SecoCube

36kV Gas Insulated Medium Voltage Switchgear
User Manual

Leading the future of electrification
Safety first!

Important recommendations:

- Switchgear should be installed in a clean, dry, ventilated room suitable for electrical equipment.
- Installation, operation and maintenance should be carried out by licensed electricians.
- Fully comply with the applicable standards (e.g. IEC or national standards), the utility connection requirements and the applicable safety regulations.
- Observe the relevant instructions in the instruction manual for all actions in relation to switchgear.
- Pay attention to the hazard notes in the instruction manual marked with this ⚠️ warning symbol.
- Make sure that the operating limits of the switchgear are not exceeded.
- Keep the instruction manual accessible to all personnel involved in installation, operation and maintenance.
- The users must act responsibly in all matters affecting safety at work and correct handling of the switchgear.

⚠️ WARNING

Always follow the instruction manual and respect the rules for good engineering practice! Hazardous voltage can cause electrical shocks and burns.

Disconnect power, then earth and short-circuit before proceeding with any work on the equipment!

Should you have any questions about this instruction manual, our field team will be pleased to provide the required information.

GE Energy reserves the right to correct any errors or omissions regarding this document. Check that the latest version of this document.
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1 General

1.1 Overview

SecoCube is an innovative cubicle gas-insulated switchgear platform provided by GE Energy. It perfectly combines HV gas insulated technology and MV metal enclosed technology together. All the high voltage parts, such as circuit breaker, disconnector, busbar etc. are effectively sealed in a stainless steel gas tank filled with high performance insulated gas; provide customer a compact, modular, smart, high performance and maintenance free switchgear.

With modern digital manufacturing, automatic testing, sensing, monitoring and protection technology, SecoCube provides perfect solutions for power distribution network, especially for metro, tunnel, railway, airport, mining, O&G, wind farm, and urban power grid substations, requiring high reliability.

1.2 Product Type

SecoCube - 40.5 / T

1.3 Operating Conditions

1.3.1 Normal Operating Conditions

The switchgears are fundamentally designed for the normal service conditions for indoor switchgears to GB 3906-2006 and the IEC 62271-200:2003.

- Ambient temperature
  - Maximum +40°C
  - Minimum -25°C
  - Daily average maximum temperature +35°C
- The maximum site altitude is 1000 m above sea level
- Humidity
  - Daily average relative humidity ≤ 95%
- Monthly average relative humidity ≤ 90%
- Daily average air pressure ≤ 2.2 × 10^{-3} MPa
- Monthly average air pressure ≤ 1.8 × 10^{-3} MPa

- The ambient shall not suffer obvious pollution caused by corrosive, flammable or explosive gas.
- Electromagnetic interference in the secondary system shall be less than 1.6kV.
- Pollution level is more than class II identified by IEC 507:1991

1.3.2 Special Operating Conditions

High altitude (> 1000m a.s.l.) SecoCube is available. Special operating conditions apply, please contact GE in advance.

In accordance with IEC 62271-1, the manufacturer and end-user must agree about special operating conditions which deviate from operation under normal conditions. The manufacturer/ supplier must be consulted in advance if especially severe operating conditions are involved.

1.4 Standard and Specification

SecoCube complies with the standards and specifications for factory-assembled, metal enclosed and type tested high voltage switchgear to IEC publications as given below.

<table>
<thead>
<tr>
<th>IEC Publication</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC62271-200 (GB3906)</td>
<td>High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52 kV</td>
</tr>
<tr>
<td>IEC62271-100 (GB1984)</td>
<td>High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers</td>
</tr>
<tr>
<td>IEC62271-1 (GB/T11022)</td>
<td>The Common specifications for high-voltage switchgear and control gear standards</td>
</tr>
<tr>
<td>IEC62271-102 (GB1985)</td>
<td>High-voltage switchgear and controlgear – Part 102: Alternating-current disconnectors and earthing switches</td>
</tr>
<tr>
<td>IEC 60480 (GB8905)</td>
<td>Guidelines for the checking and treatment of sulfur hexafluoride (SF6) taken from electrical equipment and specification for its re-use</td>
</tr>
<tr>
<td>IEC 62271-303 (GB 28537)</td>
<td>Test guide of SF6 gas tightness for high-voltage switchgear</td>
</tr>
<tr>
<td>IEC 60376 (GB 12022)</td>
<td>Sulphur hexafluoride for industrial use</td>
</tr>
<tr>
<td>DL/T 593</td>
<td>Common specifications for high-voltage switchgear and controlgear</td>
</tr>
<tr>
<td>DL/T 404</td>
<td>Indoor AC High Voltage Switchboard Ordering requirement</td>
</tr>
</tbody>
</table>

All other corresponding IEC publications, national or local safety regulations must be followed during the installation and operation of the switchgear. In addition, any project specific advice from GE must be considered.
# 2 Technical Specification

<table>
<thead>
<tr>
<th>General</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated voltage</strong></td>
<td>kV</td>
<td>27/24/17.5/13.8</td>
</tr>
<tr>
<td><strong>Rated power frequency withstand voltage (1min)</strong></td>
<td>kV</td>
<td>95*(1)</td>
</tr>
<tr>
<td>To earth/phase to phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Across isolating distance</td>
<td>kV</td>
<td>118*(1)</td>
</tr>
<tr>
<td><strong>Rated lightning impulse withstand voltage</strong></td>
<td>kV</td>
<td>185*(1)</td>
</tr>
<tr>
<td>To earth/phase to phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Across isolating distance</td>
<td>kV</td>
<td>215*(1)</td>
</tr>
<tr>
<td><strong>Rated frequency</strong></td>
<td>Hz</td>
<td>50/60</td>
</tr>
<tr>
<td><strong>Rated current</strong></td>
<td>A</td>
<td>1250, 2500*(2)</td>
</tr>
<tr>
<td><strong>Single capacitor bank breaking capacity</strong></td>
<td>A</td>
<td>400 *(2)</td>
</tr>
<tr>
<td><strong>Rated cable charging breaking current</strong></td>
<td>A</td>
<td>50</td>
</tr>
<tr>
<td><strong>Rated short circuit breaking current</strong></td>
<td>kA</td>
<td>31.5</td>
</tr>
<tr>
<td><strong>Rated short circuit making current(peak)</strong></td>
<td>kA</td>
<td>82</td>
</tr>
<tr>
<td><strong>Rated short time withstand current and endurance time</strong></td>
<td>kA/s</td>
<td>31.5/3s</td>
</tr>
<tr>
<td><strong>Rated peak withstand current</strong></td>
<td>kA</td>
<td>82</td>
</tr>
<tr>
<td><strong>Operating Sequence</strong></td>
<td></td>
<td>O-0.3s-CO-180s-CO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>O-0.3s-CO-15s-CO</td>
</tr>
<tr>
<td><strong>Gas System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Insulated gas</strong></td>
<td></td>
<td>50%SF₆+50%N₂</td>
</tr>
<tr>
<td><strong>Annual leakage rate</strong></td>
<td>%/Y</td>
<td>≤0.1</td>
</tr>
<tr>
<td><strong>Rated gas pressure (abs, 20˚C)</strong></td>
<td>MPa</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>Alarm pressure (abs, 20˚C)</strong></td>
<td>MPa</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Minimum operating pressure (abs, 20˚C)</strong></td>
<td>MPa</td>
<td>0.10</td>
</tr>
<tr>
<td><strong>Degree of protection</strong></td>
<td></td>
<td>IP65</td>
</tr>
<tr>
<td><strong>Gas tank</strong></td>
<td></td>
<td>IP4X</td>
</tr>
<tr>
<td><strong>Enclosure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions and weight</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions(W×D×H)</strong></td>
<td>mm</td>
<td>600×1500×2400</td>
</tr>
<tr>
<td>1250A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2500A</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>kg</td>
<td>800 ~ 1000</td>
</tr>
<tr>
<td>1250A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2500A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* (1) Can maintain the rated insulation level at 0.00 MPa (rel.) SF6 pressure.
* (2) 2300A at 60Hz
* (3) At 50Hz
3 Configuration

3.1 SecoCube Configuration

VCB gas tanks and main busbar gas tank are manufactured of 3 mm stainless sheet by laser cutting and laser welding process. The enclosure, framework, sidewalls and base are manufactured of 2mm galvanized steel sheet and assembled by bolts. Front cover and side cover of end panel are made of high-quality cold-rolled steel sheet with painting process, which provides an excellent corrosion-proof capability. Personnel can access the cable compartment to install or maintenance HV cables after removing the cable compartment cover.
Warning:
Do not allow to force open the cable compartment door when the panel is engaged, otherwise it will damage the electrical interlocking and defeat the security.

The main components of SecoCube include SecoVac-G vacuum circuit breaker, IST three-position disconnector, CTs, plug-in VT, plug-in arrester, main busbar system, cable terminal etc. Protection and control device are installed in LV compartment. The main busbar connection between panels can be completed through plug-in busbar connectors.

SecoCube-40.5 offers the single busbar solutions as follows:
- Incoming and outgoing feeder panels
- Bus sectionalizer panel
- Disconnect/riser panel
- VT + Surge arrester panel
- Metering panel
- Above functional panels with multiple cables incoming or outgoing in parallel.

3.2 Insulated Gas System

All high voltage live components are completely sealed inside the gas tanks and independent of environmental influence. Each gas tank has its independent gas system and pressure relief device. Gas density sensor and/or pressure gauge can be fitted. The gas tank of each panel is independent to each other. Desiccant bags are placed in every gas tank. The insulation gas is maintenance free under normal operating conditions.

3.2.1 Monitor SF6 Gas Pressure

Each gas tank is equipped with a temperature compensated gas pressure gauge (density indicator or density monitor on request) to indicate its inner pressure. In case the pressure inside the tank falls below the preset alarming pressure, the density monitor will give an alarm signal or trip the circuit breaker. Compared with density monitor

SecoCube can maintain the rated insulation level at 0.00 MPa (rel.) SF6 pressure.
Figure 3.2 Temperature compensated pressure gauge (standard)
* Compared with gas density indicator and gas density monitor, pressure gauge doesn't have function to send alarm signal.

