Base Load Power Hub (BLPH)

INSTALLATION, OPERATING AND MAINTENANCE MANUAL - 66kV GIS

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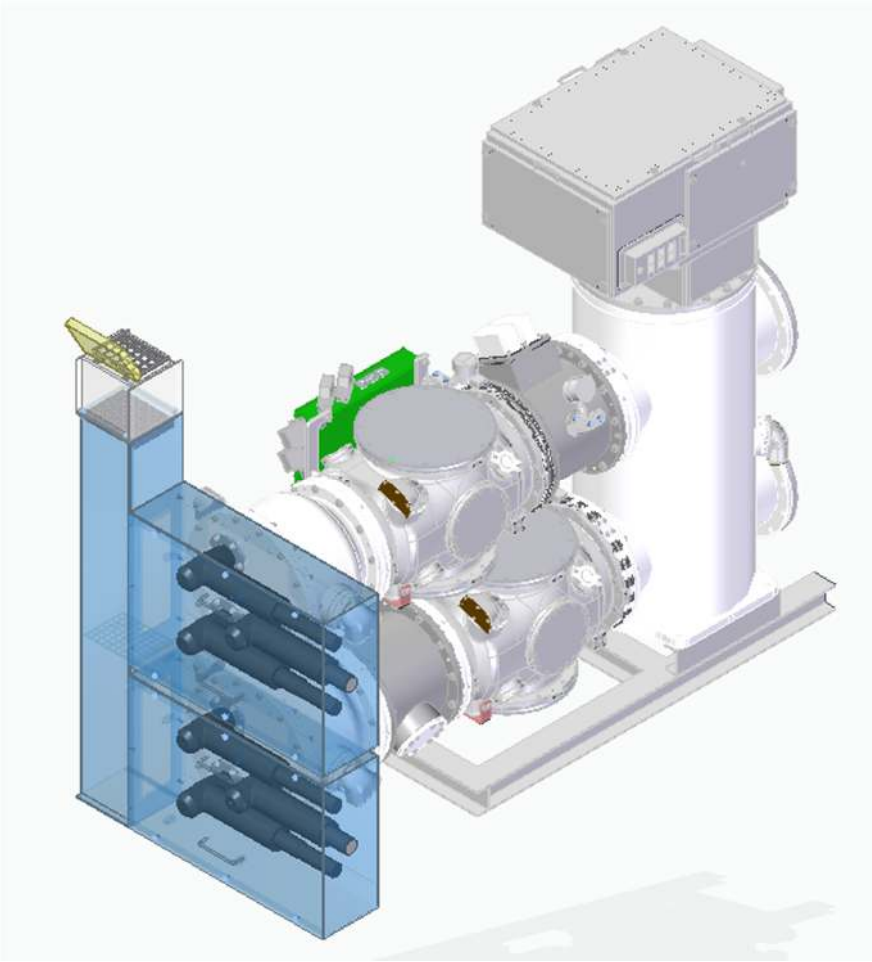
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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

72.5kV SF6 FREE SWITCHGEAR ECO-FRIENDLY GIS



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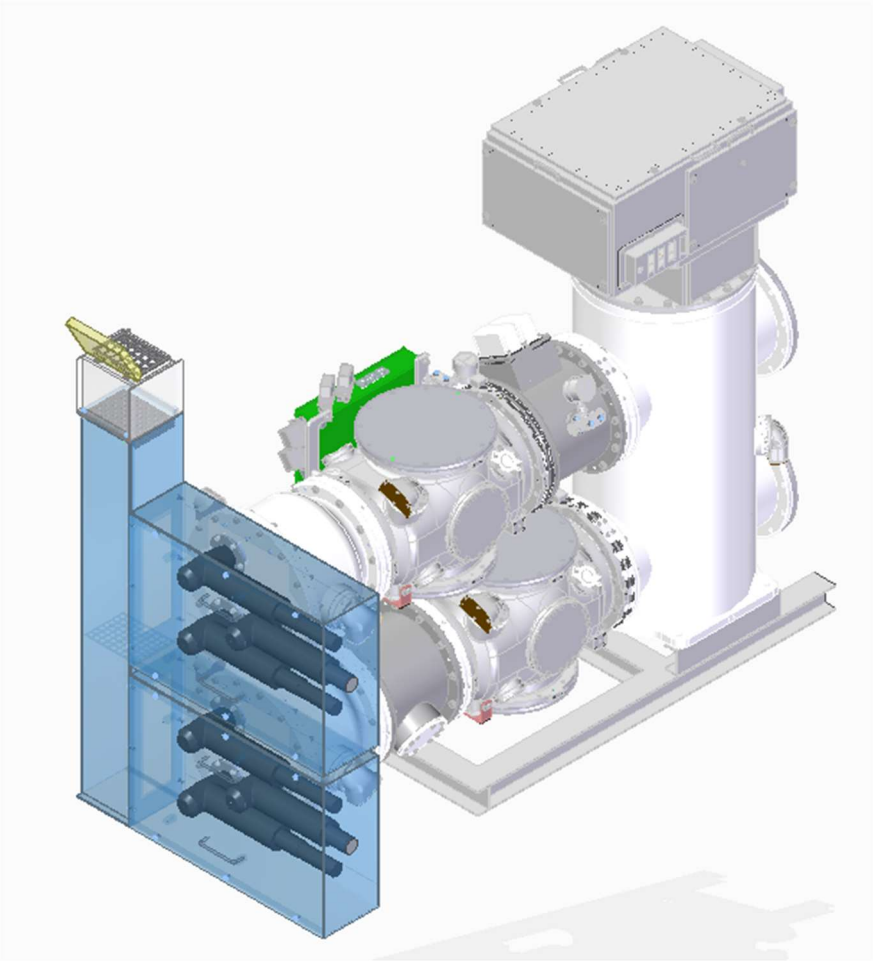
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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART A-0 INTRODUCTION



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1.1 Introduction

During manufacturing, the products described in this manual meet applicable International Electrotechnical Commission (IEC), Institute of Electrical and Electronics Engineers (IEEE), American National Standards Institute (ANSI), and National Electrical Manufacturers Association (NEMA) required standards. However, no such assurance is given with respect to local codes and ordinances because they vary greatly. The term, GIS, includes all equipment mounted on the GIS foundation.

Note: These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with equipment installation, operation, or maintenance. Should further information be desired or should a particular problem arise that is not covered sufficiently for the purchaser's purposes, the matter should be referred to HYOSUNG Corporation, HICO's parent company.

Each user is responsible for instructing all personnel associated with this equipment on all safety precautions that must be observed.

The following are recommendations to be considered in developing a user's safety program. These recommendations are not intended to replace the user's responsibility for developing a complete safety program and shall not be considered as such. The recommendations cover the more important aspects of personnel safety related to GIS. HYOSUNG neither condones nor assumes any responsibility for user practices that deviate from these recommendations.

1.2 Warning Signs

Throughout this manual, warning signs are used to emphasize instructions and information that should be very carefully observed.



Danger

Danger indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.



Warning

Warning indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.



Caution

Caution indicates a hazardous situation that, if not avoided, may result in minor or moderate injury.

Notice

Notice indicates hazards that may result in property damage only.

Important

Important indicates an operational tip or maintenance suggestion.

1.3 General Safety



Danger

All personnel associated with the installation, operation, and maintenance of power GISs should be thoroughly instructed and supervised on power equipment, in general, and on the particular model of equipment with which they are working. Instruction manuals and service advisories should be closely studied and followed.

Maintenance programs must be well planned and carried out in a way that is consistent with both customer experience and manufacturer's recommendations, including service advisories and instruction manuals. Good maintenance is essential to GIS reliability and safety.

Safety programs should also take into account the local environment and GIS application, including such variables as ambient temperatures, actual continuous current, number of operations, type of interrupting duty, and any unusual local condition, such as a corrosive atmosphere or major insect problems.

Important

The network function can be used when the Network Interface option is installed.

1.3 Specific Safety



Danger

Do not work on an energized GIS. If work must be performed on the GIS, take it out of service, open the disconnect switches at each side of the GIS, then close the GIS and ground each phase.

Do not work on any part of the de-energized GIS until all control power has been disconnected.

Do not disassemble any portion of the gas system of any GIS until system pressure has been reduced to zero psig (0 psig) by opening the appropriate drain valves. When the gas pressure has been reduced to zero, cautiously remove covers, tubes, fittings, and other parts.

Dry air is to be added to a pressurized system, measures should be taken to protect personnel against sudden gas release. After dry air gas has been added to the GIS, close the fill valve to relieve pressure between the source and the fill valve prior to removing the transfer tool/filter drier.

Keep personnel clear of all spring-charged mechanisms. Only skilled and knowledgeable personnel capable of releasing each spring load in a controlled manner must service the GIS. Information on the construction of such mechanisms is provided in this manual.

Important

This GIS is spring open and spring closed. Always ensure that *both* springs are discharged before working on the GIS.

The gas GIS will hold line-to-ground voltage under positive dry air pressure on an energized transmission line where no voltage disturbances are present. Under these conditions, the GIS should be de-energized by back-up protection GISs, isolated, and removed from the system as a safety precaution.

If there is any evidence of deterioration of the GIS's dielectric capability, the GIS should be de-energized by back-up protection GISs and isolated from the systems by disconnect switches.

Operational tests and checks should be made on a GIS after maintenance and prior to returning the GIS to service to ensure that it is capable of operating properly. The extent of such tests and checks should be consistent with the level of maintenance performed.

