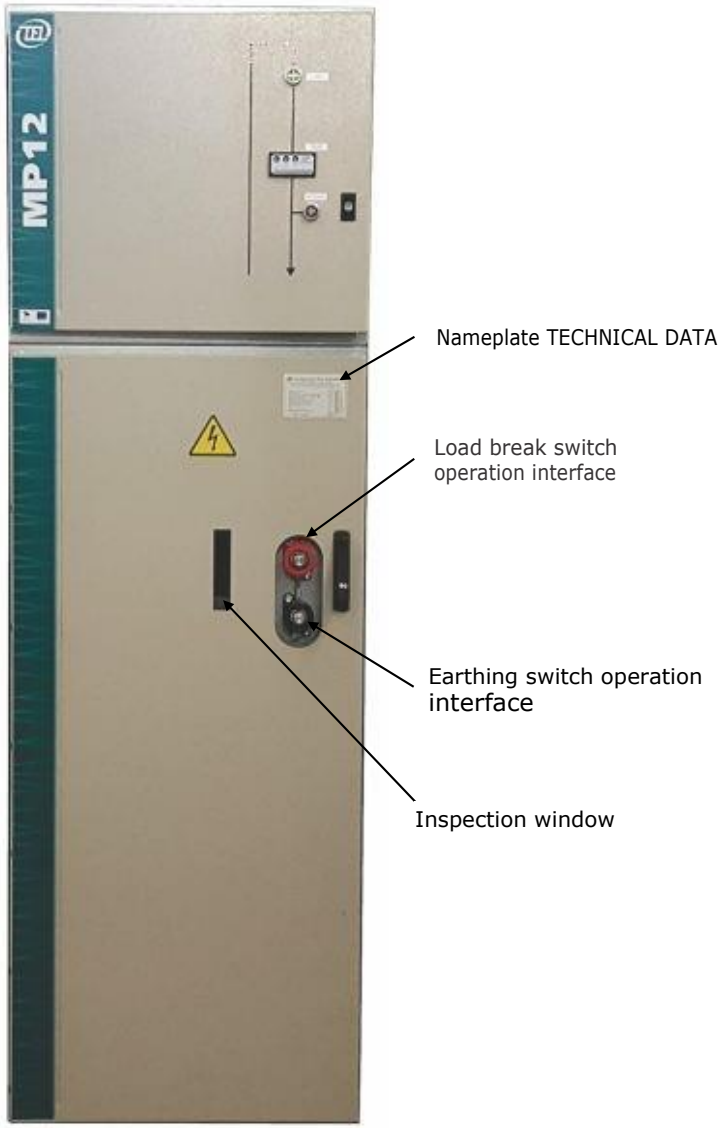
**Switching ON**

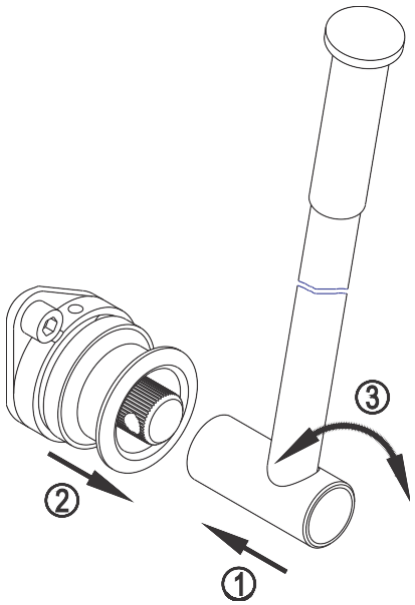
1. Open earthing mechanism cover.
2. Push the tag downward and insert earthing switch tool (3).
3. Turn tool to 180° clockwise to CLOSE earthing switch.
4. Remove the earthing switch tool to open cable compartment door.

**Switching OFF**

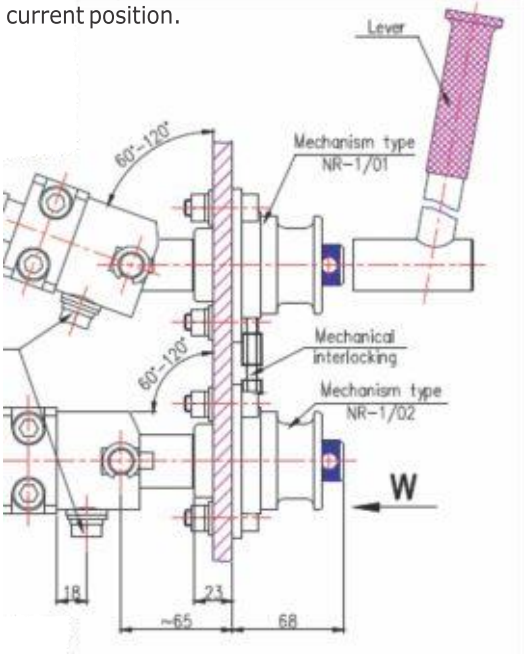
1. Close the cable compartment door.
2. Open earthing mechanism cover.
3. Push the tag downward and insert earthing switch tool (3).
4. Turn tool to 180° counterclockwise to OPEN earthing switch.
5. Remove the earthing switch tool.