Figure 3.3 Gas density indicator (Optional)
* When a gas density indicator is fitted, operator can monitor the gas pressure both locally and remotely.

Figure 3.4 Gas density monitor (Optional)
* Without local indicator, Gas density monitor is used to monitor the gas pressure remotely.

3.2.2 Limitation of Internal Arc fault

In the event of internal arc fault, the gas density indicator/monitor could give out signal to the relay to trip the circuit breaker.
Each gas tank of SecoCube is equipped with a pressure relief device. If an internal arc fault occurs, and the actual pressure exceeds its designed pressure, the pressure relief device will open, allowing the pressurized gas flowing to the pressure relief channel at the top or bottom of the switchgear, to release the pressure. Thus ensures the safety of the equipment and personnel.

![Figure 3.5 Pressure relief device](image)

### 3.2.3 Design And Description Of Arc Duct

An arc fault is a fault in which the current flow is through the air as opposed to a short circuit faults where in the solid connection between the conductors causes the current to flow. The arc fault can happen due to many reasons like improper usage of equipment or aging of parts. Arc faults cause both personnel hazard and significant economic losses due to damage to equipment and interruption of process. The damage is caused due to the let through energy through the fault which develops enormous amount of pressure, heat etc.

In the unlikely event of an internal arc fault, the pressure generated inside is guided into the pressure relief ducts through the pressure relief vents.

The switchgear panel is designed to sustain the internal arc fault in main busbar, breaker and cable compartments independently. The switchgear has provided the arc ducts on the side walls of the panel to channel out the gases generated during the internal arc fault inside the compartments to the outside of the switchgear panel in order to prevent the damages in the panel and to the operating personnel.

- In case of an arc fault in circuit breaker tank, the pressure relief vent opens and guides the pressure outside through the arc duct installed on the side walls of the panel. (Refer Figure 3.5)
In the event of an internal arc fault in main busbar tank, the pressure relief vent in main busbar tank opens to guide the pressure outside through the installed arc duct on the side walls of the panel (Refer Figure 3.6).

In the case of an arc fault in cable compartment, the pressure relief flap opens in the pressure relief.
duct and the gases are channeled out through the duct. Figure 3.7.

Figure 3.8: Channeling out of gases from cable compartment through arc duct

From the figures shown above, it can be observed that the arc duct is installed on the side walls of the panel which is in green color. The arrows are marked to show the gases been channeling out. The pressure relief disks are provided for both the breaker tank and the main busbar tank. In case of arc fault happens in breaker tank, the pressure relief disk in breaker tank opens and the gas is guided to arc duct through the top (as shown in Figure 3.5), while arc fault happens in main busbar tank, the pressure relief vent opens and it releases the gas through arc duct from bottom of the panel (as shown in Figure 3.6).

3.3 SecoVac-G Embedded Pole Vacuum Circuit Breaker

3.3.1 Function

SecoVac-G vacuum circuit breaker performs the following functions:

- Making and breaking the load current.
- Making and withstanding the short circuit fault current.
- Breaking the fault current, such as short circuit current.

The embedded poles inside SecoVac-G vacuum circuit breaker are arranged vertically into the circuit breaker gas tank. The operating mechanism is mounted outside the gas tank, convenient for maintenance. The mechanical endurance of SecoVac-G is 10000 operations.
### 3.3.2 Circuit Breaker Specification

SecoVac-G Vacuum Circuit breaker

| General |
|-----------------|-----------------|-----------------|
| Rated voltage   | kV              | 27/24/17.5/13.8 | 36              |
| Rated insulation level **(2)** | kV              | 95**(1)**       | 95**(1)**       |
| Rated frequency withstand voltage (1min) | kV              | 185**(1)**      | 185**(1)**      |
| Rated lightning impulse withstand voltage | kV              | 185**(1)**      | 185**(1)**      |
| Rated frequency | Hz              | 50/60           | 50/60           |
| Rated current   | A               | 1250, 2500**(2)** | 1250, 2500**(2)** |
| Single capacitor bank breaking capacity | A               | 400 **(3)**   | 400 **(3)**   |
| Rated cable charging breaking current | A               | 50              | 50              |
| Rated shortcircuit breaking current | kA              | 31.5            | 31.5            |
| Rated shortcircuit making current(peak) | kA              | 82             | 82             |
| Rated short time withstand current and endurance time | kA/s            | 31.5/3s        | 31.5/3s        |
| Rated peak withstand current | kA              | 82             | 82             |
| Mechanical Characteristic |
| Closing time (Rated operating voltage) | ms              | 50 ~ 80         | 50 ~ 80         |
| Opening time (Rated operating voltage) | ms              | 25 ~ 40         | 25 ~ 40         |
| Mechanical endurance | times          | 10000 (Class M2) | 10000 (Class M2) |
| Rated voltage of auxiliary circuit | V               | DC 24, 30, 36, 48, 60, 110, 125, 220; AC 110, 125, 220, 240 | DC 24, 30, 36, 48, 60, 110, 125, 220; AC 110, 125, 220, 240 |
| Opening speed | m/s             | 1.4 ~1.9        | 1.4 ~1.9        |
| Closing speed | m/s             | 0.6 ~1.3        | 0.6 ~1.3        |
| Clearance between open contacts | mm             | 19 ± 1.0        | 19 ± 1.0        |
| Bouncing time during closing | ms             | ≤3             | ≤2             |
| Asynchronous time during closing | ms             | ≤2             | ≤2             |
| Asynchronous time during opening | ms             | ≤2             | ≤2             |

* (1) Can maintain the rated insulation level at 0.00 MPa (rel.) SF6 pressure.
* (2) 2300A at 60Hz
* (3) At 50Hz
Motor

The spring charge motor will be charged automatically after each closing operation of the circuit breaker.

Manual charging carried out by plugging the charging handle is only used when auxiliary power supply is out of service.

<table>
<thead>
<tr>
<th>Rated Voltage (kV)</th>
<th>Normal Operation Voltage Scope</th>
<th>Energy Storing Period Under Rated Operation Voltage (S)</th>
<th>Input Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC110</td>
<td>85% ~110%</td>
<td>≤10</td>
<td>90</td>
</tr>
<tr>
<td>DC220</td>
<td>85% ~110%</td>
<td>≤10</td>
<td>90</td>
</tr>
<tr>
<td>AC110</td>
<td>85% ~110%</td>
<td>≤10</td>
<td>90</td>
</tr>
<tr>
<td>AC220</td>
<td>85% ~110%</td>
<td>≤10</td>
<td>90</td>
</tr>
<tr>
<td>DC125</td>
<td>85% ~110%</td>
<td>≤10</td>
<td>90</td>
</tr>
<tr>
<td>DC60</td>
<td>85% ~110%</td>
<td>≤10</td>
<td>90</td>
</tr>
<tr>
<td>DC48</td>
<td>85% ~110%</td>
<td>≤10</td>
<td>90</td>
</tr>
</tbody>
</table>

Closing Trip Coil

While energized, the closing trip coil is tripped to release the spring energy and close the circuit breaker.

<table>
<thead>
<tr>
<th>Rated Voltage (kV)</th>
<th>Normal Operation Voltage Scope</th>
<th>Rated Current (A)</th>
<th>Input Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC 24</td>
<td>80% ~ 110%</td>
<td>11.86</td>
<td>220</td>
</tr>
<tr>
<td>DC 30</td>
<td>80% ~ 110%</td>
<td>10.78</td>
<td>220</td>
</tr>
<tr>
<td>DC 36</td>
<td>80% ~ 110%</td>
<td>8.84</td>
<td>220</td>
</tr>
<tr>
<td>DC 48</td>
<td>80% ~ 110%</td>
<td>5.97</td>
<td>220</td>
</tr>
<tr>
<td>DC 60</td>
<td>80% ~ 110%</td>
<td>3.55</td>
<td>220</td>
</tr>
<tr>
<td>DC 110</td>
<td>80% ~ 110%</td>
<td>1.92</td>
<td>220</td>
</tr>
<tr>
<td>DC 125</td>
<td>80% ~ 110%</td>
<td>1.73</td>
<td>220</td>
</tr>
<tr>
<td>DC 220</td>
<td>80% ~ 110%</td>
<td>1.07</td>
<td>220</td>
</tr>
<tr>
<td>AC 110</td>
<td>85% ~ 110%</td>
<td>1.92</td>
<td>220</td>
</tr>
<tr>
<td>AC 125</td>
<td>85% ~ 110%</td>
<td>1.73</td>
<td>220</td>
</tr>
<tr>
<td>AC 220</td>
<td>85% ~ 110%</td>
<td>1.07</td>
<td>220</td>
</tr>
</tbody>
</table>
Opening Trip Coil

Opening trip coil is tripped by protection relay or control device to open the circuit breaker.

<table>
<thead>
<tr>
<th>Rated Voltage (kV)</th>
<th>Normal Operation Voltage Scope</th>
<th>Rated Current (A)</th>
<th>Input Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC 24</td>
<td>65% ~ 120%</td>
<td>11.86</td>
<td>220</td>
</tr>
<tr>
<td>DC 30</td>
<td>65% ~ 120%</td>
<td>10.78</td>
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<tr>
<td>DC 36</td>
<td>65% ~ 120%</td>
<td>8.84</td>
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<td>DC 48</td>
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<tr>
<td>AC 220</td>
<td>85% ~ 120%</td>
<td>1.07</td>
<td>220</td>
</tr>
</tbody>
</table>

Anti-pumping Device

If constant CLOSE and OPEN commands are present at the vacuum circuit-breaker at the same time, the vacuum circuit-breaker will return to the open position after closing. It remains in this position until a new CLOSE command is given. In this manner, continuous closing and opening (pumping) is avoided.
3.3.3 Configuration of SecoVac-G

Figure 3.9 SecoVac-G vacuum circuit breaker

The vacuum interrupter of the VCB is of an optimized design, the ceramic insulator is compact with high insulation level and a high current breaking capability. The contacts are made of Copper-Chromium, with excellent abrasion resistance, long electrical endurance, and high short circuit breaking capacity. The embedded poles are assembled on the flange plate of the frame. The vacuum interrupter and terminals are fixed inside the embedded pole by APG epoxy moulding process.
The vacuum circuit breaker is equipped by a modularized spring-charging mechanism, which can be operated manually or electrically. Thanks to the optimized design, fewer components are used and high reliability is realized.