1.4 Service Safety

There are three simple and basic rules that will provide safety for anyone working on this type of GIS:

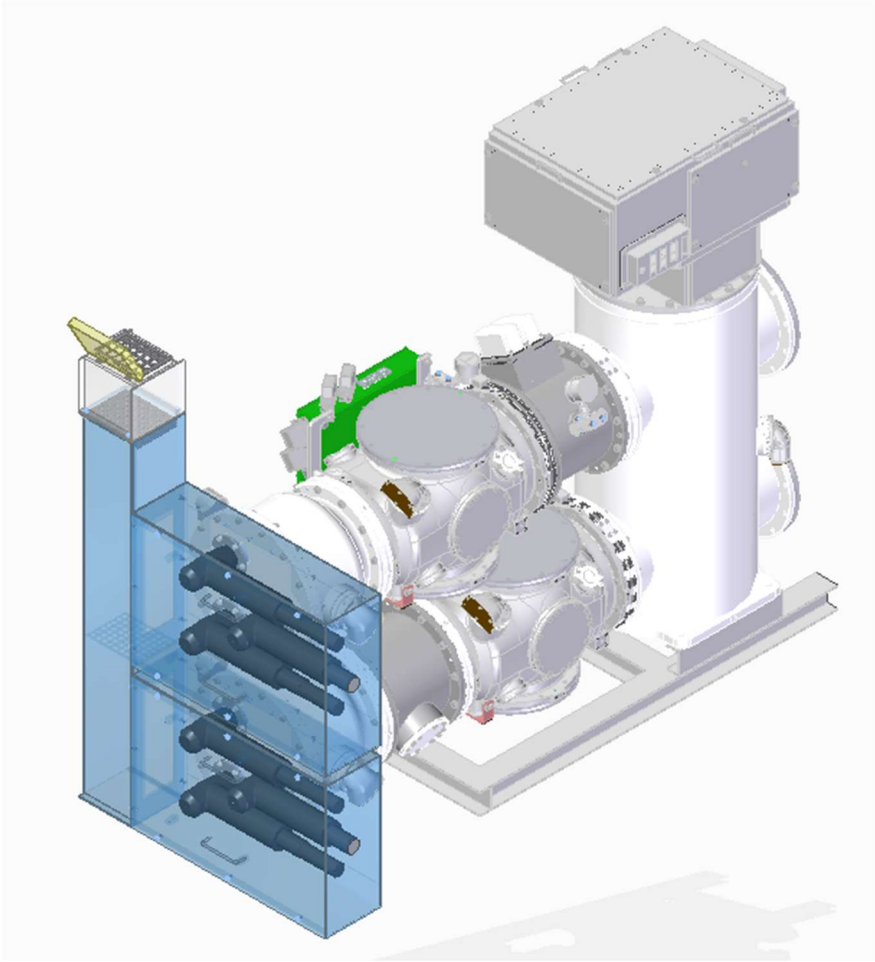
- Disconnect AC and DC power supplies at the GIS.
- Turn the dry air test valve to the test position.
- GIS open and close spring discharged

1.4.1 Disconnecting AC and DC Power Supplies at the GIS

When the AC and DC power supplies have been removed from the GIS, no powered operation can be done, either locally or remotely. This prevents anyone from accidentally operating the GIS by pressing the local trip/close push buttons (optional) or remotely operating the GIS from the control system. Although the GIS control power has been removed, the GIS can still operate mechanically. Safe position is GIS status open and close spring discharged.

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PART A-1 PACKING



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1. TRANSPORT

1.1 Packaging

1.1.1 Packaging requirements

For packaging equipment, the followings should be considered:
Appropriate standards and requirements
Environmental preservation
Packaging method (material and type)
Transportation conditions (means of transportation, routes)
Various potential damage (moisture, rain, rust, corrosion, shocks, force, handling etc.)
Weather conditions
Transportation dimensions, weights and volumes
Storage after shipment

1.1.2 Types of packaging

Depending on the property, weight and shape of items, packaging types shall be selected, such as wood case, crate, skid bundle, pallet bundle or bare equipment, etc.

1) Seaworthy packaging

All materials shall be packaged as compact and durable as possible. All packages shall be properly and solidly made to be suitable for all mechanical and inland transportation. All packages shall also take into account the following eventualities.

a. Handling at the loading and unloading port 3 or 4 times.
b. Outdoor storage after shipment to job site
c. Significant variation in ambient temperature during ocean shipment
d. Design in consideration of the weight when loading them in accordance with related standards of the project.

2) Wooden Framed Box

a. Closed Crate

This packing form shall be closed completely and applied to packing needed for the prevention of damage due to vibration, pressure weight and shock. Accessories and small parts shall be packed in this packing form.

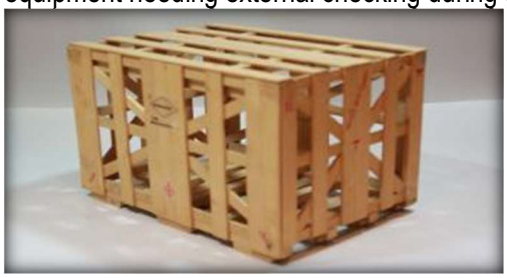
b. Water-proof Closed Crate

This packing form shall be applied as a water-proof case for the item, such as instrumentation or electric equipment, requiring complete protection from water or moisture. Watertight paper or sheets will be used inside case wall.



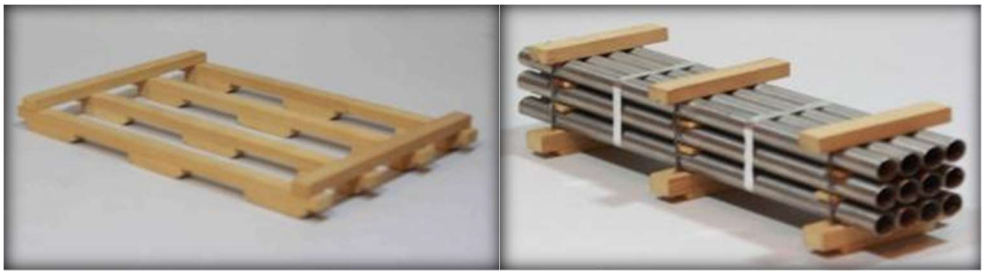
c. Open Crate

Crate packing shall be applied to equipment and parts resistant to rain, dust, sunshine, vibration, pressure and shock. And this type of packing shall be applied to equipment needing external checking during transportation.



d. Wooden Skid Bundle

This type of packaging shall be applied for items which are weatherproof and strong enough to resist an external impact such as vessel, exchanger, large beams, column, box column, girders etc. Wooden skids and goods will be tightened with cord straps or stud bolts.



e. Bundle

This type of packaging shall be applied for items which are weatherproof and have a simple shape. The quality of goods should not be affected by weather during transportation and storage as a bundle. The bundle should be property packed to protect goods from external impact during handling, transportation and storage.

3) Steel Frame

This type of packaging shall be applied for items which could be damage easily due to their large sizes and light weights compared to the sizes. Special care shall be taken to protect the goods when they are stacked.



4) Drum Packing

Drum packing shall be used for the packing of chemical, liquid, powder and tower packing. A wooden drum shall be used for the packing of electric cable or wire



5) Moisture-proof packaging

This type of packaging shall be applied for items such as precision instruments, bearing equipment, etc. to be protected from moisture. Products required to be packaged in moisture-proof packaging shall be wrapped with the moisture-proof materials (e.g. Aluminum sheet) to protect damage or defect from outer contamination. The inside air shall be removed to keep the inside closed off to the corrosion factors and sustain the origin shape.

6) Special Case

Special cases are to be used for shipping and handling and shall be designed considering weights and volumes of modules.

1.1.3 Packaging unit

Package size and weight shall be decided after considering the delivery condition and handling method.

1.1.4 Environmental factors

Packing must protect the equipment against all kinds of damage (moisture, rain, rust, etc.) during transportation by different means of transportation such as truck, railway, air, ship.

Materials shall be suitably protected from weather damage. Packing shall include preservatives suitable to weather conditions.

1.1.5 Sealing of equipment

For transportation, the equipment is filled with N2 or dry air to an absolute pressure of 150 kPa.

The gas pressure shall not drop below 110 kPa during shipment and storage.

All open flanges must be sealed with a shipping cover.

1.1.6 Marking

Marking Specification and position for Boxes, crates and shrink packaging are followed by below TABLE 4.1.

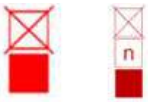
		Ink		Mark Location	Size	Remarks
		Color	Material			
Main Shipping Mark		Black	High Quality Waterproof Ink or Oil Paint	Both Sides	Optimum Size For each Package	Printed Weatherproof Paper
Care Mark	Sling mark and Center of Gravity Mark, other Marks	Red	High Quality Waterproof Ink or Oil Paint	Both Sides	Optimum Size For each Package	
Approximate Weight		Red	High Quality Waterproof Ink or Oil Paint	Both Sides	15cm and over	Only for Packages exceeding 5tons: Hand Writing is Permissible unit shall be in tons.
Packing List Cover		Yellow Letters on Black Background	Enamel	Upper part of one Side	L : 18cm W:14cm	Do not overlap with Care Mark Use Template

TABLE 4.1 Marking applications for case, crate wooden box

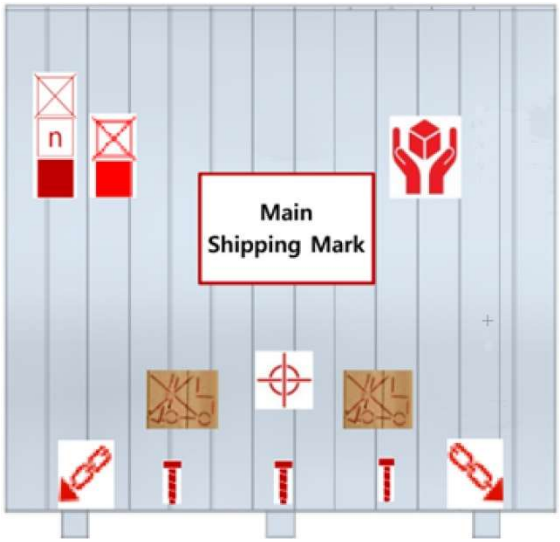
2) Marking shipping mark

Main shipping mark shall be clearly stenciled on surface of package or attached on printed shipping paper. When the mark is to be stenciled directly onto the surface of equipment such as a column, drum and tower, etc., a color contrasting to the color of the equipment shall be used. If the package does not have sufficient space for the main shipping mark or in the case of bundles cargo cannot be stenciled, three or more labels of appropriate size shall be firmly affixed to the package.

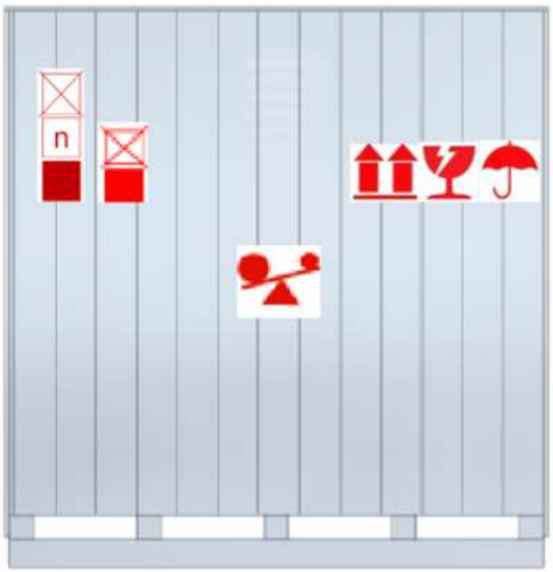
3) Auxiliary Shipping Mark

No.	Name of Mark	Stenciled Marked and Letters	Remarks
1	Center of Gravity		At the center of gravity
2	Sling		Where sling wire is to be applied
3	Top		When package cannot be placed upside down
4	Keep Dry		For boxes that need protection from water and moisture
5	Hand With Care		For Handling with care
6	Heavy Weight this end		When center of gravity is on one side
7	Bolt		Bolt fastened area
8	Fragile		For fragile cargo
9	Forklift Prohibition		Do not lift using Fork Lift
10	Do Not Stack		Stack limited