## 7.8 Load-break switch panel LBSF




1. Attach the operating lever to the mechanism's shaft.
2. Pull back the operation sleeve.
3. Close or open the switch disconnector depend on its current position.




**The load break switch is mechanically and electrically interlocked with the earthing switch.**

### 7.8.1 Operations with load break switch

1. Attach the operation lever to the mechanism shaft.
2. To switch LBSF ON, turn operation lever 180° clockwise.
3. To switch LBSF OFF, turn operation lever 180° counterclockwise.

### 7.8.2 Operations with earthing switch

1. Attach the operation lever to the red mechanism shaft.
2. To switch earthing switch ON, turn operation lever 180° clockwise.
3. To switch earthing switch OFF, turn operation lever 180° counterclockwise.

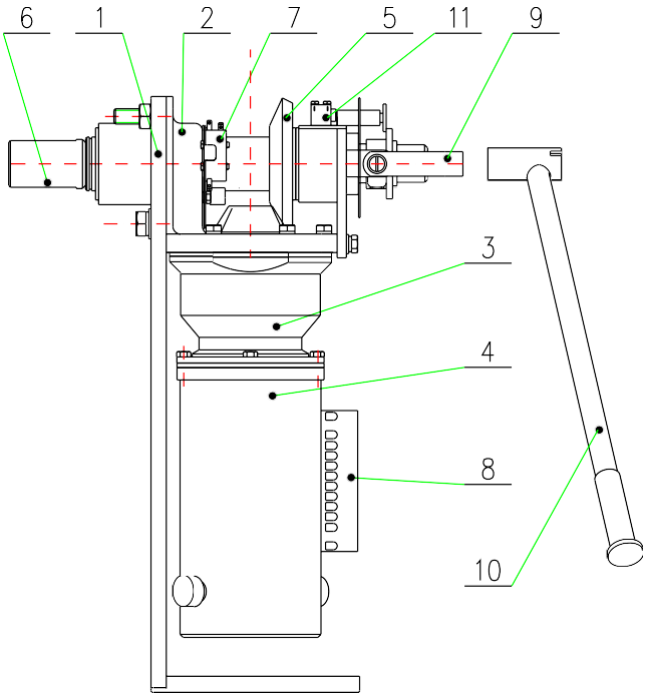
### 7.8.3 Load-break switch panel LBSF with motor operating device NSW30

Load break switches and earthing switches are available with motor drive in LBSF panel.

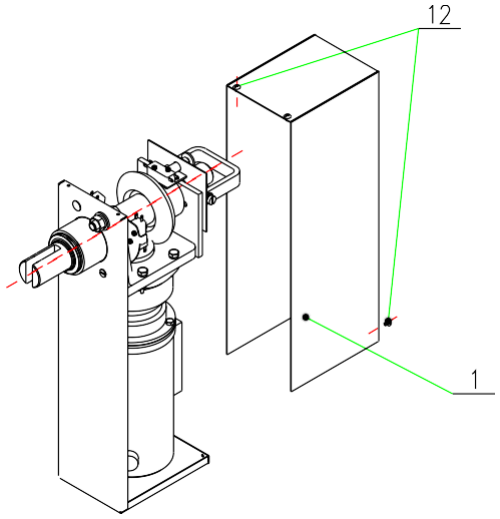

LBSF panel with motor operating devices inside

Motor operating device type NSW30 is designed for application within the medium voltage switchboard. The motor operating device can be operated manually or via remote control.
The motor operating device consists of:

- Graded gearbox mechanism, drives by DC series motor.
- Microswitches that switch the motor off after reaching nominal shaft angle.
- Terminals for control and supply circuit.
- Interlocking microswitch for disconnecting the supply when operating the device manually.




The operating device structure:
1 - Enclosure
1 - Frame
2 - Transmission
4 - Motor
5 - Gearbox
6 - Output shaft
7 - Microswitch
8 - Terminal strip
9 - Clutch hand grip/blocking holder
10 - Hand lever
11 – Interlocking microswitch




**Manual operation**
In the case of manual emergency operation, the following procedure should be followed:

1. Attach the operating lever - 10 on the blocking holder - 9.
2. Deflect operation sleeve as shown in the sketch below.
3. Attach the operating lever - 10 on the mechanism's shaft.
4. Close or open the switch disconnector depending on its position.

The output shaft should be blocked by setting back the blocking holder.

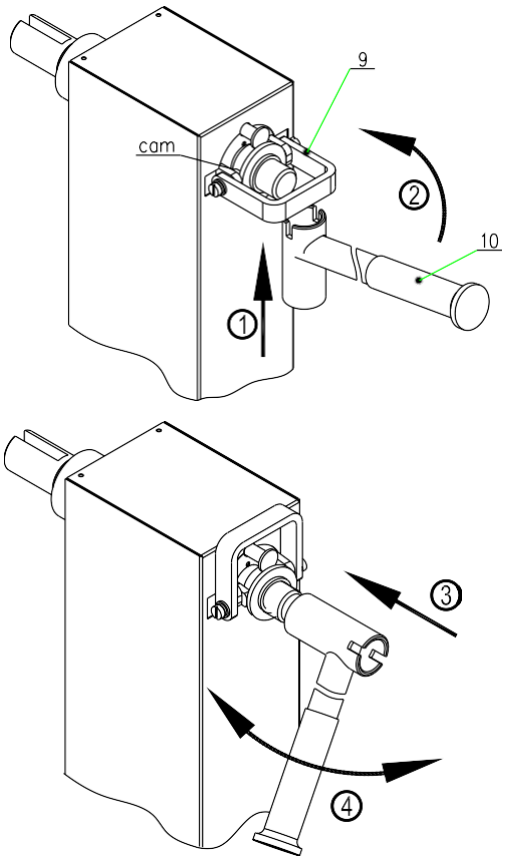
**NOTE: Ensure shaft coupling is complete after a manual operation (For primary position withdrawal).**