The VCB enclosure also serves as the frame for the operating mechanism. The enclosure is divided into five sections by four pre-assembled plates of the opening and closing modules. The transmission, charging, tripping, closing and damping device are mounted inside. Opening and closing the circuit breaker is realized by controlling the main shaft.

The embedded poles with vacuum interrupter inside and operating mechanism are assembled as a whole part, which simplify the transmission device and optimize the mechanical characteristics. Such design reduces the energy consumption and improves the mechanical reliability.

### 3.3.4 Principle of Arc Extinguishing

The arc inside the vacuum interrupter is extinguished by axial magnetic field (AMF) principle. The vacuum interrupter has a very high vacuum degree and a very low contact resistance.

When the VCB breaks normal load current or fault current in the serving power system, vapour arc arises between the moving and fixed contacts. There will be axial magnetic field between the open contacts which makes the arc moving around the contact surface with low arc voltage. The arc is extinguished at the first natural zero of the alternating current after switch-off, while the ion, electron and metal vapour will polymerize together to re-establish a high dielectric strength between the contacts. Then the current flow is securely interrupted.

### 3.3.5 Charging The Mechanism

The mechanism can be charged manually or electrically.

In electrical charging procedure, the charging shaft (16) will be driven by the sprocket under the control of the torque output of the charging motor. Then the charging lever (15) will move to charge the closing spring.

When the closing spring charging is completed, the energy is retained by the retention stop(13). At the same time, the cam(19) push the lever to drive the micro switch in order to switch off the power supply of the motor. Then the position indicator on the circuit breaker panel shows “charged”.

The motor (18) will finish its charging automatically after each closing of the circuit breaker in electrical operation procedure.

Manual charging will be carried out by plugging the charging handle (Figure 3.10) into the aperture. Push the handle up and down repeatedly until hearing a “clicking” sound, and then the spring is fully charged.
Note: Once the operator fell the gear or handle have gotten the power, approximately 15 cycles up and down will finish the charge operation.

### 3.3.6 Closing Operation

When receive the closing signal after the mechanism is charged, the closing solenoid (10) will be energized and move forward. Driven by the closing lever (11), the closing half shaft (12) turns and release the restriction conducted by the retention stop (13) on the charging shaft (16). The closing spring (14) will release the charged energy and drive the charging shaft (16) and cam (19) to turn clockwise. The main shaft (7) will be driven by its driving lever and the cam (19) to make the insulating coupling rod inside the embedded pole moving upward to close the circuit breaker by controlling the 4-level mechanism (9). Then the position indicator on the circuit breaker panel shows “I” (as shown in Figure 3.11(a)). Manual closing can be realized by pressing the “I” button in green on the front panel of the circuit breaker (as shown in Figure 3.11(b)).
3.3.7 Opening Operation

When receive the opening signal after the closing operation is completed, the opening solenoid (24) will be energized and move forward. Driven by the opening lever (23), the opening half shaft (22) turns to make the main shaft (7) turn clockwise under the force of the opening spring (6) and the closing spring. The main shaft (7) drives the 4-level mechanism (9) to move. The insulating coupling rod (3) pulls the insulating rod of the vacuum interrupter downward to open the circuit breaker. Then the position indicator on the circuit breaker panel shows “O”.

Manual opening can be realized by pressing the “O” button in red on the front panel of the circuit breaker (as shown in Figure 3.12).

![Figure 3.13 SecoVac-G front panel](image)

3.4 IST Three-position Disconnector

The three-position disconnector inside the SecoCube is of straight-moving design and driven by motor via insulation spindle. A moving contact assembly makes the natural interlocks between three stable positions as follows:

- Connect to the main busbar (Closed)
- Disconnect from the main busbar (Open)
- Connect to the earthing contacts (Earthed)

![Figure 3.14 IST three-position disconnector and its operating handle](image)
The earthing position can be cancelled or blocked on request, so that two-position disconnector is realized. *Earthing of the three-position disconnector only realizes the connection between the main circuit and the earthing circuit. The cable earthing is performed by the circuit breaker. See 3.4.1

Operating mechanism of three-position disconnector is mounted in the low voltage compartment outside the gas tank, which can be operated electrically and manually. The moving speed of the switching contacts depends on the motor speed or the manually operation speed.

The driving mechanism is composed of the following functional units:
- Drive motor
- Position detection with micro switches and auxiliary switches
- Mechanical position indication
- Emergent manual operating system
- Mechanical interlocks for emergent manual operation

### 3.4.1 Three-position Switch Specification

<table>
<thead>
<tr>
<th>General</th>
<th>27/24/17.5/13.8</th>
<th>36</th>
<th>50/60</th>
<th>1250, 2500</th>
<th>31.5/3s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>kv</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated power frequency withstand</td>
<td>kV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>voltage (1min)</td>
<td>To earth/phase</td>
<td>kV</td>
<td>95*(1)</td>
<td>95*(1)</td>
<td>95*(1)</td>
</tr>
<tr>
<td></td>
<td>to phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Across isolating</td>
<td>kV</td>
<td>118*(1)</td>
<td>118*(1)</td>
<td>118*(1)</td>
</tr>
<tr>
<td></td>
<td>distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated lightning impulse withstand</td>
<td>kV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>voltage</td>
<td>To earth/phase</td>
<td>kV</td>
<td>185*(1)</td>
<td>185*(1)</td>
<td>185*(1)</td>
</tr>
<tr>
<td></td>
<td>to phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Across isolating</td>
<td>kV</td>
<td>215*(1)</td>
<td>215*(1)</td>
<td>215*(1)</td>
</tr>
<tr>
<td></td>
<td>distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated frequency</td>
<td>Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated current</td>
<td>A</td>
<td></td>
<td>1250, 2500*(2)</td>
<td>1250, 2500*(2)</td>
<td></td>
</tr>
<tr>
<td>Rated short time withstand current</td>
<td>kA/s</td>
<td></td>
<td>31.5/3s</td>
<td>31.5/3s</td>
<td>31.5/3s</td>
</tr>
<tr>
<td>and endurance time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated peak withstand current</td>
<td>kA</td>
<td>82</td>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated voltage of auxiliary circuit</td>
<td>V</td>
<td>DC 24, 30, 36, 48, 60, 110, 125, 220; AC 110, 125, 220, 240</td>
<td>DC 24, 30, 36, 48, 60, 110, 125, 220; AC 110, 125, 220, 240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor power</td>
<td>W</td>
<td>180</td>
<td>180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening/closing time of the disconnector</td>
<td>s</td>
<td>≤10</td>
<td>≤10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening/closing time of the earthing switch</td>
<td>s</td>
<td>≤10</td>
<td>≤10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical endurance</td>
<td>times</td>
<td>2000</td>
<td>2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated manual operating torque</td>
<td>Nm</td>
<td>&lt; 20</td>
<td>&lt; 20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* (1) Can maintain the rated insulation level at 0.00 MPa (rel.) SF6 pressure.
* (2) 2300A at 60Hz

### 3.4.2 Earthing Function In Conjunction With The Vacuum Circuit Breaker

There are mechanical and electrical interlocking between the operating mechanism of 3-position disconnector and VCB. Only in the opening position of the circuit breaker, the 3-position disconnector can be switched to the earthing position.

Cable earthing is carried out by cooperation of the three-position disconnector and the VCB, which provide better performance than being carried out by normal earthing switch.
- More reliable making capacity
- Longer electrical endurance

![Earthing Function Diagram](image)

Figure 3.16 Earthing of the cable circuit

### 3.4.3 Motor Operation of 3-position Disconnector

Press the button on the panel to operate the three-position disconnector electrically. The electrical interlocking between the operating circuit and the circuit breaker prevent the switchgear from misoperation.
3.4.4 Manual Operation of 3-position Disconnector

Make sure the circuit breaker is in the “O” position.
Make sure the operation lock lever (see Figure 3.16) is in the “unlock” position. If not, lift the lever up.
Slide the cover to the left (see figure 3.17), insert the operating handle and carry out one of the following operations:

**Closed -> Open**
Turn the handle clockwise to the engaged position. When position indicator shows “O O” (See figure 3.17), the disconnector is in the open position. Pull out the operating handle from the aperture.

**Open -> Closed**
Turn the handle counterclockwise to the engaged position. When position indicator shows “I O” (see figure 3.16), the disconnector is in the closed position. Pull out the operating handle from the aperture.

**Open -> Earthed**
Turn the handle clockwise to the engaged position. When position indicator shows “O I” (see figure 3.18), the earthing switch is in the earthed position, while the disconnector in the opening position. Pull out the operating handle from the aperture.
Close the circuit breaker to complete the whole earthing operation.