4) Position of main auxiliary shipping mark



<Front and Rear board>

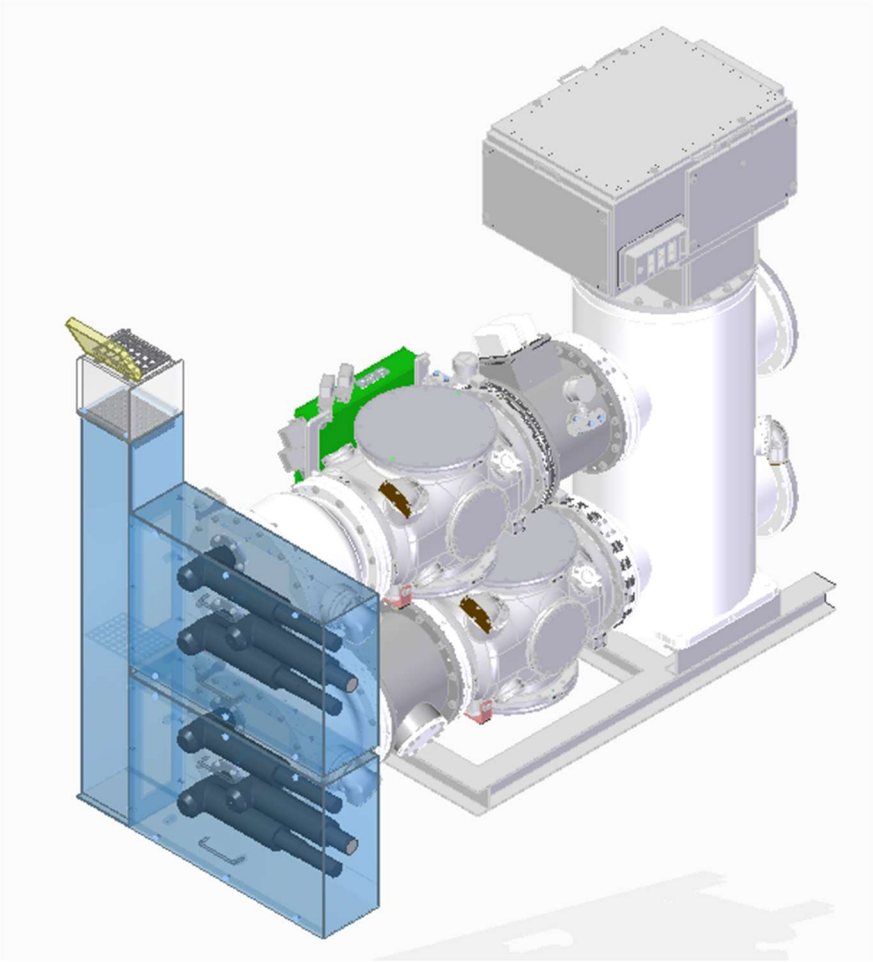


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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART A-2 TRANSPORTATION & STORAGE



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1. SHIPPING

1.1 Preparations

A worker shall investigate specification and characteristics (weight, center of gravity, etc.) of products. And shall designate carriers and vehicles in accordance with specification of cargo. The means of transportation shall be selected for ensure that shipping units will be subjected to the smallest-possible amount of vibration.
Select appropriate equipment and ropes to lift products in a safe manner.
When lifting products, it is required to adjust equipment or ropes properly to prevent products from tilting toward one direction.

1.2 Loading in vehicles

A worker shall check characteristics and specification of transportation vehicles. And then, shall lift products to a loading position onto a vehicle and suspend cargo above a cargo deck for a moment in a non-swaying state. Lower cargo down in a correct position. When loading products on a cargo deck, it shall be put in a correct position on the cargo deck while paying attention to prevent a vehicle from tilting due to weight pressed toward one direction.

1.3 Lashing

Select ropes or wires suitable for characteristics and specification of products, and check if they are broken before use. Bind each loaded product with ropes or wires in two or more positions so that products may be fixed to avoid swaying in a cargo deck of transportation vehicle.

1.4 Unloading

1.4.1 Prepare appropriate capacity of crane, folk lift, wire rope sling and hook.
1.4.2 Check the marking for the point of notice based on the center of gravity as shown in Figure 1.
1.4.3 Unload products using crane or folk lift as shown in Figure 2,3 and 4.



[Fig. 1]



[Fig. 2]



[Fig. 3]



[Fig. 4]

1.5 Inspection

Before shipment

Prior to closing the shipping containers, make sure that the equipment to be shipped is properly secured and without damage.

After shipment

Check shipping container for any damage before opening.

After opening a container, immediately check the equipment for external damage and completeness.

1.6 Irregularities

1.6.1 During shipment

Any damage which has occurred on the package in transit shall, to the extent possible, be repaired immediately. If this cannot be done, appropriate measures shall be taken at once to avoid any further damage to the cargo.

All irregularities occurring during shipment as well as any remedial action taken shall be documented and reported.

1.6.2 After shipment

In the event of any damage detected on the packaging or equipment, the insurance company should be called and the damage should be assessed and recorded by an authorized agent.

Photographs should be taken of any damaged packaging to serve as evidence at a later time.

Any packaging which is damaged or soaked shall under no circumstances be used for prolonged storage of equipment.

Any corrective action taken with regard to packaging or equipment preservation shall be recorded in detail. All materials used for these measure must have been tested and approved.

1.7 On-site Transportation

1.7.1 On-site transportation includes the moving of packed or unpacked product before or during installation.

1.7.2 Check the capacity and type of trucks or other vehicles for transportation.
1.7.3 Remove all possible dangerous objects and obstacles of the road to final destination for transportation of the product. Check the limit of road condition (like tunnel height limit) on the way in advance.
1.7.4 When transporting the assembly of products or wooden crates, stabilize the transport vehicle during loading and then load the products on suitable position of the rack of vehicle considering the center of gravity to prevent them from any possible vibration or damage.
1.7.5 The speed limit of the vehicle should be considered properly with depending on the road condition during transportation. Under the condition of paved road, 50~60km/h (30~37.2 mi/h) is proposed and Under the condition of unpaved road, below 20km/h is proposed.
1.7.6 When the package arrives at final destination, follow unloading procedure mentioned in section 1.4.

2. STORAGE

2.1 Storage requirements

All storage areas must comply with the following general requirements:
Good accessibility for transport and inspection
Protection against damage
Restricted access for authorized personnel only
Guaranteed fire protection
The storage area must be clean and free from unused packing material
When stocking, the moisture contents of the packing must be considered
Flammable material must be stored in a separated area
Compliance with all local regulations and requirements must be guaranteed

2.2 Warehouse requirements

Warehouse should be built on a concrete floor as shown in Figure 5 and 6. and the concrete floor level must be higher than ground level. In case that site condition is not applicable, the drainage should be equipped around the floor.
Warehouse should supported by steel structure. Ensure each structure installed inside warehouse and the warehouse roof has enough space for moving GIS box into the warehouse.
The packing side aspect vinyl of the GIS in the wooden box should be removed for air circulation for long storage.
The storage warehouse should be kept proper humidity lower than 80% and temperature between -10~35℃



[Fig. 5]



[Fig. 6]

2.3 Check point before storage of GIS.

2.3.1 Upon arrival, a visual inspection shall be performed to ensure that all materials are properly transferred. Check that all equipment and goods coincide with packing list.



2.3.2 The GIS is filled to 0.2~0.5 bar of N2 or dry air for transportation. Open the gas valve with care and check the leaking from inside. In case product is stored more than six months, it is necessary to supplement nitrogen gas up to 0.2bar.

Dry air bottle shall be stored inside of building at below 40℃ and keep out of the direct sunlight.

2.3.4 Control cubicle such as local control panel or control mechanism shall be kept away from unauthorized person and should be covered with vinyl to prevent contamination from water, moisture and dust. If the place does not satisfy the conditions specified above, unpack the goods and operate a heater to prevent damage by corrosion and/or freezing.

2.3.5 Store spare parts and special tools the same as they are packed initially. Items which are made of rubber (seals) should be protected from direct sunlight to prevent deterioration.

2.4 Checking point after unpacking

2.4.1 Do not stack packing box on box to prevent damage to the packing box.
2.4.2 Cover for transportation shall be opened just before assembly. The internal inspection and cleaning shall be performed to remove any dust inside.
2.4.1 A visual inspection of the exterior shall be performed to check any crack, deformation and/or rust.



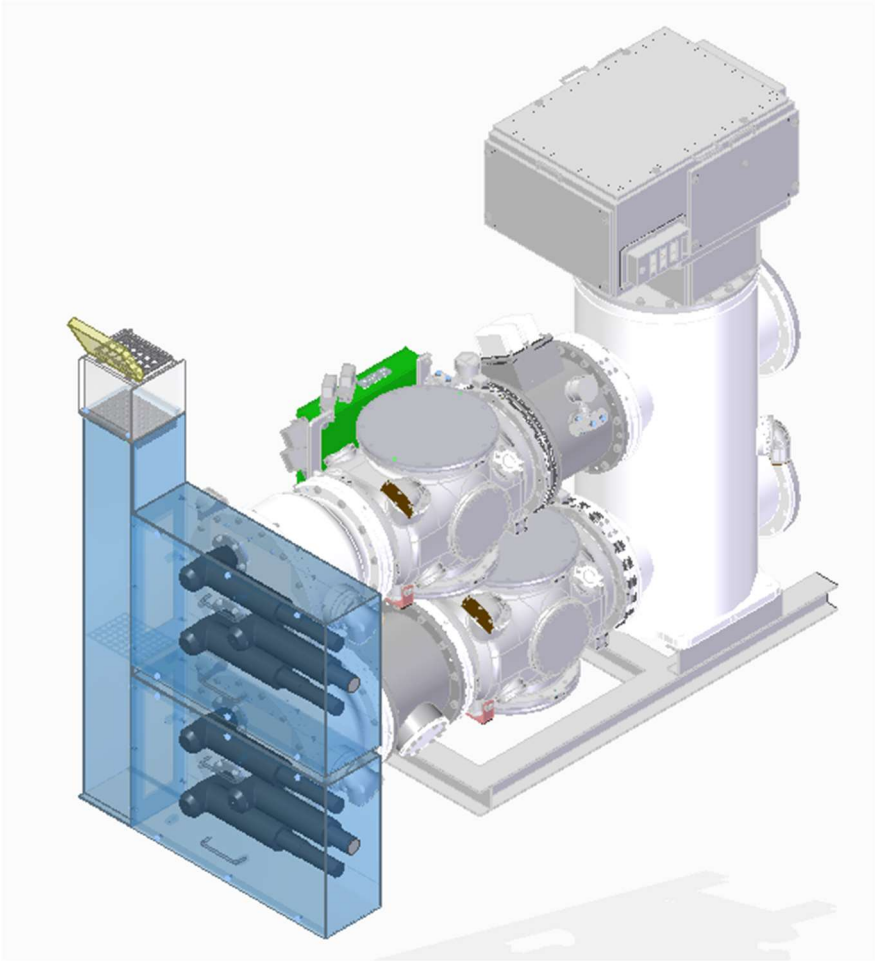
Caution

- Since the inside of GIS is filled with 0.2~0.5 bar of N2 or dry air for transportation, no valve should be manipulated before dry air injection is prepared.
- Do not remove the cover of gas pipe until piping facilities are prepared.
- In case of storing hydraulic operating mechanism more than 6 months, inner operation oil circulation shall be performed.