**Door Interlock**

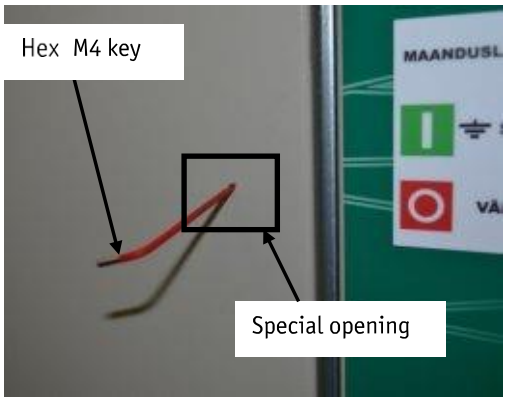
LBSF panel with a motor operating device for load break switch and earthing switch is equipped with an electromagnetic door interlock.
If the earthing switch is in the OPEN position, the interlock blocks LBSF panel door.

Opening of the blocked door in case of emergency - insert hexahedron spanner into special opening in the LBSF door and push.

Enclosure:
The enclosure - 1 is made of painted sheet aluminium. Its cover is bolted on with four pieces M2.9 bolts - 12. In the lower part, a 14mm cable choke will be found. It allows control and supply conductor connection.



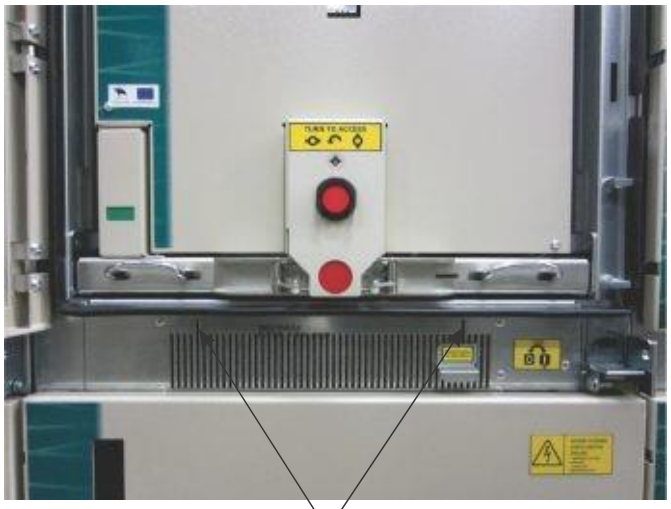

LBSF electromagnetic interlock door




Opening of a blocked door in case of emergency

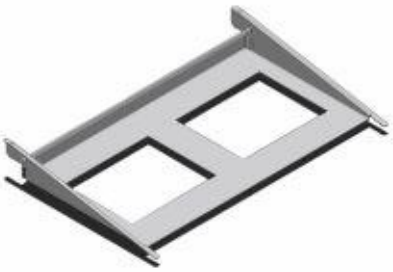
### 7.9 Service trolley operation

For the convenience of transportation, inserting and withdrawal of all types of DOUs, TEE has designed a Service Trolley. It is intended for application for both the circuit breaker compartment and the cable compartment DOUs. The service trolley has 2-level adjustable ramps. The upper ramp is used with the circuit breaker compartment DOUs, the lower ramp is used for the cable compartment DOUs. The service trolley is equipped with four wheels with stoppers, hardened handles, and a self-locking mechanism which guarantees secure coupling of the trolley and the SG_Mile switchgear during inserting and withdrawal operations. Both DOUs (the circuit breaker and the voltage transformer trucks) can be moved at once. Both DOUs are secured with sliding locks during their transportation on the trolley. The SG_Mile switchgear interface for service trolley operation is shown in the picture.



Openings for trolley guides

Trolley guides

Voltage transformer ramp

### 7.9.1 Inserting the draw-out unit to the panel

- Open the switchgear door.
- Position trolley in a such way that trolley guides are directed into the guide openings of the panel. Adjust the height of the ramp, if needed.
- Move the trolley close to the panel, push the trolley forward until the trolley guides clicks in.
- In order to release DOU, slide 2 handles simultaneously to the middle, holding the DOU handles push DOU into the compartment until it sets into place.
- The DOU must be fixed by clicking into 2 locks.
- Release DOU lock and roll it from panel.