**Earthed -> Open**
Turn the handle counterclockwise to the engaged position. When position indicator shows “O O” (see figure 3.19), both the disconnector and the earthing switch are in the open position. Pull out the operating handle from the aperture.
1. Cover  
2. Aperture  
3. Direction of earthing operation  
4. Direction of closing the disconnector  
5. Position indication of the disconnector  
6. Position indication of the earthing switch

Figure 3.18 Disconnector closed, earthing switch open

Figure 3.19 Disconnector open, earthing switch open

Figure 3.20 Disconnector open, earthing switch closed

Manually operation instruction:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Direction</th>
<th>1250A</th>
<th>2500A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed - Open</td>
<td>Clockwise</td>
<td>24 cycles</td>
<td>18.5 cycles</td>
</tr>
<tr>
<td>Open - Earthed</td>
<td>Clockwise</td>
<td>20 cycles</td>
<td>16.5 cycles</td>
</tr>
<tr>
<td>Open - Closed</td>
<td>Counterclockwise</td>
<td>24 cycles</td>
<td>18.5 cycles</td>
</tr>
<tr>
<td>Earthed - Open</td>
<td>Counterclockwise</td>
<td>20 cycles</td>
<td>16.5 cycles</td>
</tr>
</tbody>
</table>

Whether the 3-position disconnector is in place or not can be checked by the following methods:

- Mechanical position indication does not show or not reaches its designated position properly.
- Electrical position indication does not show.
- The circuit breaker is locked and cannot be closed.
3.5 Locking Operation

Door of the low voltage compartment is controlled by the padlock with key (see figure 3.20). The lower cover of the control compartment is accessible only after the control compartment door is open. Manual operation of the circuit breaker and 3-position disconnector can only be performed when the low voltage compartment door is open.

**Operation of unlocking the door:**
- Unlock the blocking with key (if blocked);
- Push the lower button of padlock to release the lock handle. (About 45°)
- Turn the lock handle to left side (About 45°)
- Pull the lock handle and open the control compartment door.

**Operation of locking the door**
- Opposite to the unlocking operation above.

---

**Attention:**
When manually operate to the open, or closed, or earthed position, the mechanism will latch the operating handle automatically. Operator should push the lever up to the “Unlock” position prior to performing the next manual or motorized operation. In manual operation, the circuit breaker will be locked and can not be closed, if the operating handle is pull out before operation is completed or the switch is not operated to the proper position.

---

Figure 3.21 Locking operation
3.6 HV Components Connection

3.6.1 Cable Connection

High voltage cables can be connected to the inner-cone cable bushing (See figure 3.21) by inner-cone cable terminal (See figure 3.21).

Inner-cone cable terminal and cable bushing comply to IEC 60137, EN 50181, DIN EN 60137, VDE 0674/PART 5 standards in size 2 and 3.

Customers are recommended to check the dimension and specification of their cable terminals according to the order checklist.

Inner-cone cable bushing (figure 3.22) is a gas tight component installed on the gas tank to realize electrical connection with other switchgear gas tanks.

Apart from cable and busbar connection, inner-cone cable bushing (figure 3.21) also suitable for connecting plug-in PT, surge arrester and testing adaptor.

Figure 3.22 Inner-cone cable terminal  
Figure 3.23 Inner-cone cable bushing

3.6.2 Busbar Connection

SecoCube panels can be connected by plug-in busbar connectors (see figure 3.23), requiring no gas work on site.

The silicone-rubber busbar connectors are standardized according to DIN47637.

The busbar connector differs from voltage and current. Its application should be based on specific requirements and specification.

Figure 3.24 Plug-in busbar connector
3.7 Secondary System For Controlling And Monitoring

In SecoCube, controlling and monitoring the position of circuit breaker and 3-position disconnector is performed by a digital control and protection unit. The signals are provided by auxiliary switches or micro switches located on the main shaft of the VCB mechanism or 3-position disconnector mechanism separately.

SecoCube can be equipped with various types of digital control and protection unit, containing the functions as follows:

- Protection
- Interlocking and operation sequence control
- Measurement
- Switch position indication
- Fault signal and alarm
- Remote control and communication
- Information of switchgear position

SecoCube is also possible to be equipped with a conventional protection relay as an option. In specific cases, an extended control compartment is available.

3.8 Interlocking

3.8.1 Overview

In order to prevent dangerous maloperation, a series interlocks are designed to protect the operators and the equipment. Protect against maloperation can be realized by the following facilities:

- Intelligent protection and control unit.
- Control unit with a separate protection relay.
- Conventional relay circuit.
- Mechanical interlocks between circuit breaker and 3-position disconnector.
  - The circuit breaker and the 3-position disconnector can be controlled locally or remotely. Local control can be done by protection relay or buttons on the mimic single-line diagram on the front panel, while remote control is realized by local/remote switch.
  - The IST type 3-position disconnector and the vacuum circuit breaker are mechanically and electrically interlocked.
  - Electrical interlock between panels (if applicable) can be established via control circuit between panels.
- Operation on the failure of secondary power supply:
  - On failure of the secondary power supply, circuit breaker and 3-position disconnector can be operated manually.
  - In any cases, operation sequence and interlocking shall be taken into account.
3.8.2 Interlocks Between Circuit Breaker And 3-position Disconnector

**Electrical interlocking**
- Protection and control unit provides electrical interlock based on logical calculation and position monitoring of 3-position disconnector and circuit breaker (Detail logics are shown in table 8.1).
- Electrical interlocking can also be achieved by control circuit.

*Table 8.1: Interlock logics between VCB and 3-position disconnector*

<table>
<thead>
<tr>
<th>VCB Status</th>
<th>VCB Operation</th>
<th>VCB Disconnecting switch</th>
<th>VCB Earthing switch</th>
<th>Operating handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Off</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Off</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Off</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Off</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Off</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

Note: Use respective operating handles to operate the VCB and Disconnector manually.

**Mechanical interlocking**

Mechanical interlocking is achieved by OPEN/CLOSED status controlling of the operation locking plate.
- When circuit breaker is closed, mechanical interlock will lock the locking plate (see Figure 3.24) to the closed position, so that it's impossible to insert the operating handle to operate the three-position disconnector.
- Mechanical interlock allows the locking plate being opened only under the condition of circuit breaker is open. Then 3-position disconnector can be operated.
- The VCB cannot be operated when the locking plate of the operation plate is open.

警告:
所有切换操作必须在开关达到正确位置后完成。在必要时的紧急手动操作前，请确保关闭 MCB 以断开二次电源。
3.9 Earthing The Tee-off Busbar

3.9.1 Motor-driven Earthing Operation of Three-position Disconnector

The motor-driven operation of the earthing switch is achieved by the control and protection unit or pushing buttons on the panel front door.

Operation sequence for motor-driven tee-off earthing:

- Open the circuit breaker.
- Open disconnector.
- Close earthing switch.
- Test for circuit power-off condition (by means of the capacitive voltage indicator system, please refer to section 6.4.1)
- Close circuit breaker.
- Switch MCB off to avoid the motor-driven operation of switchgear.
- Lock the LV compartment door or lock the “O” button on the VCB front panel with the padlock.
- Label the panel to indicate that panel is earthed.

Operation sequence to release the motor-driven tee-off earthing:

- Open the door of LV compartment.
- Close MCB.
- Release the latching for the “O” button on the circuit breaker front panel (if applicable).
- Open the circuit breaker. In case the user forbids the electrical release of earthing position, the circuit breaker shall be opened manually. That is, the electrical opening of the circuit breaker is latched when the earthing switch is in the earthed position.
- Open earthing switch and remove the earthing warning label on the panel.

3.9.2 Manual Operation of Release The Tee-off Earthing

Release the tee-off earthing manually follows the same operation sequences as releasing the tee-off earthing electrically. However, manual operation on circuit breaker is achieved by pressing ON/OFF buttons, while manual operation on three-position disconnector is performed by operating handles.
**Operation sequence for manual tee-off earthing:**

- Open the door of LV compartment.
- Open circuit breaker manually by pressing OPEN button.
- Open the locking plate of 3-position disconnector (it can only be opened when circuit breaker is in the open position) and insert the operating handle into the operating aperture.
- Turn the operating handle counterclockwise until the disconnector reaches the "O" position. Then pull out the operating handle.
- Push the lever up to the “unlock” position. Open the locking plate of 3-position disconnector and insert the operating handle into the operating aperture.
- Turn the operating handle clockwise until the earthing switch reaches the "I" position. Then pull out the operating handle.
- Test for circuit power-off condition (by means of the capacitive voltage indicator).
- Close the circuit breaker manually by pressing the “I” button on the circuit breaker front panel.
- Switch MCCB in the LV compartment.
- Lock the door of LV compartment and/or the “O” button on VCB front panel (if applicable).
- Label the door to indicate that panel is earthed.

⚠️ **Attention:**

Do not apply excessive operating force. The interlocking will lock the operating handle automatically when the switch is operated to the proper position. After pulling out the operating handle, the locking plate will close the operating aperture automatically.

**Operation sequence to release the tee-off earthing manually:**

- Open LV compartment door and close the MCB to release the latching (if applicable).
- Press "O" button to open the circuit breaker manually.
- Open the locking plate and insert the 3-position disconnector operating handle into the operating aperture.
- Turn the operating handle counterclockwise to open the earthing switch.
- Remove the earthing label on the panel.

### 3.10 Earthing The Main Busbar

Operation sequence for earthing the main busbar depends on the type of the power supply network. Main busbar earthing can be realized if busbar sectionalizer is used. Earthing solution is determined by both the power supply network and the switchgear configuration. Some earthing solutions are mentioned below as an example.

#### 3.10.1 Earthed By Main Busbar Earthing Panel

If permitted, main busbar earthing panel can be realized by modifying any incoming/ outgoing feeder panels on site and put into service.

Main busbar earthing panel can also be manufactured in the factory as per order requirement. If
manufactured in factory site, earthing switch with short circuit making capacity can be equipped in the main busbar earthing panel.

The method to modify the incoming/outgoing feeder panel into a main busbar earthing panel is as follows: Short circuit the main circuit of an incoming/outgoing feeder panel and earth the three-phase inner-cone cable bushings reliably by using special earthing plugs.

**Attention:**
Before carrying out the modifying work on site, please earth the tee-off busbar first according to section 3.9. Also please release the tee-off earthing according to section 3.9 after modification is completed.

The default configuration for main busbar earthing panel is manual operation panel. If electrical operation is required, please specify in the order form.