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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART A-3 INSTALLATION



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12. DRY AIR FILLING AND EVACUATION 12

1. INSTALLATION REQUIREMENT

1.1 The gas insulated switchgear (GIS) outline, lay out, section view, plant view drawings will be submitted as attachment drawings. Shop drawing such as base channel, cable termination position, grounding position, for GIS installation and for civil work will be submitted later by partial.

1.2 All components of GCB, bus bars, disconnecting switches, earthing switches, VT, CT, and operation mechanism assembly arrangement will be provided under approved drawings.

1.3 For the bus bar (GIB) to be connected between GIS and main power transformer, we will submit the GIS drawing and the connection drawing for transformer's primary bushing connection.

2. CLEANLINESS ON SITE

2.1 Before any assembly housings are opened at the site, all work in the switchgear room must be completed and the floor should be coated with a dust-binding primer. Windows and doors should be lockable. Caulking, drilling and other such work must be prohibited inside the building while module assemblies are open.

2.2 If an air conditioning unit exists, it should be in operation before assembly work begins.

The air conditioning unit should not be turned on for the first time during switchgear installation due to the likelihood of whirling dust.

2.3 Protection against dust and humidity

- Dust quantity : less than 20 CPM (0.2 mg/m3)
- Relative humidity : less than 80%

3. UNPACKING GIS

3.1 Check the quantity of total packing BOX

3.2 Check the quantity of N2 or dry air Gas at each packing BOX.



3.3 Confirm GIS room base level and line marking as per foundation drawing.
3.4 Unpack GIS preventing damage to GIS equipment
a) Before unpacking GIS, check if there is any damage or any shock indicator turns red before proceeding. If there is damage recognized before unpacking, information including photo of damage and box number and other appropriate details shall be sent to Hyosung supervisor.



<Confirm GIS Room Base Level>



<Line Marking on the GIS Room>



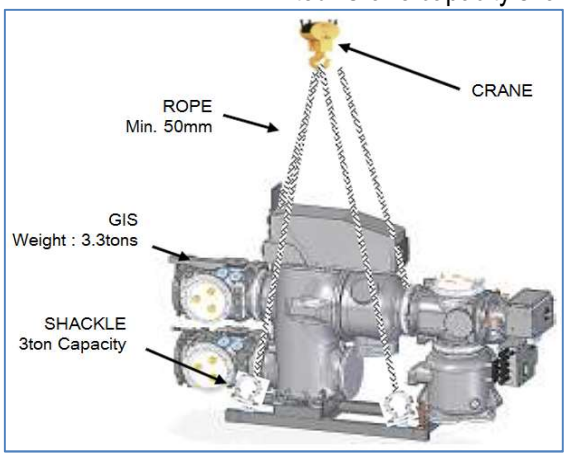


<Unpacking GIS>

4. CARRYING GIS INTO BUILDING

4.1.Lifting GIS

a) To lift and unload GIS, Crane is required up to weight of each GIS module to be lifted. Crane capacity shall exceed weight information provided by Hyosung.





4.2. Lowering and placing GIS upon foundation

a) After lowering GIS, GIS equipment can move upon embedded plate on foundation by overhead crane at site. If overhead crane in GIS substation is not available, steel pipe or roller can be used to move GIS to proper location as shown in the picture below.



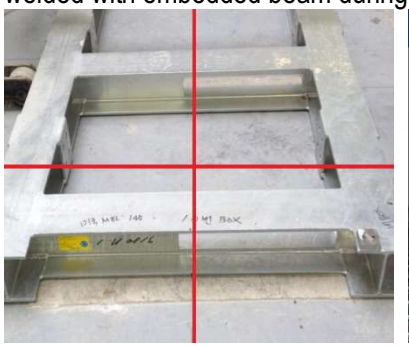


5. ARRANGEMENT OF GIS

5.1 Place GIS according to approved foundation drawing.

a) Center line of each bay and main busbar shall be marked by Hyosung supervisor

b) Check the location of open hole and H-beam as per foundation drawing.
c) H-beam level tolerance should be ±1 mm (Total 2mm)
5.2 GIS shall be put onto embedded beam bay by bay and main base of GIS shall be welded with embedded beam during docking process.





6. BUS DOCKING PROCEDURE

6.1 GIS is filled to 0.2-0.5 kg/cm2 of dry air inside circuit breaker tank and 0.2-0.5 kg/cm2 of N2 gas inside other tanks. No gas shall be released from the portion of adjointing tanks and other gas sections in which other components are installed.

6.2 While working inside tank, proper tool management is required to keep tools from being lost or left inside the tank.
a) Tool management
- All tools necessary for work shall be put in tool-hanger
- Any remained extra tool shall be locked in a tool box.
- Make sure that all tools not locked are on the tool-hanger.
b) Tool work
- When working inside tank, tie tool being used to worker's hand to prevent any tool from being lost inside the tank.

6.3 In case of an extension installation, work is carried out during an interruption of power on existing portion. Gas shall not be released from gas section in operation.
a) Check gas-distribution-section by checking the combination of gas section diagram of existing close-open device and gas-section diagram of extension portion.
b) According to the above a) result, adhere "DO NOT OPERATE" warning mark on gas valve operating handle after winding up red tape on the section from which gas leakage shall be prohibited.
c) At extension work, first close handle of each panel on existing portion, second, attach "DO NOT OPERATE" mark, third, on DS side, then close its operating substantially.
d) At extension work, the inside-work shall start after checking earthing state when opening the end-cover of Main-bus.

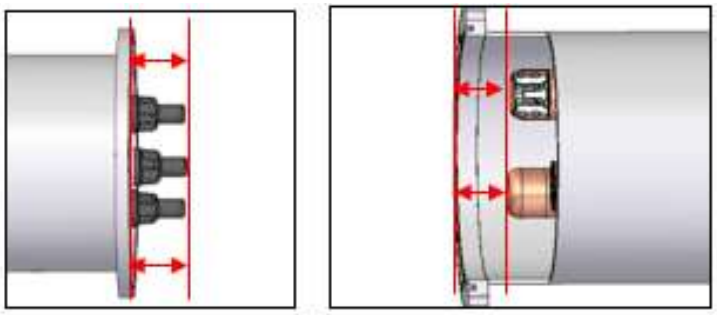
6.4 After recording total quantity of components taken in, finish the work, then check the components quantity used and the remaining quantity. Also, any damaged component shall be marked "Do not use".

6.5 After removal of the cover for transportation at tank connecting portion, clean the inside component while checking the condition.
a) After removing of the cover for transportation, cover with vinyl cover for dust protection (see picture below).
Make sure that the inside of vinyl shall be used in order to protect the tank from attached dust on the outside of vinyl.
b) The portion which consists of manual deep grooves between fabricated components shall be vacuumed with a flat nozzle hose.
c) Clean insulating material, shield, conductor and inside-surface of tank with industrial wipe. At this time in case an industrial wipe is used for metal portions such as conductor or shield, do not use the wipe again on which metal particles might be, to clean insulating material.



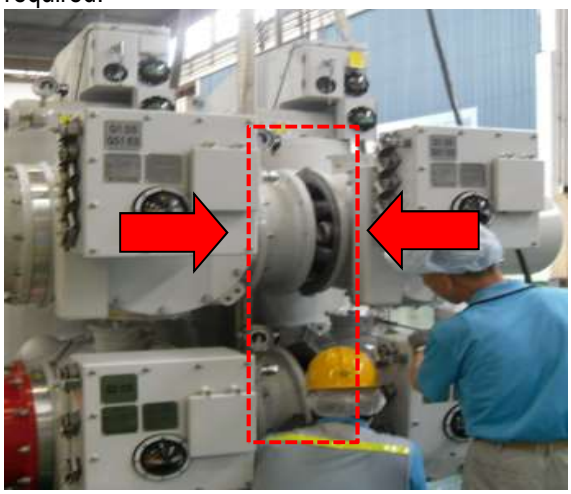

6.6 As gas tight surface is likely to affect product life, check any scratch, friction or painting defects.
a) If there is any scratch, use sandpaper, then clean that part with a wipe.
b) For the portion of paint defects, sand that portion and re-paint before cleaning with wipe.

6.7 In case of too-much HITALUBE in O-ring groove when inserting O-ring paraffin, the extra HITALUBE which provides connection would cause gas leakages. Therefore, the thickness of HITALUBE coating shall be thick as a finger-print leaves. (Air tight surface of insulating spacers do not require HITALUBE coating)
6.8 Before tank connection, check tank flange surface and contactor length like the figure to check connecting depth of contactor.
a) Tank Connection
Contact-depth of contactor (depth criteria : 56±2mm)



b) Tank and bellows connection

Check the connection depth, comparing it to the compression side of bellow shall be required.



Before connection bellows

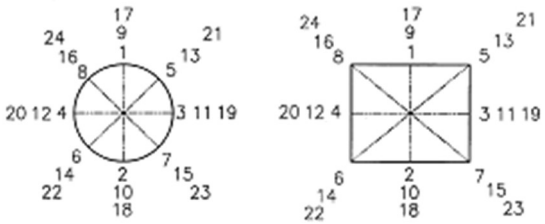
Check the connection depth of contactor according to the change of bellow side it's connecting.

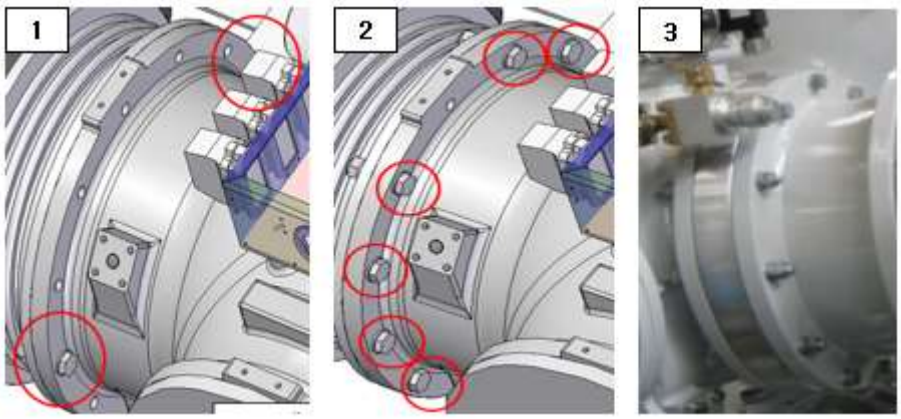
After docking bellow of main bus and injecting gas, unfasten nut about 5mm. (Only the inside nut)

6.9 Flange connection and bolting cover portion shall be done as bellow.

a) In case of small diameter flange with bolting numbers less than 8, cracking O-ring's complete adherence by bolting No.1, No.2 bolt, and the remaining bolts in the sequence of No.3 to No.8.

b) In case of large diameter flange with bolts numbering more then 9, checking O-ring's complete adherence by bolting No.1 to No.4 and the remaining in the sequence of No.5 to No.16.