Position trolley guides directed into the guide openings

Slide 2 handles simultaneously to the middle

Push DOU into the compartment until it sets into place

DOU is in the test position

Service trolley handle fixator should be pushed down for trolley guides fixing in the guide openings of the panel

### 7.9.2 Removing the draw-out unit from the panel

- Open the switchgear door.
- Disconnect the auxiliary plug. The DOU is in the isolated position.
- Move the trolley close to the panel as described above.
- In order to release DOU from the compartment, slide 2 handles simultaneously to the middle and pull DOU back on to the trolley ramp until the DOU fixing guides click.
- In order to remove the service trolley, press fixator handle downward and move the trolley back at the same time.

Service trolley handle fixator should be pushed down for trolley guides fixing in the guide openings of the panel

Position of trolley guides directed into the guide openings

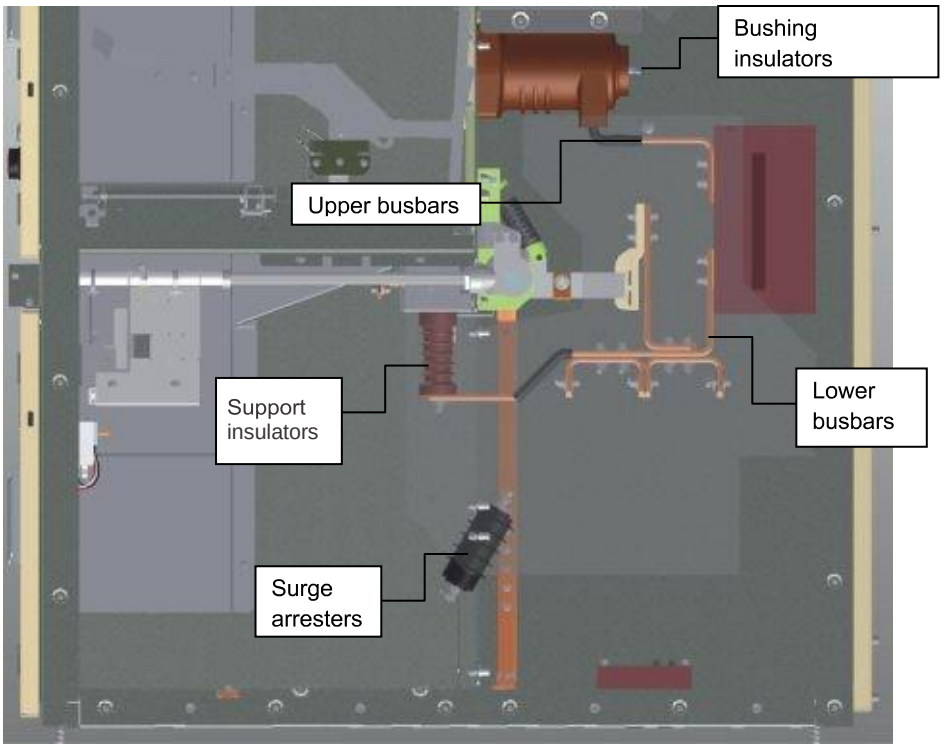
Slide 2 handles simultaneously to the middle