The precondition for bar earthing is that all the 3-position disconnectors connecting on the main busbar should be disconnected or earthed.

**Operation sequences of main busbar-earthing (Modified incoming/outgoing feeder panels):**
- Open the LV compartment door and trip the MCB in the control circuit (if applicable).
- Close the three-position disconnector manually.
- Close the circuit breaker manually. Then the main busbar is earthed.
- Lock the LV compartment door.
- Label the panel to indicate that panel is earthed.

Release the earthing follows the opposite sequences mentioned above.

**Operating sequences of main busbar earthing (Including earthing switch):**
- Open the LV compartment door.
- Close the earthing switch by operating handle.
- Lock the LV compartment door by padlock.
- Label the panel to indicate that panel is earthed.

Release the earthing follows the opposite sequences mentioned above.

![Figure 3.26 Earthing by main busbar earthing panel](image_url)
3.10.2 Earthing By Main Busbar Sectionaliser / Disconnector Panel

Power supply network with bus sectionaliser panel can realize earthing through disconnector panel. As a necessary condition, circuit breaker and 3-position disconnector of the sectionaliser panel to be earthed should be in the open position.

Please read this instruction manual carefully before operation.

**Operation sequences of earthing operation:**
- Open the circuit breaker of the bus sectionaliser panel.
- Switch all 3-position disconnectors connecting to this section busbar to the earthed position, except the disconnector between this section busbar and the sectionalizer circuit breaker.
- Close the earthing switch of the bus sectionalizer panel or the disconnect panel, according to which section of busbar is to be earthed.
- Close the circuit breaker of the bus sectionalizer panel.
- Switch the MCB of the control circuit.
- Label the panel to indicate that panel is earthed.

Release the earthing follows the opposite sequences mentioned above.

3.11 Testing Process and Testing Equipment

SecoCube will pass through routine test according to GB3906 and IEC 62271-200 in factory with rated insulating gas pressure inside.

Routine test can be performed as per the following procedure:
- Voltage and current tests can be performed without disconnecting the incoming/outgoing cables or vacuumizing the gas tank. The tests can be performed via inner-cone bushing, either spare bushing or the one for installing surge arrester (please see figure 3.21).
- Voltage transformer and surge arrester should be removed for voltage test. All the spare inner-cone bushings should be covered by end plugs (see figure 5.20).
- Busbar system can be accessible via the busbar bushing of the end panels.
- Testing voltage can be applied via a voltage adapter (as shown in figure 3.26).
- Testing current for circuit resistance test can be applied via a current adapter (as shown in figure 3.27).
- In combination with a voltage adapter, the current adapter can be used to provide a fixed earthing for an additional earth connection.

(a) Voltage adaptor  
(b) Current adaptor

*Figure 3.27 High voltage testing tool*
4 Packing, Delivery and Storage

4.1 Conditions on Delivery

At the time of dispatch, SecoCube panels are checked in factory for proper assembly and completeness as per order requirement, and also passed routine tests as per IEC 62271-200:2003.

Conditions on delivery:
- Check the panels on request by the order.
- The routine tests shall be carried out according to GB3906,DL/T404 and IEC62271-200 standards.
- Installation materials and accessories are packed separately.
- Busbar bushings shall be sealed by protective covers.
- Gas tanks are filled with rated pressure insulating gas and are equipped with desiccant bags.
- In some cases, if the switchgear needs to be shipped by air, the manufacturer shall be consulted and informed in advance.

4.2 Packing

The packing varies as per different transportation and country of destination. To protect against moisture, a drying agent bag is provided. Below guidelines are followed:
- Panels with standard packaging or without packaging. Usually each panel unit are packed separately.
- Seaworthy or similar packaging (such as containerized packing or packing for airfreight).
  - Sealed in polyethylene sheeting;
  - Transport drying desiccant bags inside.
- Take into account the instructions for the drying desiccant bags.
  - Coloured indicator blue: contents dry;
  - Coloured indicator pink: contents moist (e.g. Relative humidity over 40% ).

4.3 Transportation

- Transportation unit can be an individual panel or a small group of panels (normally consist of 2 panels; maximum consist of 3 panels).
- Keep the panels vertically upwards. Do not step on the top of the panels in any circumstance.
- A forklift truck can be used for moving the wooden pallets. Centre of panel gravity should be taken into account.
- Cranes are recommended if wooden pallets are not used. The suspension ropes of the crane should have enough loads bearing capacity and allow no slippage. The angle between the lifting ropes shall be less than 90° to avoid distortion of the panel enclosure caused by lateral force. (Please see figure 4.1).
- The switchgear shall be fixed during transportation to avoid incidental damages.
• Proper protective measures shall be taken into account to protect the safety of the equipment and personnel during loading and unloading process.

![Figure 4.1 SecoCube on-site transportation](image)

### 4.4 Upon Receipt

The responsibilities of the consignee when the switchgear arrives at the site include, but are not limited to the following items:

- Upon receiving the SecoCube products, please check the delivered equipment is complete without any damage (e.g. injurious effects caused by moisture or transportation).
- If any delivery shortage or damage because of transportation, please follow:
  - Record and prove it on the waybill;
  - A claim must be submitted to the carrier/shipper and insurance company immediately;
  - Always take photographs to document any damage.

### 4.5 Storage

SecoCube is stored in proper conditions according to GB3906, DL/T404 and IEC 62271-200.

**Panels with standard packaging or without packaging:**

- A dry, well-ventilated storeroom with a climate in accordance with IEC62271-1:2007;
- Storeroom temperature shall not fall below \(-15^\circ\text{C}\);
- Store the panels upright;
- Do not stack panels;
- Open the packing as less as possible.

**Panels without packing:**

- Loosely covered with PE protective foil sheeting;
- Keep good for ventilation;
- Check for condensation regularly.
Panels with seaworthy (or similar) packing and internal protective covers:

- The stored transportation unit should be protected from the climate influence;
- Store in a dry place;
- Safe from any damage;
- Check the packaging for damage on delivery and later at appropriate intervals.

The protective effect of the packing cannot be guaranteed if the maximum storage time (3 months) is expired. Proper actions and measures shall be taken for further storage.
5. Switchgear On-site Installation

In order to ensure the correct installation sequence and installation quality, on-site installation of SecoCube shall only be carried out, or at least supervised, by specially trained skilled person.

5.1 On-site Conditions

On commencement of installation on site, the switchgear room must be fundamentally finished, provided with lighting and the electricity supply, lockable, dry and with facilities for ventilation. Make sure all necessary provisions for cable trench and cable entry place are already in place. Indoor switchgear working conditions should comply with local regulatory and IEC60654-1 standards, including indoor temperature and humidity conditions.

5.2 Floor Preparation

SecoCube shall be installed on the base frame or pre-laid channel steel in the switchgear room. The size of the cable trench should be determined by the quantity of the HV cables accommodated. Cable trench shall be able to prevent eddy current.

The following items shall be taken into account when design the switchgear room:

- Dimension and weight of the standard SecoCube panels (as shown in figure 5.1).
- Dimension and load-bearing requirements for the switchgear room design (standard design, shown in table 5/1).
- Special requirement of the project should be taken into account.
- There may be 2-way unit, or 3-way unit delivered to site.
- The weight of each delivery products may be non-standard due to specific equipment of instrument transformers, relay or other customized variation.
- In any case, customer will be informed about the size and weight of each delivery in advance.
<table>
<thead>
<tr>
<th>SecoCube</th>
<th>Rated current</th>
<th>a (mm)</th>
<th>b (mm)</th>
<th>c (mm)</th>
<th>d (mm)</th>
<th>e (mm)</th>
<th>f (mm)</th>
<th>g (mm)</th>
<th>weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1250A</td>
<td>600</td>
<td>1500</td>
<td>2400</td>
<td>1000</td>
<td>990</td>
<td>500</td>
<td>700</td>
<td>850</td>
</tr>
<tr>
<td></td>
<td>2500A</td>
<td>800</td>
<td>1500</td>
<td>2400</td>
<td>1000</td>
<td>990</td>
<td>500</td>
<td>700</td>
<td>1300</td>
</tr>
</tbody>
</table>

Figure 5.1 IEC 36kV SecoCube dimensions
5.3 Note of On-site Installation

It is significant to ensure the correct and high quality installation. On-site transportation, installation and commissioning shall only be carried out or at least supervised, by trained skilled person.

- Make sure the basic order documents, schematic drawings, single line diagrams and user manual are available on site.
- Clean the dust on the surface of the equipment and the insulating material.
- In case of any question, please contact the manufacturer.
- Use standard bolts of class 8.8 according to the tightening torque in table 5/2.

**Table 5/2 Tightening torque**

<table>
<thead>
<tr>
<th>Bolts</th>
<th>Recommended tightening torque (Nm)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without lubricating oil/grease</td>
<td>With lubricating oil/grease</td>
</tr>
<tr>
<td></td>
<td>Panel connection</td>
<td><strong>Bushing connection</strong></td>
</tr>
<tr>
<td>M6</td>
<td>10.5</td>
<td>4.5</td>
</tr>
<tr>
<td>M8</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>M8 *</td>
<td>12</td>
<td>/</td>
</tr>
<tr>
<td>M10</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>M12</td>
<td>86</td>
<td>60</td>
</tr>
<tr>
<td>M16</td>
<td>200</td>
<td>120</td>
</tr>
</tbody>
</table>

*Only applicable for welding studs.
** Only applicable for bushing assembly, such as cable terminal, surge arrester, voltage adapter, voltage transformer, end plug etc.

⚠️ **Attention:**

It is strongly recommended that site installation and commissioning is carried out under the supervision of certified supervisor from GE.

5.4 Installation Foundation

SecoCube shall be mounted on proper and permanent functional base frame or channel steels, which is recommended to be laid out by certified skilled engineer.

Installation foundation drawing is shown in figure 5.2.