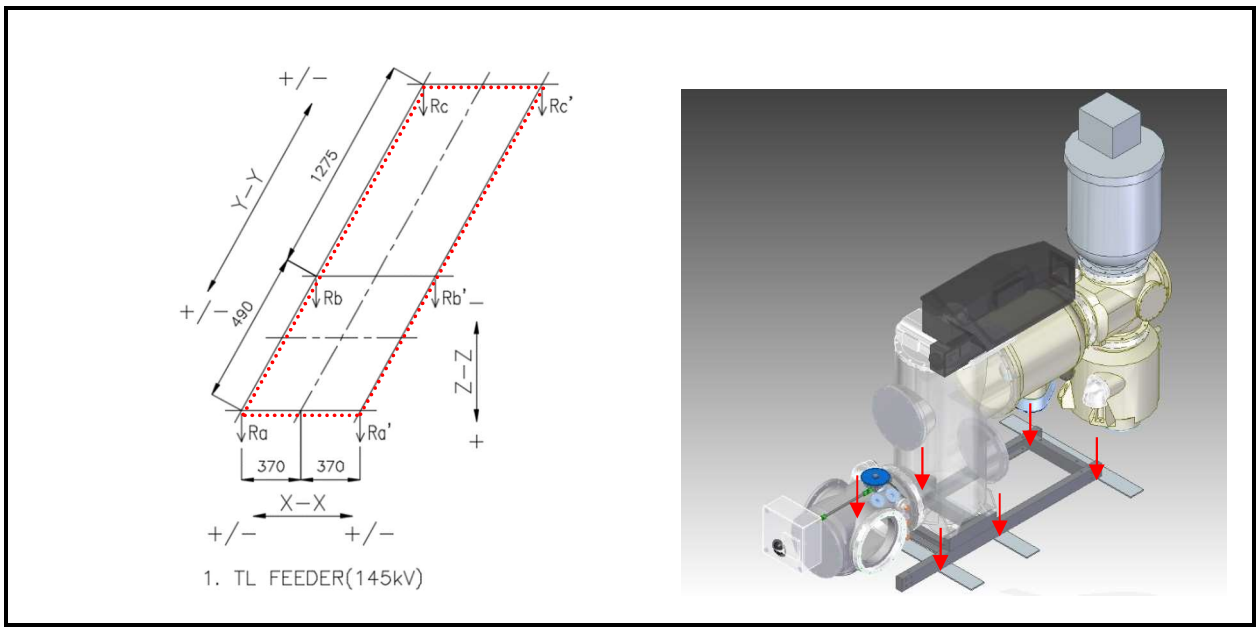




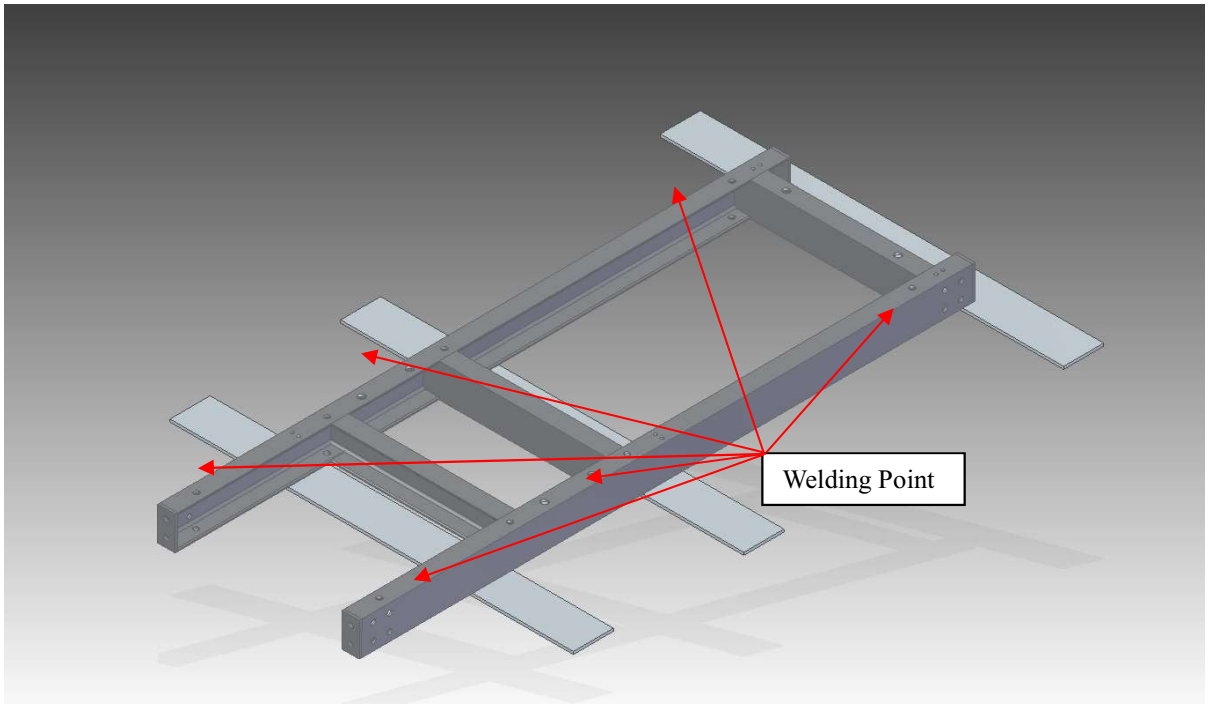
6.10 At gas-pipe connection, work gas pipe holes of flange or valve shall be covered with vinyl tape to protect it from dust.
At this time, the vinyl tape is required a little longer than pipe hole covering size in order to attach the remaining tape to the pipe side which provides easy-checking from outlook.
6.11 After removing absorbent for work, substitute it with new zeolite.

7. WELDING LOCATION

Welding location shall basically follow foundation drawing.



<Figure 1. Welding location in Foundation drawing & 3D Modeling>



<Figure 2. Welding point on 3D Modeling

8. DOCKING OF VT/LA/BUSHING (If needed)

8.1 Check the condition of O-ring on the surface of flange.

8.2 Check the connection depth of conductor through the drawing.

8.3 Mount the VT/LA by crane.

8.4 Docking between VT/LA and GIS.

8.5 Docking between Bushing Enclosure and Conductor. <Figure.3>

8.6 Mount the Bushing by crane.

8.7 Check the center of Bushing and Conductor. <Figure.4>

8.8 Docking between Air-Bushing and Conductor.

9. CABLE CONNECTION

9.1 Check the specification of cable.

9.2 Spread and cut of cable

9.3 Insulate between cable and core.

9.4 Insert the cable numbering tube.

9.5 Select the amp terminal and pressure.

9.6 Work for insulation tube.

9.7 Make a bundle wire.

10. LAY A PIPE FOR GAS

10.1 Constitute the gas line through gas system diagram.

11. WORK FOR VACUUM

11.1 Check the identity of vacuum section and pipe connection.

11.2 Vacuum machine is connected at valve using the exclusive hose for vacuum.

11.3 Vacuum of GIS is continued during more than 2 hours after the degree of vacuum has reached 1Torr. And record the final Torr.

11.4 Close cover at valve inlet after finished vacuum work.

11.5 Vinyl tape both ends of hose.

12. DRY AIR GAS FILLING AND EVACUATION

12.1 Connect the evacuation device (including vacuum pump) to the fill (Dilo) valve.

12.2 Operate the evacuation device (vacuum pump) until reaching 0.2mmHg(0.2torr). Check the vacuum degree with vacuum pump off. Turn vacuum back on and vacuum over 3 hours after reaching a reading below 0.2mmHg. Total vacuum pump operating time should exceed 5 hours, depending on the evacuation device.

12.3 Disconnect the evacuation device.

12.4 Connect DRY AIR gas cylinder to the valve of the GIS.

Refer to the manual of Dilo valve manufacturer with customer.

Do not fill the cylinder with too much pressure, or the equipment could be damaged.

12.5 Gas flow may cease due to chilling; the cylinder may have to be heated.

12.6 Monitor gas pressure using the gauge provided in the control cabinet.

12.7 Fill the GIS gas compartment until the correct pressure has been reached.

12.8 Close the DRY AIR gas cylinder valve.

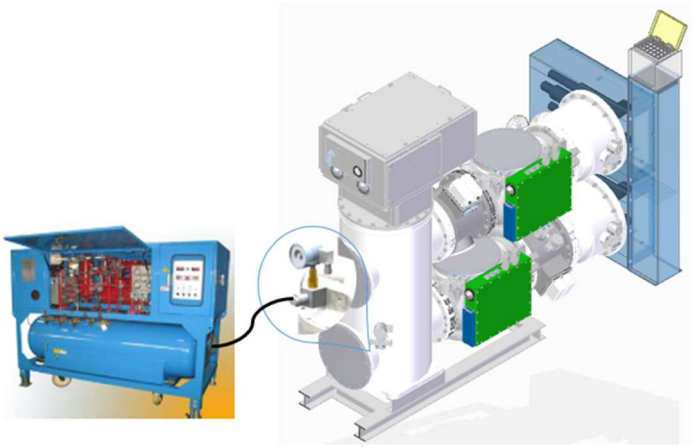
12.9 Remove the fill hose from the tank-fill valve and the cylinder valve. Replace the Safety cap on the DRY AIR cylinder and the tank-fill valve.

12.10 Allow the gas pressure to balance for twelve hours and the recheck the pressure level. If additional gas is needed add as required.

12.11 Sample the gas from the breaker for moisture after twenty-four hours. Use the fill valve for sampling instead of the valve in the control cabinet.

12.12 Leave the hygrometer on until a reading of less than 150ppm has been obtained. If a reading of 150ppm cannot be reached, dry the hygrometer with dry air or nitrogen until attaining a reading of below 100ppm. Immediately recheck the breaker gas. If a reading of 150ppm is still not obtained, wait one week and recheck during the cool morning hours.

12.13 If hygrometer reading is higher than 150ppm, then remove gas, replace desiccant, and refill with new gas.



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PART B-1

OPERATION SEQUENCE

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   1.1 PREPARATION BEFORE OPERATION 2
   1.2 OPERATION FROM LOCAL CONTROL PANEL AND REMOTE CONTROL PANEL 2
2. OPERATING LIMITS 3
3. PRE-STATE CHECK LIST 4
4. IN-SERVICE CHECK LIST 5
5. ABNORMAL CONDITIONS 7

1. OPERATING SEQUENCE

1.1 PREPARATION BEFORE OPERATION

Gas Insulated Switchgear (GIS) must be filled with Dry air before operation.
In the final stage of installation or maintenance, fill Dry air into enclosure of GIS to the rated gas pressure. If Dry air is not filled before operation, under-mentioned performance will not be ready;

1.1.1) Dielectric strength for main circuit
1.1.2) Interruption performance
1.1.3) Mechanical damping action for Circuit Breaker operation

Before charging gas, evacuation of air is needed for more than 1 hour after 1Torr vacuum is reached.

After charging gas, normal open gas valve should be open and normal closed gas valve should be closed on each gas piping system.

1.2 OPERATION FROM LOCAL CONTROL PANEL AND REMOTE-CONTROL PANEL

Operation of CB, DS and ES is able to be performed at Local position and/or Remote position by the Change-Over Switch (43R).