Pull DOU backward on the trolley ramp until the DOU fixing blades click

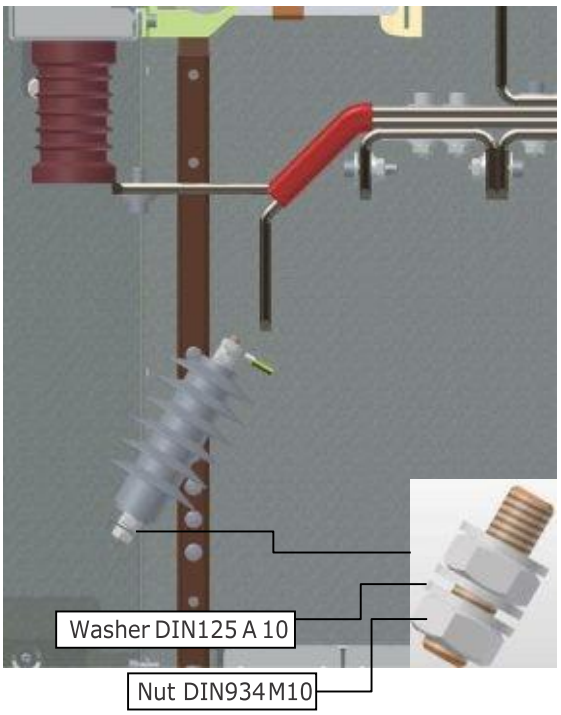
DOU is in the removed position

## 7.10 Current transformer replacement (front access only)

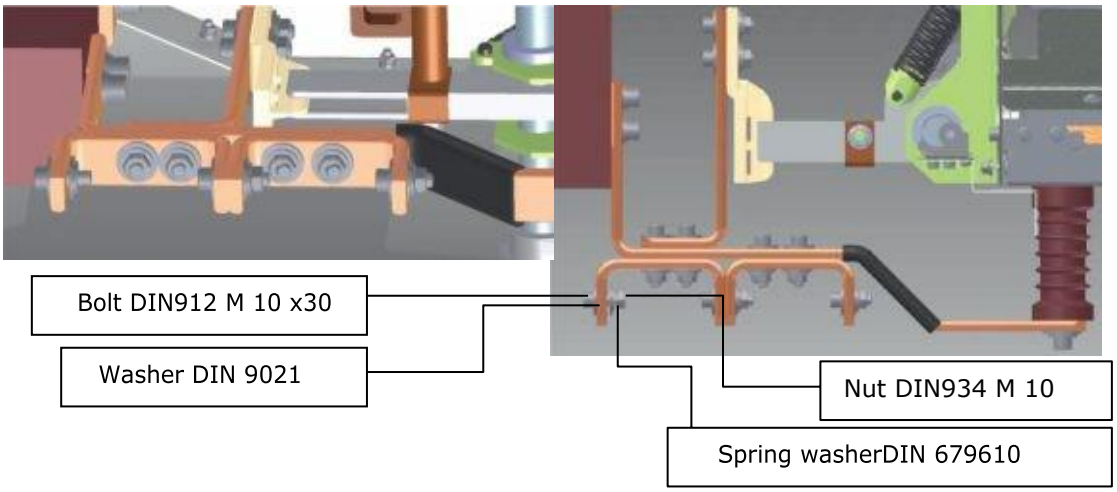
**General view of upper and lower branch busbars system, connected with current transformers (cassette type)**



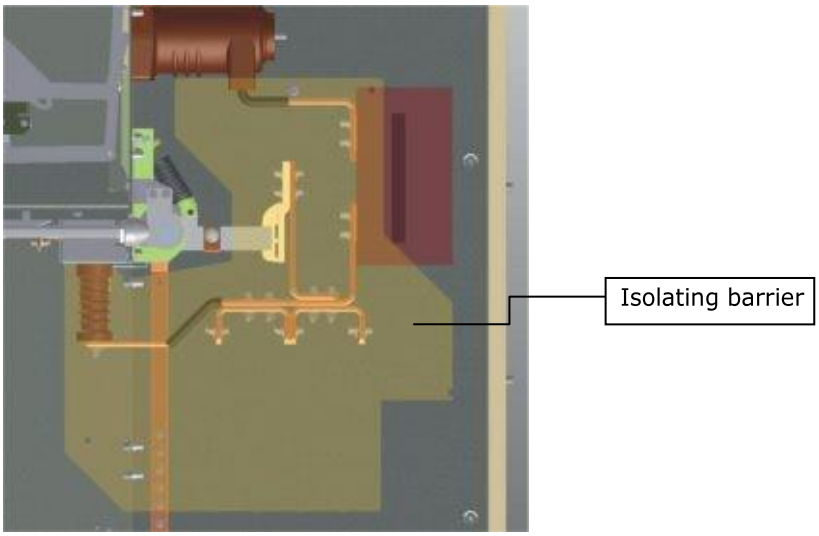

1. Make sure that the draw-out unit is in test position and circuit breaker is opened.
2. Close the earthing switch.
3. Make sure there is no voltage present, no light at LED diodes of the voltage indication unit. Double-check with a hot-stick indicator.
4. Open cable compartment door.
5. If surge arresters are installed, they should be removed first.



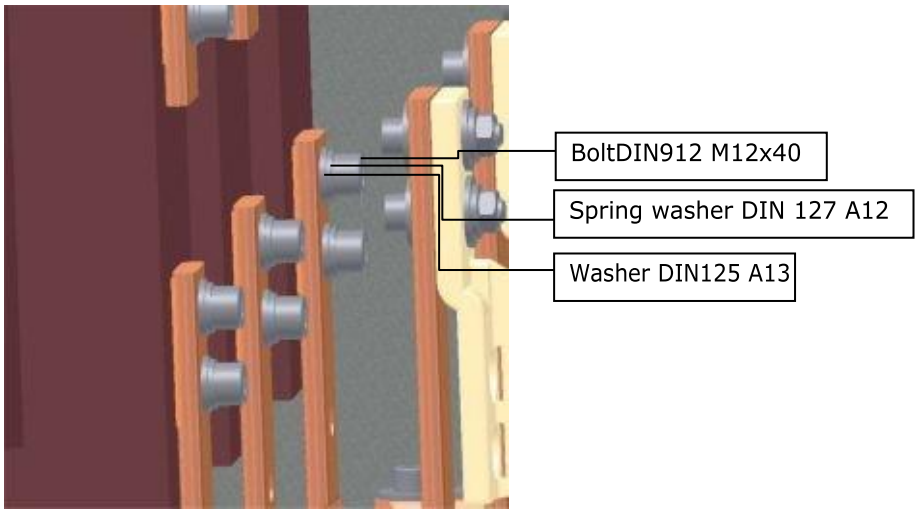
6. Disconnect power cables. Remove them carefully to cable cellar.