It is recommended that laying the installation foundation should comply with local standard. Tolerances for laying the floor frame are:

- Evenness tolerance: ± 1mm/m².
- Straightness tolerance: Max. 1 mm/m, but max. 2 mm for the entire length of the frame.
Figure 5.2 SecoCube foundation framework, with arc duct
Please refer to Figure 5.1 for dimensions.

Figure 5.3 SecoCube Layout drawing, with arc duct
![Figure 5.4 SecoCube Panel Line-up drawing, with arc duct](image)

**Table 5/1**

<table>
<thead>
<tr>
<th>Dimension and load-bearing requirements for the switchgear room design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated current</td>
</tr>
<tr>
<td>Panel width</td>
</tr>
<tr>
<td>Room height (min.)</td>
</tr>
<tr>
<td>Min. back to wall distance</td>
</tr>
<tr>
<td>Min. front to wall distance</td>
</tr>
<tr>
<td>Panel weight</td>
</tr>
<tr>
<td>Min. load-breaking of the floor</td>
</tr>
</tbody>
</table>

Remark: Arc ducting affects the installation; please refer to section 5.8 for more details.
1. SecoCube switchgear
2. Pressure relief channel in the panel
3. Lower ventilation device
4. Cable interlayer
5. Upper ventilation device
6. Pressure relief channel in the panel
7. Cable interlayer ventilation device

*Figure 5.5 Cable interlayer for SecoCube installation*
5.5 Panel Installation and Extension

⚠️ Notice:
Do not step on the top of the panels, in order to avoid damage to the pressure relief system.

Figure 5.6 Cable trench for SecoCube installation
5.5.1 Preparation before installing

- Lubricate the surface of the foundation frame by some machinery lubricate grease, in order to reduce friction and make the panel installation and alignment more easily.
- Make sure all necessary components and correct material are available, such as insulators, cable plugs, busbar connectors, silicon grease, cleaning cloth, neat alcohol etc.
- Make sure the installation work, such as handling the plug-in busbar connector, voltage transformer, power cables, are all performed by trained skilled technicians.

![Figure 5.7 Tools for installing plug-in components](image)

5.5.2 Panel Installation

Please refer to Figure 5.3 for SecoCube layout drawing.
Please refer to Figure 5.5 and Figure 5.6 for the installation structure of cable layer and cable trench.
Please refer to Figure 5.1 and table 5/1 for dimensions and load-bearing requirements of the switchgear room. Please contact the manufacturer if necessary.

**Panel extension procedure**

**Step 1: Fix the first panel**

- Fix the first panel on the channel steel foundation reliably. (Accurate positioning is essential.)
- Move the panel to be installed into position by aligning with the first panel, until the distance between the two panels is 350–400mm. Shown in Figure 5.8.
Remove the bracket on both sides in the front of the panel so as to install the panel connecting bolts. Shown in Figure 5.9.

Figure 5.9 Remove the secondary cable bracket cover
Step 2: Install the Busbar connector

- Remove the plastic protection cover on the busbar bushing.
- Clean the surface of the inner-cone busbar bushing (see Figure 5.10) and the busbar conductor bolts (see Figure 5.12) by use of the supplied clean cloth with a small amount of ethanol.
- Lubricate the surface of the inner-cone bushing with silicone grease.

![Image](image1.jpg)

*Figure 5.10 Lubricate the inner-cone busbar bushing*

![Image](image2.jpg)

*Figure 5.11 Silicone grease*

*Figure 5.12 Busbar conductor bolts*

- Plug the busbar conductor bolts into the end of the inner-cone busbar bushings on the fixed panel (See Figure 5.13).

![Image](image3.jpg)

*Figure 5.13 Plug in the busbar conductor bolts*
• Clean the surface of the silicon rubber busbar connector by means of dielectric clean cloth dipped in ethanol. Check and make sure there is no defect or damage on the surface of the silicon rubber. Lubricate the surface of the silicon rubber by proper amount of silicone grease. (See Figure 5.14).

![Figure 5.14 Clean and lubricate the busbar connector](image)

• Plug the silicon rubber connector onto the busbar connector bolts (See Figure 5.15) and connect the earthing wirings to the tank side wall screws.
• Connect the earthing springs to the black semi-conductive surface of the silicone rubber busbar connector. Connect the earthing wiring to the earthing screws of gas tank and attach.
• Fit the busbar connector and connect the earthing wire to earth.

![Figure 5.15 Install the busbar connector](image)

**Attention:** Make sure the earth wire is in the correct position to prevent pinching.

*Step3: Install the panel extension fixture*
• Assemble the rectangular tubes with hooks and the other tubes with the winch. Ensure that the fixing brackets are on both tubes.

![Image of rectangular tubes and hooks](image1.jpg)

*Figure 5.16 Ratchet Installation Tool*

• Install the panel ratchet installation tool near the busbar connector mounting holes on the panel side wall. Align the fixing bracket with the mounting holes; then attach with M8 screws utilizing the existing mounting captive nuts and holes.

• Attach the Hook tubes to the unfixed panel. The winch should be installed on the fixed panel only.

![Image of panel ratchet installation tool](image2.jpg)

*Figure 5.17 Install the panel extension fixture*

• Adjust the ratchet winch and the hooks tubes until the distance between the wire rope and the panel edge is 100mm. Then tighten the M5 screws to fix.
Step4: Mounting plate installation

- When the mounting fixed panel is on the left, the next panel will be installed on the right. See mounting plate installation below.
- Remove the secondary cable brackets at the front of the fixed panel in order to insert the mounting bracket at the bottom of the panel front. Insert the other mounting bracket at the bottom and back of the second panel attach with M8 bolts.
- When installing the panel on the right side of the fixed one, the mounting bracket installation is opposite.

Tighten the strainer: Connect the wire rope to the hooks on the unfixed panel. Two operators must draw up the wire rope simultaneously until the distance between two panels is around 30mm. Check
and adjust the parallel alignment of the two panels. Continue tightening the winch until the two panels are connected together.

**Figure 5.20 Panels connect together**

- Tighten the connection bolts, whilst keeping the ratchet wheel strainer in tension. Fix the bolts on the gas tank first, and then fix all the other bolts on the panels.
- Remove the winch and the mounting brackets. Move the next panel to be installed into position by aligning with the connected panels, until the distance between them is 350~400mm. Follow the same procedure to complete all the panel connections.
- Install the secondary cable brackets after panel connections are finished.

Note: Wait 8 hours later, the silicon rubber of busbar connector will fully extended and perfectly fill the inner cone.

**Attention:**

Applying high voltage tests should be at least 8 hours later, after the panel connection is finished.

### 5.6 Install Other HV Plug-in Components And Secondary Wiring

Other HV plug-in components include: power cables, voltage transformer, surge arrester and end plugs, etc.

Normally, the voltage transformer, surge arrester etc. have been installed on the switchgear as per the request of the order in factory. And all the spare inner-cone bushings have been sealed with end plugs. But they're still possible to be installed on site in the following cases:

- Change of system design;
- On-site testing requirements;
- Engineering requirements, such as special requirements for the cable bushings.
5.6.1 HV Cable Installation

For the selection of cable terminals, please refer to the instruction of the cable supplier. The installation of the cable terminals should be done only by trained personnel under the guide of the installation manual. If single-cone cable is used, please follow below procedures for installing the cable terminals and HV cables:

- Remove the white plastic protective cover of the inner-cone cable bushing.
- Clean the surface of the inner-cone cable bushing by means of dielectric clean cloth dipped in ethanol. Lubricate the surface by silicone grease.
- Make sure the cables and cable terminals are ready; phase sequence is correct. Install voltage indicator sensors (if applicable).
- Lead cable terminals through ring CT (if applicable).

⚠️ **Attention:**

Take care of the cable terminals. The silicon surface of the cable terminals shall be protected against pollution and damage (scratching etc.) during the installation!

- Clean the surface of cable terminals by means of dielectric clean cloth dipped in ethanol. Lubricate the surface by silicone grease according to the instruction manual after the alcohol has evaporates. Make sure all the cable terminals are cleaned and lubricated.
- Fit the cable terminals into the cable bushings and fasten the bolts with the torque as per Table 5/2.
- Fix the cables with clamps. Fix the voltage indicator sensors and ring CT (if applicable).
- Seal all the spare inner-cone cable bushings by end plugs. (Shown in Figure 5.21).

![Figure 5.21 Plug-in end plugs](image)

- Applying high voltage tests should be at least 8 hours, after the cable connection is finished.

5.6.2 VT, SA and End Plug Installation

Please follow the same procedure as chapter 5.6.1 for installing voltage transformer, surge arrester and end plugs. Applying high voltage tests should be at least 8 hours later, after these components connection is finished.
5.6.3 Fuse Installation and Replacement of the VT Panel

1. Fuse cap location is shown as below

2. Loosen and remove the fasten bolts on the cap
3. Pull out the fuse cover plug with caution

4. Use the supplied screw driver to undo the fuse socket

5. Withdraw the old fuse with care

6. Empty the fuse compartment
7. Spray pure ethanal onto the cleaning cloth

8. Clean the inside of fuse compartment

9. Clean the new fuse (the same type as the old one)
10. Insert the new fuse

11. Fit and tighten the socket

12. Clean the fuse cap carefully. Check there should not be any damage or scuffing on the cap.
13. Apply the supplied silicon grease

14. Fit the bolt on the cap and fasten the bolts

15. It's done
5.6.4 Secondary Wiring

Please refer to secondary wiring diagram to connecting the control wiring and secondary wiring for auxiliary power supply.