1.2.1) CB opening and closing

When opening and closing each CB, the Remote or Local operation may be performed by setting the 43R on each Local Control Panels (LCP). The 43R is marked "REMOTE & LOCAL" on LCP.

1) CB opening from RCP (or LCP)
   a) Set the 43R on each LCP to "REMOTE (or LOCAL)" position.
   b) Command the CB opening from the RCP (or LCP).

2) CB closing from RCP (or LCP)
   a) Set the 43R on each LCP to "REMOTE (or LOCAL)" position.
   b) Command the CB opening from the RCP (or LCP).

Note: The 43R on each LCP of Bay is usually set to "REMOTE" position. Do not operate the switch by force. That can cause damage to the switch.

1.2.2) DS opening and closing of combined DS & ES

1) Opening
   a) Set the 43R on each LCP(RCP) of Bay to "LOCAL (or REMOTE)" position.
   b) Push-turn the Control Switch (CS) of DS to "OPEN" position.
2) Closing
   a) Set the 43R on each LCP(RCP) of Bay to "LOCAL (or REMOTE)" position.
   b) Push-turn the CS of DS to "CLOSE" position.

1.2.3) ES opening and closing of Combined with DS & ES

1) Opening

a) Set the 43R on each LCP of Bay to "LOCAL" position.

b) Push turn the CS of ES to "OPEN" position.

2) Closing

c) Set the 43R on each LCP of Bay to "LOCAL" position.

d) Push-turn the CS of ES to "CLOSE" position.

2. OPERATING LIMITS

2.1. OPERATING DRY AIR PRESSURE

Items	Circuit Breaker (bar.G at 20°C)	Other Equipment (bar.G at 20°C)
Normal	5.0	5.0
Minimum	4.5	4.5
Reason	Dielectric characteristics Interrupting characteristics	

2.2. CONTROL VOLTAGE

Items	Closing voltage (Vdc)	Tripping voltage (Vdc)	AC circuit (Vac)
Maximum	121	121	-
Normal	110	110	120 ~ 240
Minimum	93	77	-
Reason	Operating characteristics		

3. PRE-STATE CHECK LIST

The individual items for each component are listed in each paragraph as follows;

No.	Procedure	Test and work contents		Remarks
1	Construction check	1) Check each part for proper tightness condition.		
		2) Confirm that tools and foreign substances are removed from each part.		Main terminal parts, control box interior, control cubicle
	Stop valve check	Gas	1) Fully open the stop valve on the enclosure.	Refer to "GAS SYSTEM DIAGRAM"
			2) Fully close the stop valve in the gas monitoring box.	Refer to "GAS SYSTEM
3	Gas pressure check	1) Check the stop valve of gas piping.		See Table B-2.
		2) Check the gas pressure		
4	Insulation resistance measurement	1) Prepare a 2500 volt megger.		Confirm that measured values exceed 10000 MΩ.
		2) Measure insulation resistance between main and ground with GIS kept in closed position.		
		3) Measure insulation resistance between main terminal with GIS kept in open position.		

Table B-1 CHECK PROCEDURE FOR TEST OPERATION

4. IN-SERVICE CHECK LIST

Check the equipment in service visually to ensure no abnormality appears.

Special attention shall be paid to gas pressure.

The procedure is as shown in Table B-2 and the individual items for each component are listed in each paragraph as follows:

No.	Check item	Check procedure	Range of acceptable valve	Remedy
1	Gas pressure	1) Read gas pressure on Dry air density monitor. 2) Record the gas pressure and temperature. If Dry air leakage occurs, supply Dry air according to the procedure described in part labeled MAINTENANCE before the gas pressure drops to the alarm pressure. After supplying dry air, close the gas stop valve and then accurately install the protective cover.	a) 5.0-5.2 bar. G at 20 for CB b)5.0-5.2 bar. G at 20 for others	Recharge Dry air
2	Operation counter	Check and record the operation number during detail inspection.		
3	Space heater	When humidity is high, the temperature drops Sharply, or the temperature is low.		
4	Others	Check for signs of abnormal noises and contamination of insulators.		

Table B-2 IN-SERVICE CHECK (PATROLLING INSPECTION) PROCEDURE

*** Table B-3 shown remedies to abnormal noise ***

No.	Phenomena	Remedy
1	Abnormal noise	Confirm the location of noise source.
2	a) Mechanical noise b) Corona noise	a) Frequency analysis: Noise will have the frequency multiplied by the power frequency. b) Dry air analysis: Decomposed gas will be detected.
3	In case of mechanical noise	Loose hardware is suspected. Tighten loose hardware and ensure proper operation without noises before putting back in service..
4	In case of corona noise	Electrical floating is expected inside. Replace gas in the section including the noise,
5		After taking above remedies, consult to the nearest representative of HYOSUNG CORPORATION.

Table B-3 REMEDIES TO ABNORMAL NOISE

5. ABNORMAL CONDITIONS

The following Table B-4 show the abnormal condition which may appear annunciator windows.

Part	Name of alarm	Cause of alarm detection	Symptoms	Remedy
CB	1ST GAS LEAK (**CB)	1st stage gas leak contact operated.	Gas leak from CB compartment, density above lower limit.	Confirm the location of leakage and repair. Recharge Dry air.
	2ND GAS LEAK (**CB)	2nd stage gas leak contact operated.	Gas leak from CB compartment, density under lower limit.	Confirm the location of leakage and repair. Replace the leakage section, if possible. Recharge Dry air.
Others	1ST GAS LEAK (****)	1st stage gas leak contact operated.	Gas leak from compartment, density still above lower limit.	Confirm the location of leakage and repair. Recharge Dry air.
	2ND GAS LEAK (****)	2nd stage gas leak contact operated.	Gas leak from compartment, density under lower limit.	Confirm the location of leakage and repair. Replace the leakage section, if possible. Recharge Dry air.

Table B-4 Abnormal condition of LCP

INSTALLATION, OPERATION, MAINTENANCE MANUAL

PART B-2
OPERATION OF CIRCUIT BREAKER

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3.2 Interrupter assembly (See FIG. CB-2) 6
3.3 Control box assembly 6
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4.3 Interrupting operation (See FIG. CB-8) 8
4.4 Closing operation (See FIG. CB-9) 9
4.5 Manual operation(See FIG. CB-10) 9

1. GENERAL

The type HCSP-E074C is an eco-friendly circuit breaker that uses dead tank type dry air.

This vaccum circuit breaker is eco-friendly by using dry air, and has improved voltage withstanding and breaking characteristics, by utilizing the excellent dielectric and arc quenching capability.

The HCSP-E074C vaccum circuit breaker has following characteristics.

(1) Excellent in fault current interrupting performance type HCSP-E074C circuit breaker can attain the rated short-circuit breaking current of 31.5kA and rated voltage of 72.5kV.

(2) Small size and light weight

The adoption of the motor spring operating mechanism, type HCSP-E074C circuit breaker, contributes to the reduction of installation space.

(3) High reliability

Motor spring operating mechanism is block-constructed to minimize the piping and has high reliability.

(4) Low noise

adoption of motor spring operating mechanism makes low noise operation possible.

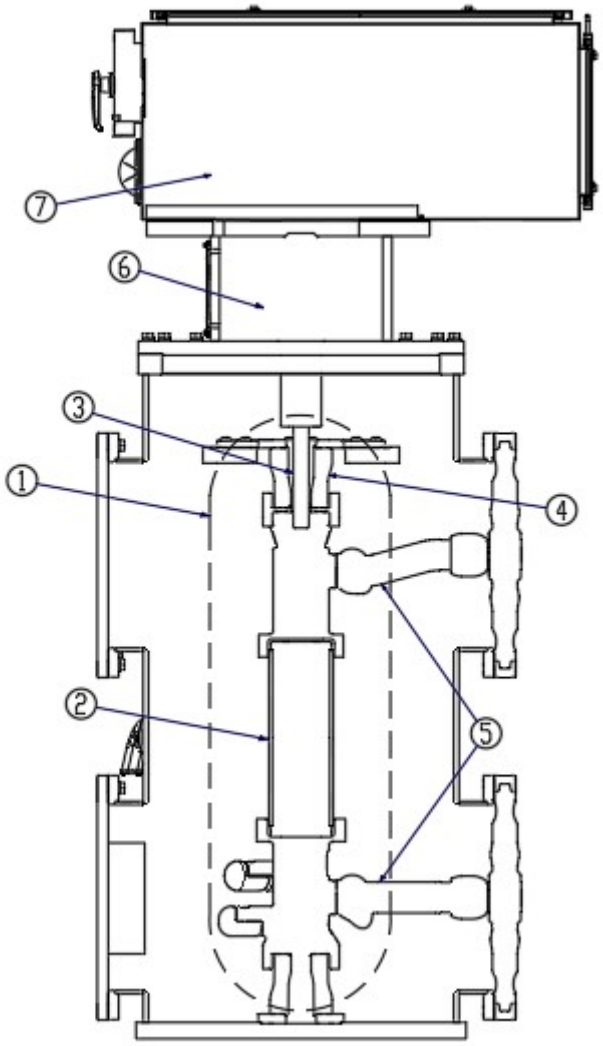
(5) Easy maintenance

Simple construction and a small number of parts allows easy maintenance.

2. RATINGS

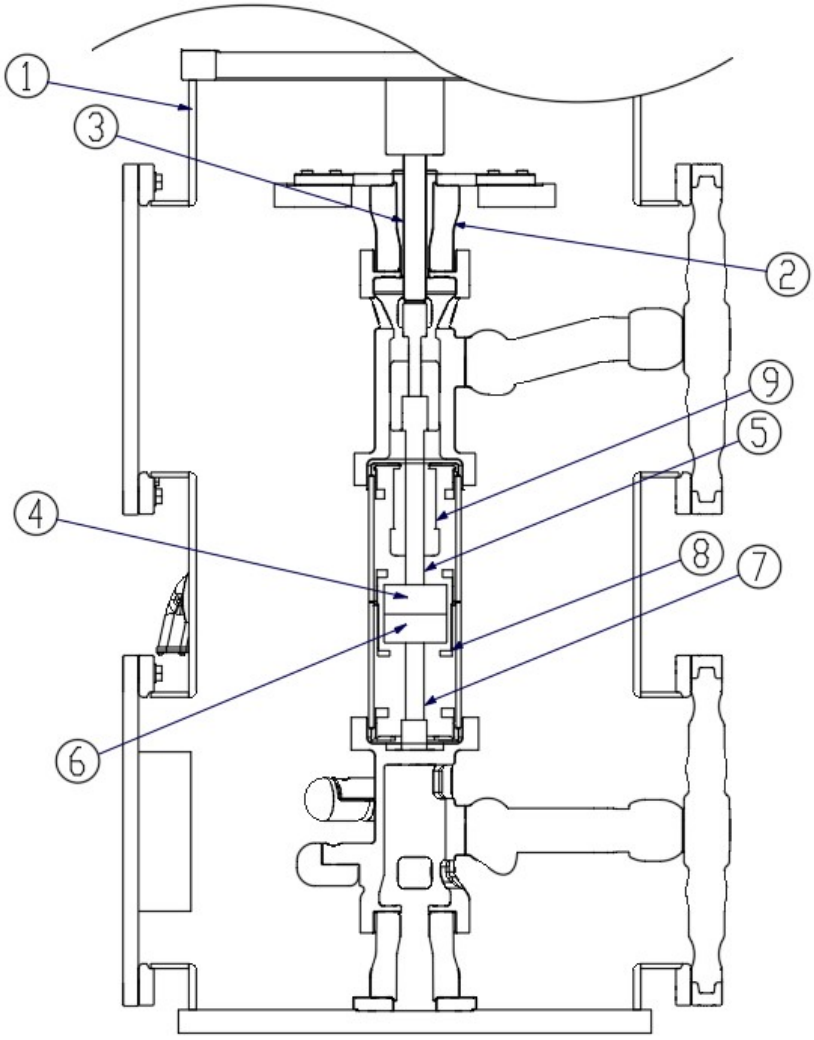
Function	CIRCUIT BREAKER
Model No	HCSP-E074C
Type	Vacuum interupter
Model of operating Mechanism	SOM
Enclosure Material & Diameter	Aluminum, Ø736
Rated continuous current (at 40℃) . TL feeder . TR feeder	 Up to 2500 A Up to 2500 A
First-pole-to-clear-factor	1.3/1.5
Rated short circuit breaking current	31.5 kA rms
Rated short circuit making current	85 kA peak
Rated short line fault breaking current	28.4 kA rms
Rated out of phase breaking current	7.9 kA rms
Cable charging switching current	125 A