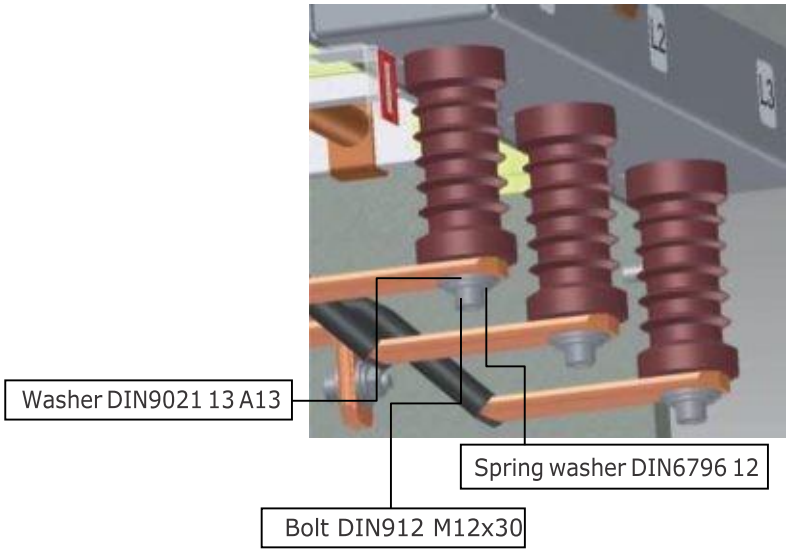

7. Remove isolating barriers fixed between phases.



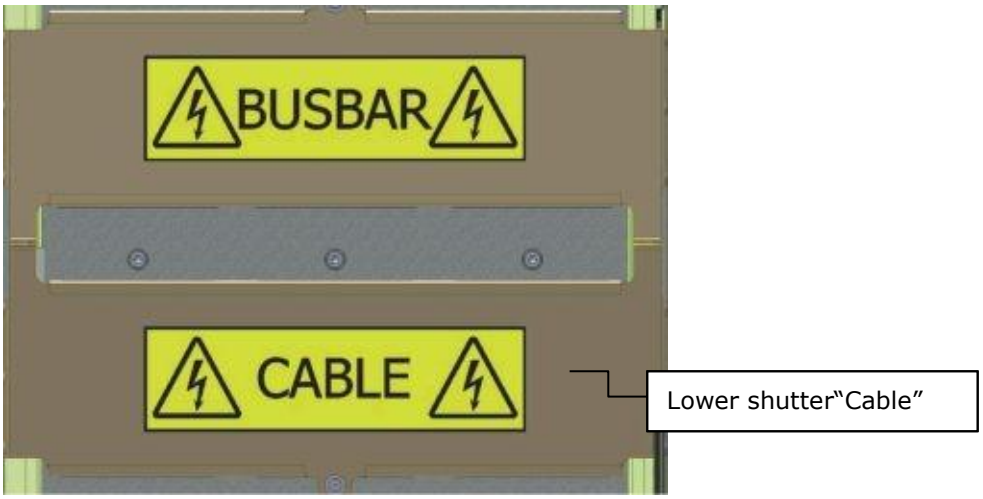

8. Dismantle the lower busbars.
   - Remove all current transformer lower busbars bolts.



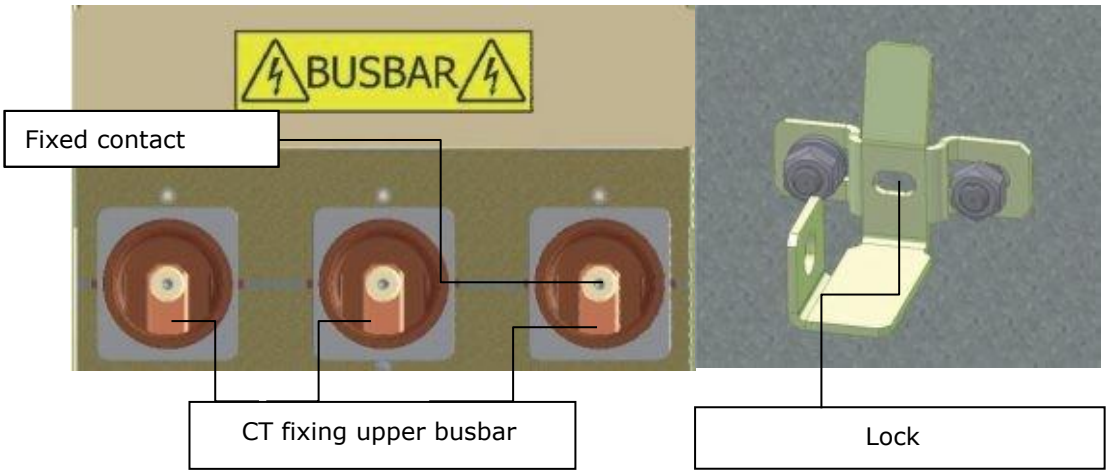
- Remove the bolt, that holds the lower busbars to the support insulator. Continue for all phases. (the busbar must be supported by hand, otherwise it may fall when all bolts are removed).