VCB Control Circuit
Remark:
This diagram shows a vacuum circuit breaker open;
C.B. spring discharged; all coils are deenergized.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y1</td>
<td>Closing block magnet</td>
<td>S1</td>
<td>Mechanism auxiliary switch</td>
</tr>
<tr>
<td>Y2</td>
<td>First opening release</td>
<td>S2</td>
<td>Aux. Switch on block magnet</td>
</tr>
<tr>
<td>Y3</td>
<td>Closing release</td>
<td>S3</td>
<td>C.B. Auxiliary switch</td>
</tr>
<tr>
<td>M0</td>
<td>Spring charging motor</td>
<td>Jp</td>
<td>R0 entry connecting line</td>
</tr>
<tr>
<td>K0</td>
<td>Anti-pumping relay</td>
<td>Js</td>
<td>K0 release connecting line</td>
</tr>
<tr>
<td>R0</td>
<td>Resistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V0 ~ V4</td>
<td>Rectifier</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3-Position Switch Control Circuit

Note:
These contacts will be reserved for three-position disconnector control circuit.
Qx1: 15-16,17-18,19-20,21-22,27-28,29-30,49-50
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qx1</td>
<td>Terminal block</td>
<td>S1', S2', S3', S4'</td>
<td>Micro switch</td>
</tr>
<tr>
<td>Qx2</td>
<td>Terminal block (Optional)</td>
<td>S5', S6'</td>
<td>Micro switch</td>
</tr>
<tr>
<td>Y0</td>
<td>Interlock coil (Optional)</td>
<td>S7'</td>
<td>Micro switch</td>
</tr>
<tr>
<td>V1</td>
<td>Rectifier (Optional)</td>
<td>S8'</td>
<td>Micro switch</td>
</tr>
<tr>
<td>M</td>
<td>Motor</td>
<td>S10'</td>
<td>Micro switch</td>
</tr>
</tbody>
</table>

5.7 Final Inspection

- Check the outer surface of the panel is clean without any scratches on the painted surfaces. Scratches shall be repaired, if applicable.
- Fix the cover of the operating mechanism, cover of cable channel, front and rear covers.
- Make sure there's no tools left inside the switchgear.
- Check the surrounding of the switchgear is in the normal condition.

5.8 Arc Duct Installation

In order to install the arc duct, follow the process mentioned below:

- Pre-assembly the arc duct short channel as Figure 5.24 and long channel as Figure 5.25 by relative parts;
- Tighten all the bolts of the two channels together by using Figure 5.26 outside support plate and Figure 5.27 inner support plate-to obtain the final assembly of the arc duct channel, see Figure 5.28;
- Install the assembly of the arc duct channel on side walls of the substation end panels accordingly, Figure 5.29;
- Finally, Install the arc collecting channel (prepared by customer) on the side walls of the arc duct channel as Figure 5.31.
Figure 5.24 Arc duct short channel

Figure 5.25 Arc duct long channel

Figure 5.26 Outside support plate

Figure 5.27 Inner support plate
Figure 5.28 Assembly of arc duct channel

Figure 5.29 Assembly of the arc duct channel
Figure 5.30 Assembly of the arc collecting channel (prepared by customer)

Figure 5.31 view of the panel's final assembly
From Figure 5.31 and Figure 5.32, the assembly of the arc duct makes the gas flow guides to top of it, then leads to outside by means of arc collecting duct (prepared by customer).
6. Commissioning and Operation

6.1 Commissioning

6.1.1 Preparation

All preparation work should be done before connecting the high voltage power supply:
- Connect the auxiliary power supply and check the polarity is correct.
- Check the mechanical and electrical interlocking according to the schematic drawing and wiring drawing.
- Check the function of the protection device.
- Check the overall condition of the system and the switchgear.
- Introduce the field operator how to operate the switchgear, and hand over the installation manuals of the switchgear, the VCB and the HV cable terminals to him.
- Introduce the field operator how to handle SF6 gas on site.
- Check the operation conditions of the electrical equipment connecting to the switchgear, especially the power cables, control cables, auxiliary power supply and its polarity, remote control and earthing conditions.

6.1.2 Initial start-up

- Comply with all the relevant safety instructions.
- Put all circuit breakers of the switchgear in the open position.
- Put all the disconnectors in the open position.
- Make sure that no panels are in the earthed position.
- If there are several busbar sections or several incoming panels connecting to the same busbar section, please check the phase sequence is correct.
- Close the circuit breaker one by one to energize the feeders, and observe the monitoring device carefully.
- Check other functions by means of the high voltage power supply.
- Any abnormal conditions shall be noted.

⚠️ **Attention:**
Commissioning and operation shall be performed by trained skilled people only!
6.2 Switchgear Operations

6.2.1 Circuit breaker

Please refer to section 3.3.
The SecoVac-G vacuum circuit breaker is equipped with motor-charging operating mechanism, able to recharge the spring automatically.
Open and close operations are performed by the opening and closing coils. These operations shall only be performed when the panel door is in the closed position.
If motor fault occurs, the spring can be charged manually and the open/close operation can be carried out by pressing "O" and "I" buttons on the front of the panel.

6.2.2 Three-position disconnector

Please refer to section 3.4.
The three-position disconnector is equipped with the motor-charging operating mechanism and operated by control unit.
When operate the three-position disconnector electrically, the front door of the switchgear shall be closed according to the interlocking.
The position of the three-position disconnector is monitored by micro switches located in the operating mechanism.
In case of emergency, the three-position disconnector can also be operated manually.

6.3 Observation, Checking and Monitoring

6.3.1 Monitor SF₆ Gas Tank

Please refer to section 3.2.
The gas tank is equipped with a gas density indicator or gas density monitor to indicate its inner pressure.
The gas density monitor is used for monitoring the gas leakage and giving out alarm signal when the gas pressure reduced to the alarming pressure.
For monitoring the gas pressure by means of gas pressure gauge, or measuring the dew point, or perform gas sampling and analysis, below procedures can be followed:
- Remove gas density monitor through a valve on the gas tank (Note: Avoid gas leak due to removing off the self-closing valve).
- Screw the pressure gauge or dew point monitor device into the valve to observe the indication.

Note:
Every monitoring for gas pressure will cause a little gas leak. It’s necessary to control the monitoring times to a reasonable value.

- Remove the pressure gauge and replace it with the gas density monitor.
• Sealing cover shall be used to cover the valve if the gas density monitor isn’t installed for a long time.

6.3.2 Electrical/mechanical Display and Monitoring

During the operation of the switchgear, all information monitored by control unit, metering instruments and other secondary indicators shall be observed regularly.

6.4 Test Procedures

6.4.1 Main Circuit Power-off Test

Panels are equipped with capacitive high voltage indicator system for testing the circuit condition.

⚠️ Note:
- The indicator shall support the display unit in the switchgear, and comply with relevant standards.
- Test jack of the earth fault indicator shall not be short circuited. Only HV test for the switchgear (such as power frequency withstand test or lightning impulse withstand test) is an exception.

User instruction of the display unit:
- A functional test should be performed on the display unit immediately before and after commissioning. The display should be clearly visible.
- The light is on if operating voltage is present.
- It means the panels are energized, when the light is on.
- Please refer to the user manual of the specific display unit for more details.

Interface testing:
- Perform interface test on all the components by means of interface tester.
- Test should be performed according to local regulatory and relative IEC standard.

6.4.2 Main Circuit Phase Sequence Test

Use proper phase comparator, in combination with a capacitive voltage indicator to check the phase sequence. The phase comparator and the capacitive voltage detecting indicator should be of same type.

Test procedure:
- Test the functionality of the phase comparator equipment, before performing phase sequence test.
- Maximum measuring distance shall not exceed the length of the connecting leads.
- Insert the phase comparator to corresponding phase sockets.
- Always follow the instruction manual of the phase comparator.
6.4.3 High Voltage Tests

High voltage test should be carried out with testing cables specified by switchgear manufacturer. The AC and DC testing should be performed according to relevant standards. High voltage test shall only be executed by certified trained person. Please consult the manufacturer for questions about the test.

Perform high voltage tests by means of proper adaptor:
- Switch off the switchgear under the instruction of the safety rules and avoid re-closing.
- Detect the absence of the operating voltage by inserting proper connecting lead to the testing socket of the capacitive voltage indicator.
- Remove the voltage transformer and surge arrester, cover the spare sockets with end plugs (See Figure 6.2).
- Keep the surface of the testing adapters clean and dry.
- High voltage adapters (shown in Figure 6.3) are suitable for plugging in inner-cone cable bushings, voltage transformer sockets, or busbar extension sockets. Installing voltage adapters follows the same procedure as installing busbar connectors or cable terminals.
- Before installing the testing adapter, an earth wire should be connected to the terminal of the testing adapter. Remove this earth wire before applying testing voltage.
- Clean the testing socket and insert the testing adapter.
- Make sure the testing adapter has enough insulating distance between phases and phase to earth.
- Make sure all the warnings/notices are followed.
- Perform the high voltage tests as per specific requirements.
- After all the tests are finished, remove the adapters and return the switchgear into the original status.
Before test, please make sure that:

- All the switchgear panels are power off;
- Proper measures are performed on the panels to avoid re-closing;
- Power-off condition has been checked;
- Inductive voltage caused by secondary winding of the VT is excluded;
- Short circuit the testing sockets of the voltage indicator;
- When doing cable testing, if the switchgear is in the earthed position, open the circuit breaker to isolate the earthed condition.

6.4.4 Current Test

Current test can be performed by current testing adapter (Shown in Figure 3.23) as follows:

- Test functions of the control and protection unit by injecting current to the primary circuit.

  **Note:**
  Disconnect the opening coil and latch the trip signal of the testing equipment during test, to avoid damaging the opening coil.

- Earthing for maintenance by means of short-circuit the main busbars through the special earthing device.

6.5 Safety Instructions For Voltage Transformer Operation

Secondary wiring and its earthing shall be connected according to the schematic drawings. It’s dangerous to loose the earthing bolts on the “N” terminal during the operation of the voltage transformer. Only at the moment of disconnecting the voltage transformer from the main circuit for testing purpose, can the earthing bolts on the “N” terminal be loosened. Only use the original earthing bolts.
7. Maintenance, Repair and Recycling

7.1 General

According to GB3906, DL/T404 and IEC 62271-200 standards, inspection and maintenance shall be provided to keep the switchgear in proper function and achieve a maximum lifetime. The recommend inspection and maintenance interval depends on the operating frequencies, short-circuit fault breaking cycles of the switchgear and its surroundings including humidity, pollution, corrosive vapour etc. All the high voltage components of SecoCube are completely sealed in the gas tank filled with insulating gas, consequently not influenced by the environment. Therefore, all the high voltage components are maintenance free under normal conditions.