Line charging switching current	10 A
Rated short time withstand current	31.5 kA rms (3 sec)
Rated breaking time	3 cycles
Operating duty cycle	O - 0.3sec - CO - 3min - CO
Lightning impulse withstand voltage	325 kV peak (1.2 x 50μs)
Power frequency withstand voltage	275 kV rms, 1 min
Operating method	Charged spring
No load opening time	Less than 100 msec
No load closing time	Less than 33 msec
Rated of rise of recovery voltage	2.0 kV / μs
Trip coil current	< 8 A
Close coil current	< 5 A
Rated control voltage	125 Vdc
Rated motor power	600 W
Rated Dry air pressure	5.0bar.G(72.5psig)(Min. 4.5bar.G(65.3psig))
Application Standard	IEC-62271-100



No	DESCRIPTION
1	INTERRUPTER ASSEMBLY
2	VACCUM INTERRUPTER
3	INSULATED OPERATING ROD
4	INSULATION SUPPORT
5	CONDUCTOR
6	CONTROL ASSEMBLY
7	OPERATING MECHANISM BOX

FIG. CB-1 CONSTRUCTION OF GCB



No	DESCRIPTION
1	INTERRUPTER ENCLOSURE
2	INSULATION SUPPORT
3	INSULATED OPERATING ROD
4	MOVING CONTACT
5	MOVING CONDUCTOR
6	STATIONARY CONTACT
7	STATIONARY CONDUCTOR
8	ARC SHIELD
9	BELLOWS

FIG. CB-2 CONSTRUCTION DIAGRAM OF INTERRUPTER

3. CONSTRUCTION

3.1 Basic construction (See FIG. CB-1)

FIG. CB-1 is the outline drawing of Vaccum Circuit Breaker using dry air with the construction diagram of this breaker.

3.2 Interrupter assembly (See FIG. CB-2)

This interrupter is the vaccum interrupter and is accommodated in a grounded tank filled with Dry air at a pressure of 600 kPa.G at 20oC.

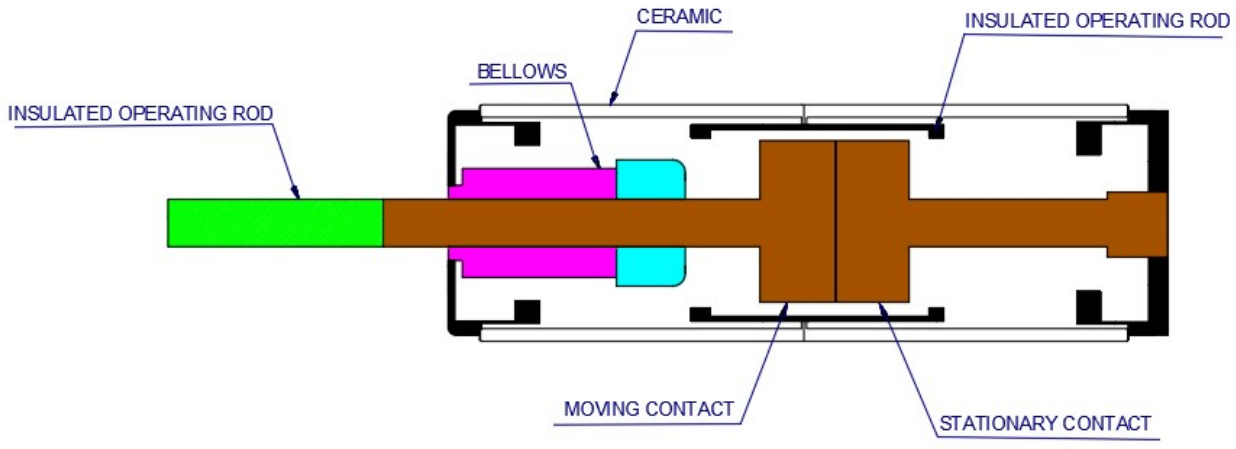
3.3 Control box assembly

This control operating mechanism is provided with control mechanism assembly and operating spring assembly in FIG. CB-1.

4. OPERATING PRINCIPLE

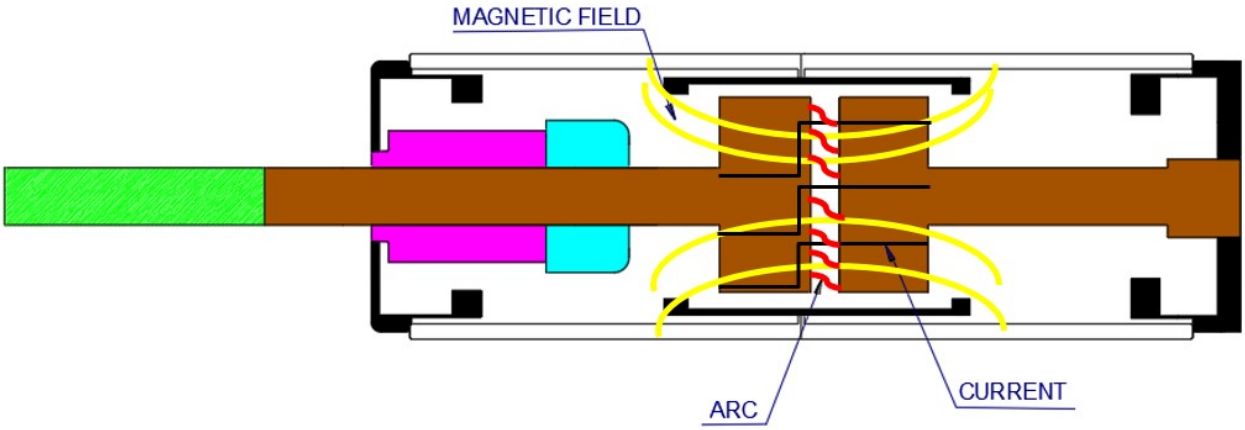
4.1 Process of ARC quenching

When the breaker operates, the moving contact separates from the fixed contact. An arc is struck between the contacts. The production of arc is due to the ionization of metal ions and depends largely on the material of contacts.



<FIG. CB-3. fully closed state>

The arc is quickly extinguished because the metallic vapors, electrons and ions produced during arc are diffused in a short time and detained by the surfaces of moving and fixed members and condensing shields.

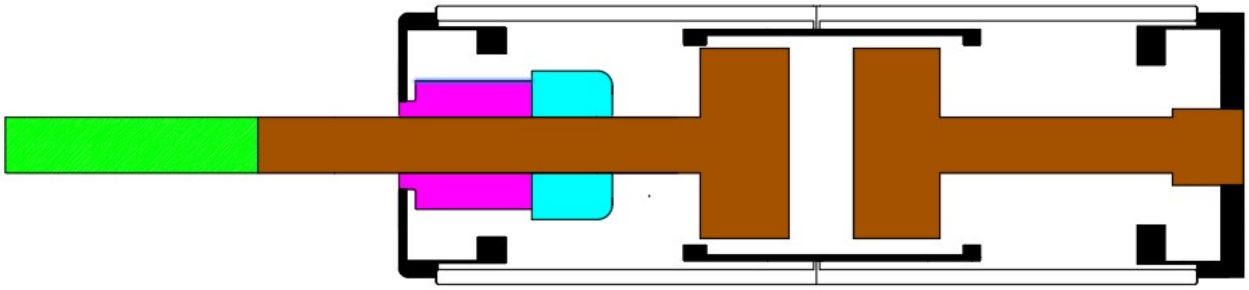


< FIG. CB-4. stage of interrupting>

Since vacuum has very fast rate of recovery of dielectric strength, the arc extinction in a vacuum breaker occurs with a short contact separation.

When the current decreases, the rate of vapor release decreases and after current zero, the medium regains its dielectric strength if the vapor density is reduced.

Next FIG. CB-5 show fully opened state of interrupter.



< FIG. CB-5. fully opened state>

4.2 Compression mechanism of Closing Spring due to Shaft (See FIG. CB-7)

When the shaft is rotated, the gear is rotated and the link becomes stimulated and the spring is compressed.

When the Close-hook is caught, the limit-switch stops the operation of the motor and the spring compression ends and becomes the Close alert-condition.