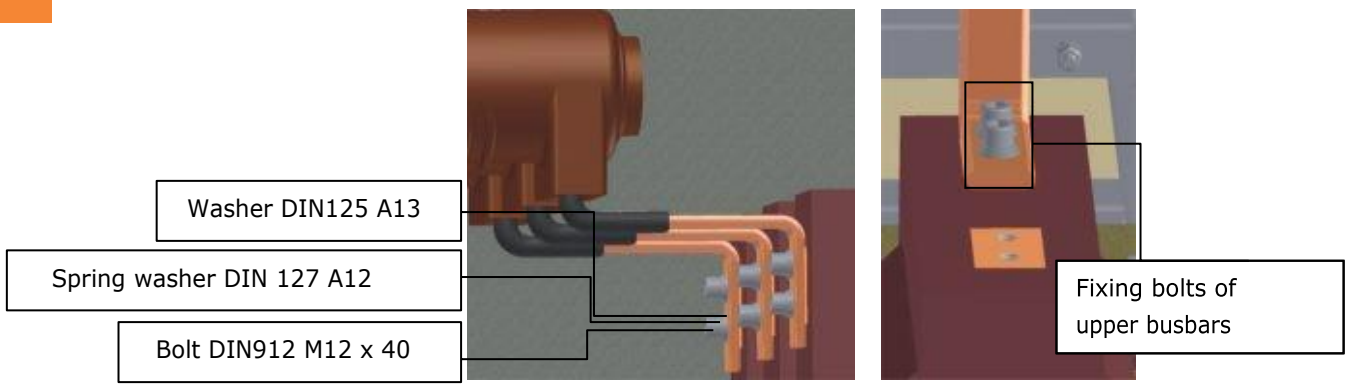

9. Disassemble the upper busbars.
   - Open the circuit breaker compartment door.



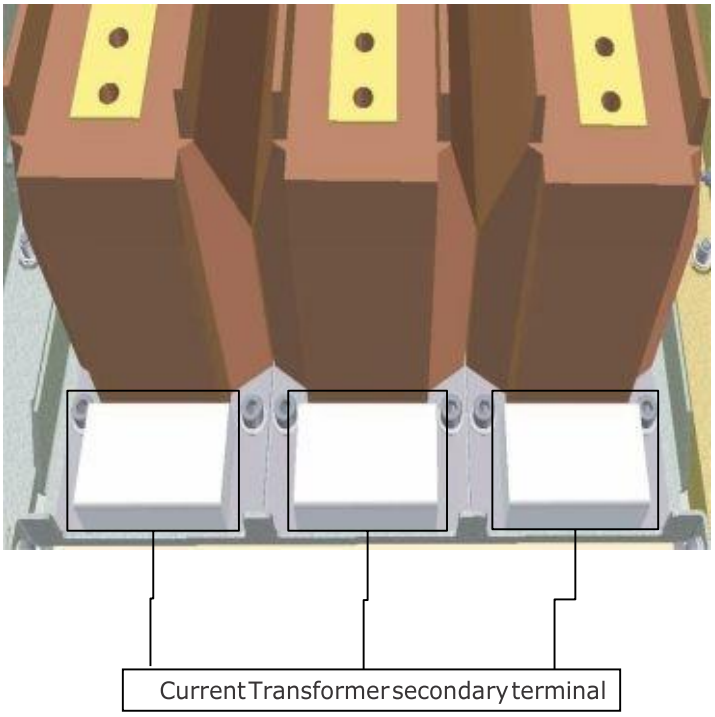

- Open the lower shutter "Cable" and fix it with the lock by manually lowering the shutter down until "click".



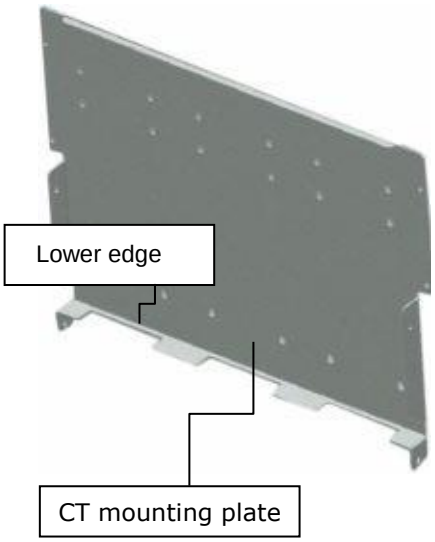
- Remove all CT upper connection bolts.
(the busbar must be supported by hand, otherwise it may fall when all bolts are removed).