Maintenance for the control compartment and its inside components depends on the ambient environment, such as humidity, pollution and corrosive vapour.

Maintenance shall be performed according to this instruction manual, as well as relevant safety regulations.

7.2 Inspection And Maintenance

Under normal operating conditions, the mechanism shall be inspected by trained skilled person after 10 years operation or every 5,000 operating cycles of the circuit breaker or every 1,000 operating cycles of the three-position disconnector. Such inspection also includes functional checking of protection and control units as well as the interlocks. In special operating conditions (such as pollution and erosion conditions), the maintenance cycle shall be shortened accordingly. The maintenance work will include the following items but not limited to:

- Appearance inspection, incl. checking the pollution, erosion and humidity conditions.
- Electrical and mechanical inspection for the switchgear and controlgear.

The following items shall be followed if cleaning is required:

- According to the instruction manual and related safety regulations, necessary isolating and safety measures shall be taken for the cleaning areas.
- Clean the dust on the surface with dry and soft cloth.
- Cable cleanser can be used to clean the silicon rubber part of cable plug and busbar bushing etc.
- In any case, the semi-conductor part of the silicon rubber and its surfacing shall not be broken.
- After cleaned, the equipment shall be dried before put into operation.

7.2.1 Vacuum Circuit Breaker

The embedded poles of SecoVac-G vacuum circuit breaker are maintenance free. However, the transmission parts of the operating mechanism shall be inspected every 10 years or every 5,000 operating cycles. Check the lubricant situation, and then re-lubricate them.
7.2.2 Three-position Disconnector

The three-position disconnector is maintenance free within its mechanical lifetime of 1,000 operating cycles. However, customer can perform regular inspection for the motor driven mechanism, such as function check and appearance inspection. The lubricating of the mechanism at accessible bearing points shall be checked every 10 years.

Figure 7.1 The chain and gear etc. of the mechanism shall be lubricated

Note: after every 10 year or correspond operation times should be check the situation of transmission part and lubricate.

7.2.3 Insulating Gas And Its Maintenance

The SecoCube gas tank is a gas-tight system, which is fully sealed within its lifetime. It is not necessary to re-fill the gas tank during the expected service life of SecoCube switchgear. Therefore, the insulating gas is maintenance free under normal operating conditions and it’s not necessary to check the gas quality. However, as per specific requirement of customer, it may become necessary to check the pressure of the insulation gas as part of the regular inspection activities. For details, please refer to section 6.3.1. If the gas pressure is lower than 0.11 MPa(abs.), re-gas should be performed by trained service engineer and the reason for the gas leak shall be detected. Please consult local service organization of the switchgear manufacturer for details.

7.3 Instruction for dispatching the gas and refilling the gas

Inspect the pressure gauge or density monitor to check if it is in the normal green area, or if there is any alarm signals send out. If normal, it means the panel is running in good condition and no need to refill the gas. Record the pressure data each time when doing inspection.

If the gas pressure gauge is found out of the green area, the density monitor alarm might have sent the signals already. And it should be informed to the service personnel or the manufacturers as soon as possible to find out the real reasons. Or the panel should be refilled the gas on site accordingly as following steps:
1) First, record the data of the gas pressure gauge indicated;

2) Second, confirm the real conditions of the gas density monitor signals if the gauge shows lower pressure;

3) Make sure the lower pressure will not affect panel normal functions at this moment;

4) Make sure the special tools of refill & dispatch gas, such as the gas filling connector, the gas filling pipeline, the pressure gauge and the SF6 gas bottle are connected properly;

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**Figure 7.2 Gas filling connector cross section**

Figure 7.2 gives the gas filling connector cross section drawings. It can be used also to the gas pressure gauge and refill gas connectors.

Figure 7.3 gives a picture showing the connector has been connected to gas density monitor and gas tank already.
5) Remove the metal limitation ring from gas pressure gauge.

6) Turn the connecting nut counterclockwise by means of special tools as Figure 7.4 showing to disassemble the pressure gauge.

⚠️ **Attention:**

To remove the connecting nut, catch the pressure gauges slightly and make sure the pressure gauge doesn’t rotate with connecting nut together to protect the gas filling connector and gas tight O-rings from damage.

7) Open the valve of SF6 bottle slightly to despatch the remained air in the pipeline of gas filling system.

8) Joint the connecting nut towards the self-tight valve of the gas tank as quickly as possible by means of pushing it inwards, then tighten the connecting nut clockwise to fix the gas connector to the gas tank. See Figure 7.5 and Figure 7.6.
Figure 7.5 Tools for dismantle the pressure gauge

Figure 7.6 Gas connector assembly to gas tank
9) Open the SF6 gas bottle valve to fill the gas to tank and observe the pressure gauge level carefully until it arrives the prospect pressure 0.02-0.03MPa (rel.). Close the SF6 gas bottle valve tightly. See Figure 7.7 and 7.8.

10) Repeat the step 6) to disassembly the connecting nut of gas filling connector from gas tank.

11) Repeat the step 8) with a pressure gauge to assembly it into the gas tank again. If the gauge shows in green area, then assembly the metal limitation ring back to its right position. Record the pressure gauge level accordingly afterwards.

12) Apply the leakage detecting system to the panel to check if any leakage happens or not. If no, increase the pressure gauge inspection times for certain period carefully.

### 7.4 Maintenance and Components Replacement

Normally, all high voltage parts and the gas tanks are maintenance free during its life time. However special service conditions or special circumstances may require maintenance work.
Customers can carry out repair works on panel enclosure themselves, while the stainless steel gas tanks, VCB mechanisms and 3-position disconnectors should be maintained by certified trained people. Please consult local service organization of the switchgear manufacturer for details.

7.5 Spare Parts and Auxiliary Materials

Spare parts and auxiliary materials for service and maintenance like nitrogen gas, SF6, drying desiccant bags, lubricant, silicon grease, dielectric clean cloth and paint may be needed. Please contact the manufacturer for specification and delivery of these materials.

7.6 Recycling Regulations

When SecoCube reaches the end of its service life, recycling for the products shall be done under the compliance of relative standards in order to protect the environment. If customer wants recycling service, please consult the manufacturer for more information.
8. Notice

8.1 Gas system

The mixture of nitrogen and $SF_6$ inside the gas tank is for insulation only, while the arc making and breaking is achieved by vacuum circuit breaker. In normal operating conditions, as the insulating gas is free from decomposing, aging and contamination, it is maintenance free in its service life.

Whenever the internal arc fault occurs, most of the decomposed insulating gas under high temperature will recompose and recover under low temperature while the remaining of it will be absorbed by the desiccant.

Both nitrogen and $SF_6$ in pure form are colorless and odorless gases, which cannot be recognized by sight or smell. Since the density of nitrogen is lower than that of air, it won't be accumulated at ventilated or low-lying place, but high density of nitrogen will have the suffocation risk in air-tight rooms. While due to higher density of $SF_6$ compared to air, it will be accumulated at low-lying place and will also have suffocation risk in air-tight rooms.

Due to the fact that nitrogen is the majority ingredient of air, the gas insulation by nitrogen eliminates the effect of aging and erosion from oxygen and moisture to the electrical equipment.

It shall be noted that the decomposition of $SF_6$ under arcing, results in a gas that is extremely poisonous. In case the decomposition occurs in low density, it has a color with pungent smell and causalgia that is harmful for the human nose, mouth and eyes. Gas mask shall be worn to avoid direct contact of the resulting gas with the skin while accessing during fault.

The decomposition of nitrogen under arcing is not poisonous and can be emitted to the atmosphere directly. But the effect on the decomposition of other insulating parts under arcing shall be considered.

In normal conditions, the insulating gas shall not suffer arcing, and the nitrogen can be emitted to the atmosphere directly. But for the mixture of nitrogen and $SF_6$, since the greenhouse effect of $SF_6$ is 23900 times more than that of CO$_2$, and will remain up to 3200 years after its emission to the atmosphere, $SF_6$ will cause extreme harm to the environment after its long-term accumulation and hence, it shall be recycled instead of being emitted to the atmosphere directly.

When nitrogen is used as the insulating gas, the air content doesn't need to be regulated in principle. But it has to be noted that the oxygen in the air will affect the aging inside the gas tank, while the moisture will affect the dew point and the insulation level under low temperature.

If need to handle insulating gas on site, please contact GE.

8.2 Connection of HV Plug-in Components

“Plug-in” technology is widely used in assembling and testing SecoCube switchgear, such as busbar connection, cable connection, VT connection, surge arrester connection and test adapter connection etc. The connection quality will impact the performance of the equipment on site.

Plug-in connection is a way to realize interface insulation by connecting two insulating interfaces together with certain pressure. Thanks to the tightly joint and the insulating grease, the insulation level will not be impacted by ambient environment.
The pressure for connecting two insulating interfaces is achieved by the tightening bolts on the plug-in components. Proper assembling dimensions and tightening torques should be ensured. There may be some residual air between the insulating interfaces after connection is done. In order to emit the residual air and maintain the insulation level, panels should be placed more than 8 hours before performing high voltage tests on them.

8.3 About Interlocking

SecoCube is equipped with reliable electrical and mechanical interlocking to avoid misoperation. The interlocks may change as per requirements of the users or the system design. Please pay attention to the changes during operation, especially on manual operation. Force to operate the switchgear is not allowed in manual operation, in order to avoid damage the interlocks and the mechanism. Please follow the instruction in delivered documents. Any question about it, please contact the manufacturer.