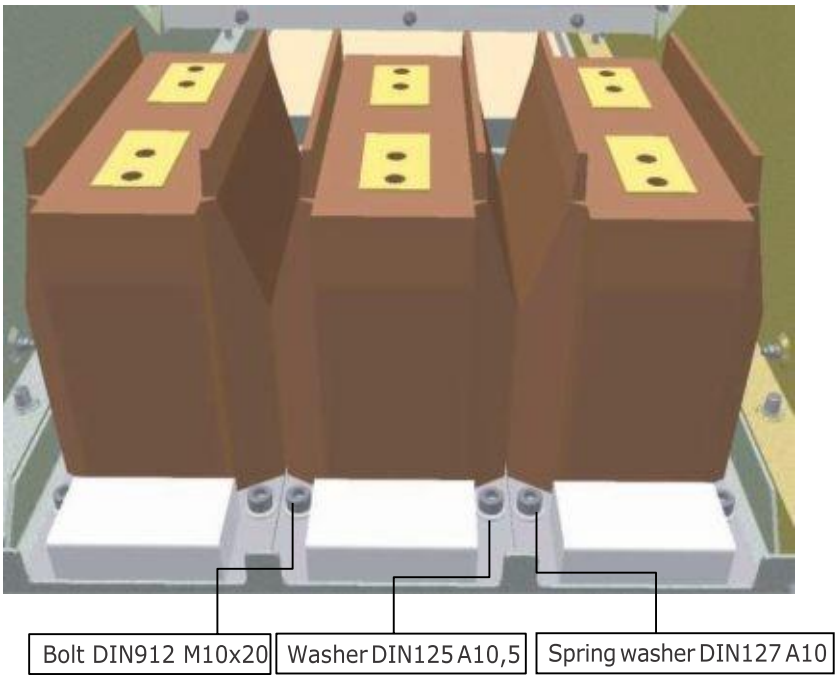



10 . Disconnect the secondary cables from CT secondary terminals.



11. Disconnect the current transformers from mounting plate.
    - Remove lower bolts (2 pcs).




- Remove upper bolts (2 pcs), holding the current transformer to the mounting plate with one hand (lower edge of the mounting plate bears the whole weight of the CT).

DANGER!


**NB! Please proceed with extreme caution, heavy items may fall.**

**NB! The current transformer primary connection threads are not designed for frequent bolt tightening or untightening. Threads can be damaged with frequent use.**

### 7.11 Set of tools

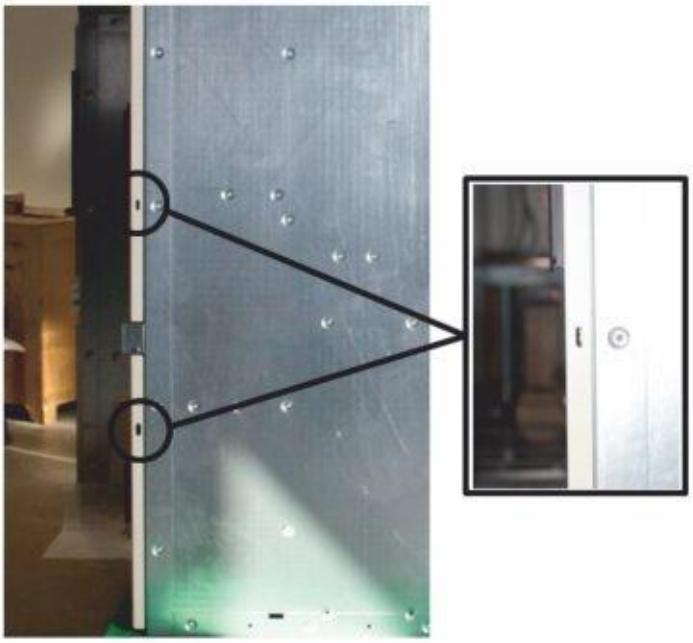
DOU operation tool
SGcomp_Lever_Mile(DOUHandle)

DOU interlock key
SGcomp_Lever_Mile(DoubleBit5)

Earth switch operation tool
SGcomp_Lever_Mile(ESHandle)

If the malfunction can not been determined and failure cannot be eliminated, please contact your nearest TEL office.

### 7.12 Opening the cable and circuit breaker compartment doors in case of emergency. Interlock bypass.



Two openings are located on the side of the cable and circuit breaker door.

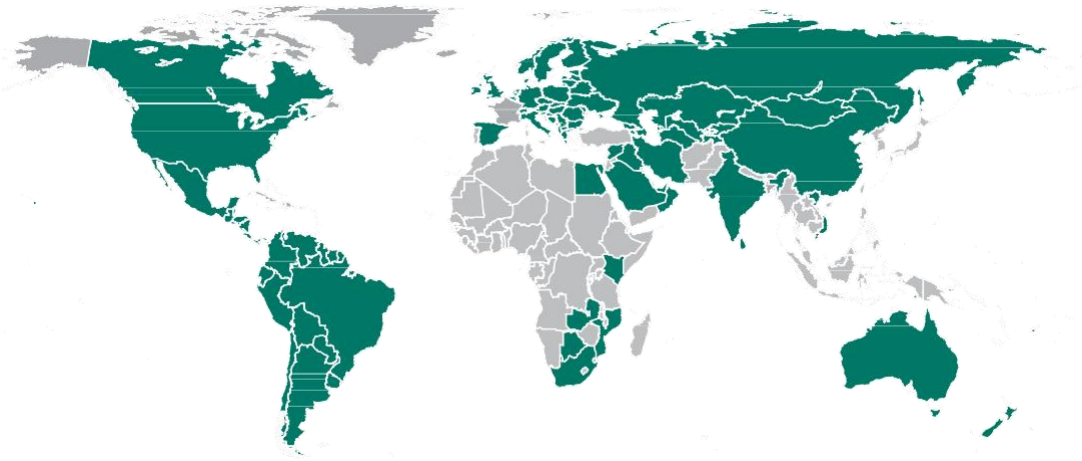
Put M4 hex key into the opening and unscrew two bolt that hold the interlocked hook.

When hook is released the door can be opened.

Hex M4 key

## 8. DISPOSAL

The equipment and materials applicable in SG_MILE series switchgear do not contain any materials that are hazardous for the environment or for personnel. No special methods of disposal are required.



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