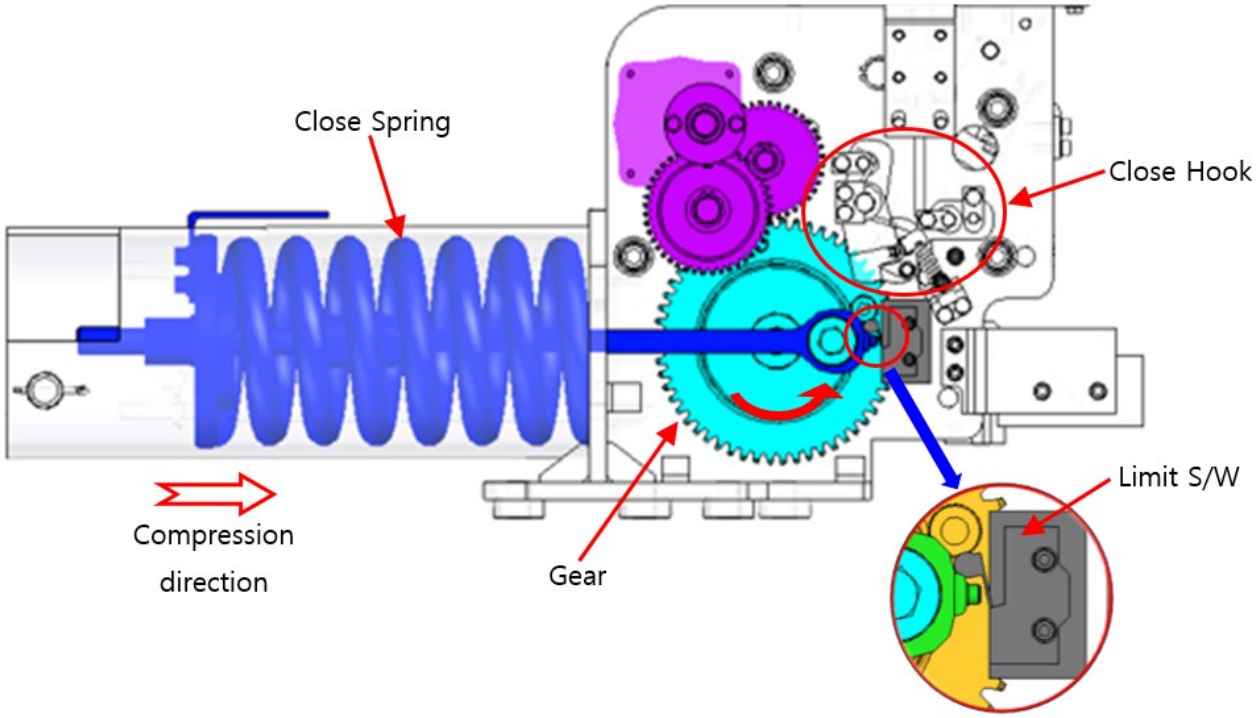


FIG. CB-7 COMPRESSION MECHANISM

4.3 Interrupting operation (See FIG. CB-8)

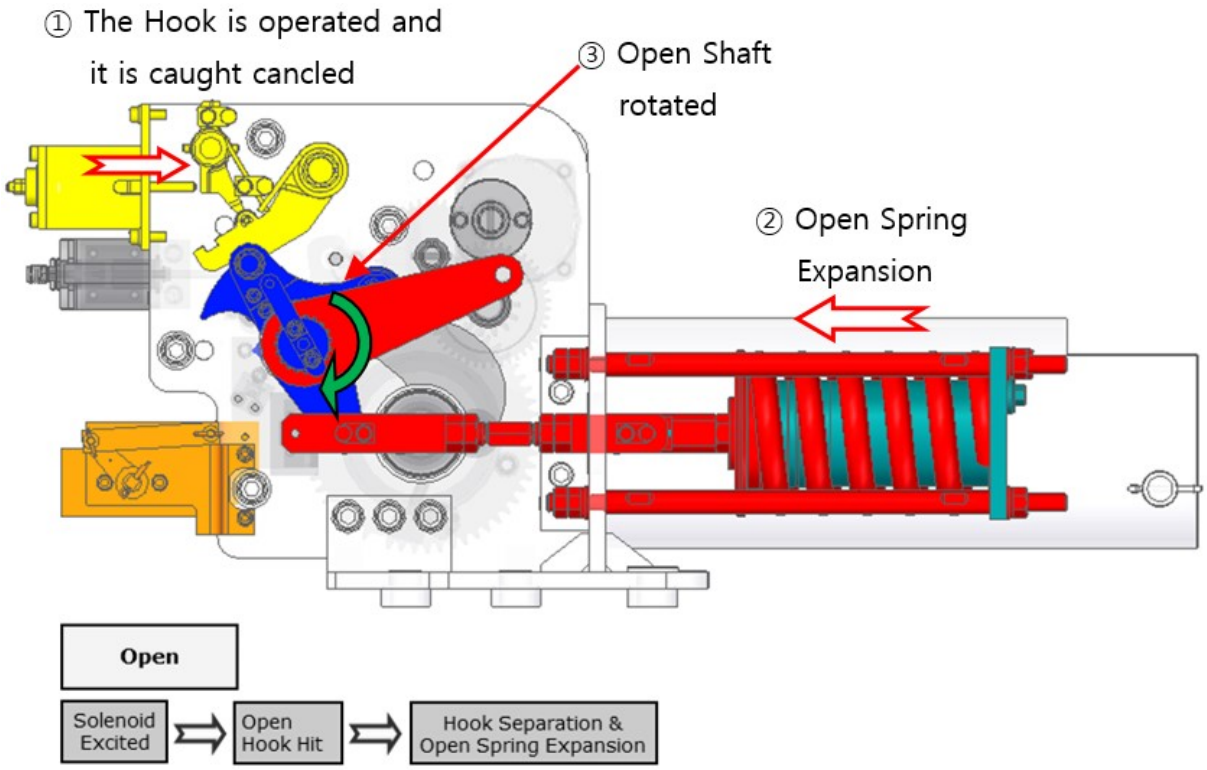


FIG. CB-8 INTERRUPTING OPERATION

4.4 Closing operation (See FIG. CB-9)

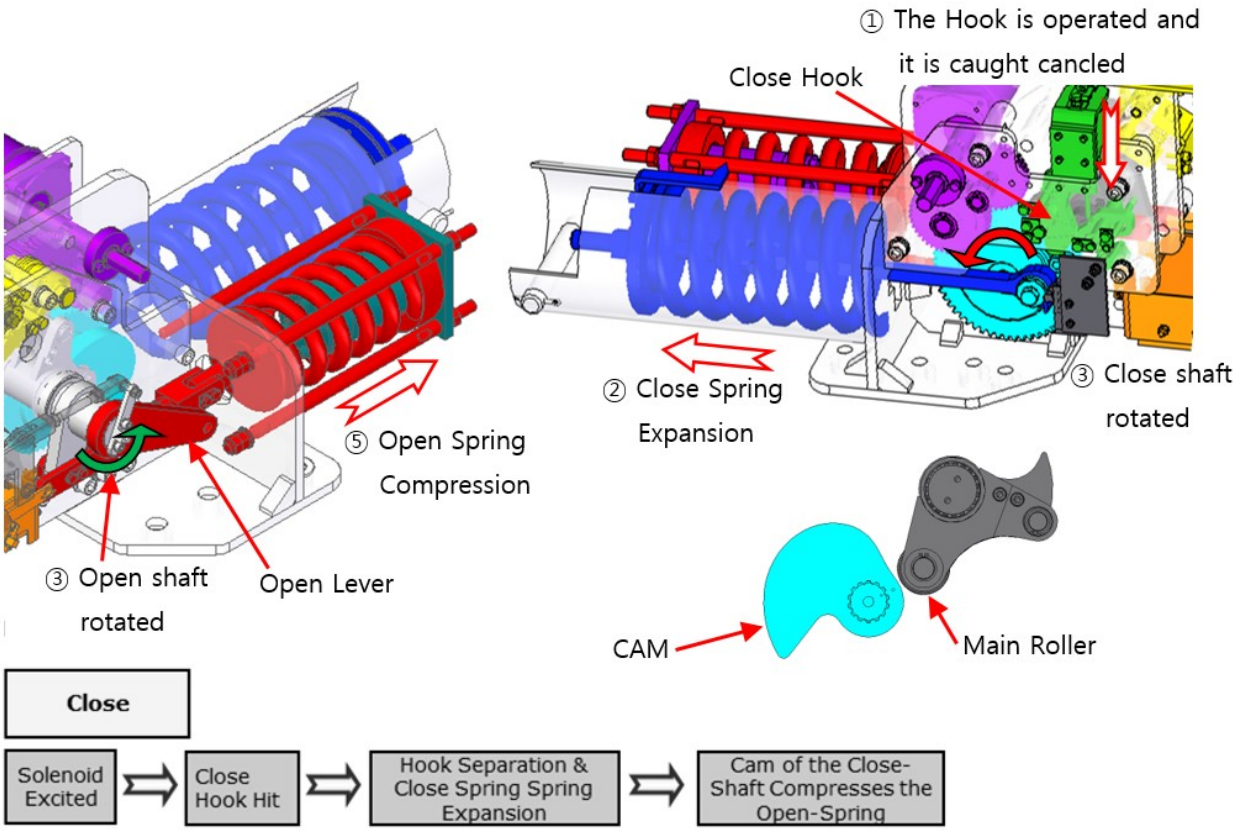


FIG. CB-9 CLOSING OPERATION

4.5 Manual operation (See FIG. CB-10)

Danger

Before manual operation, the circuit must be cut by circuit breaker itself and Disconnect switch in both side of Circuit breaker. Although power source of motor shall be off when manual handle is inserted, Hyosung recommends MCB for motor power is off also.

The circuit breaker is usually operated by an electrical command from the remote-control panel.

Since the local control cubicle is also provide with a discrepancy switch. Manual switch is for manual operation. Manual operation can be done to allow only for checking and operation in the field.

Manual operation is allowed only when the high voltage circuit is de-energized.

(Open all DS's and close all ES's associated with CB.)

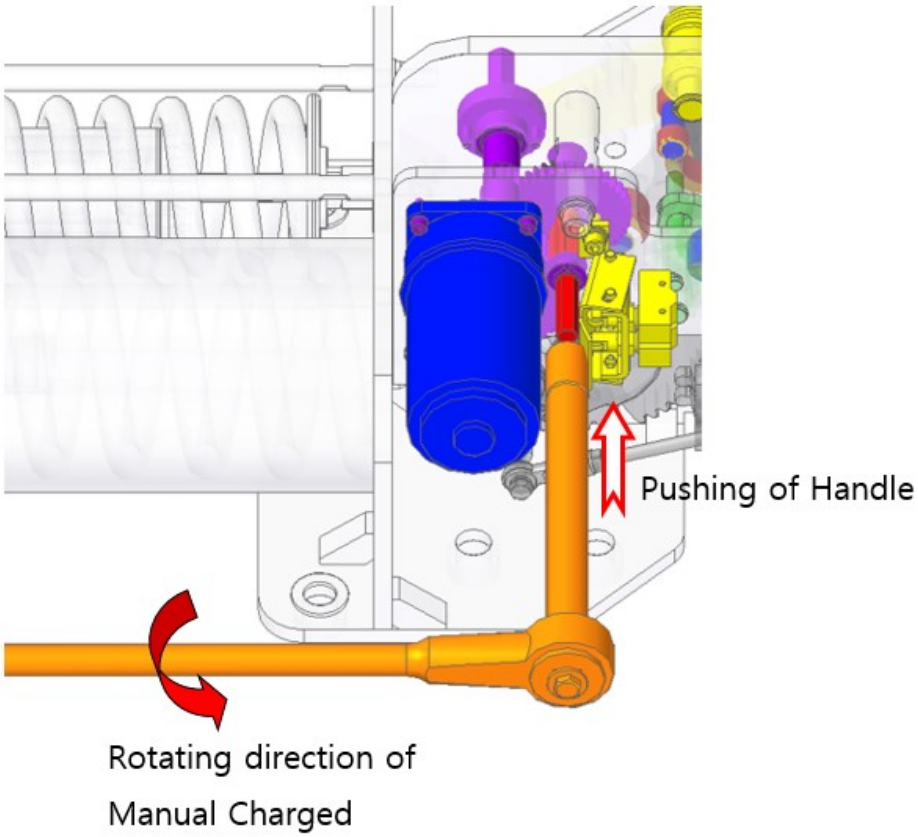


FIG. CB-10 MANUAL OPERATION

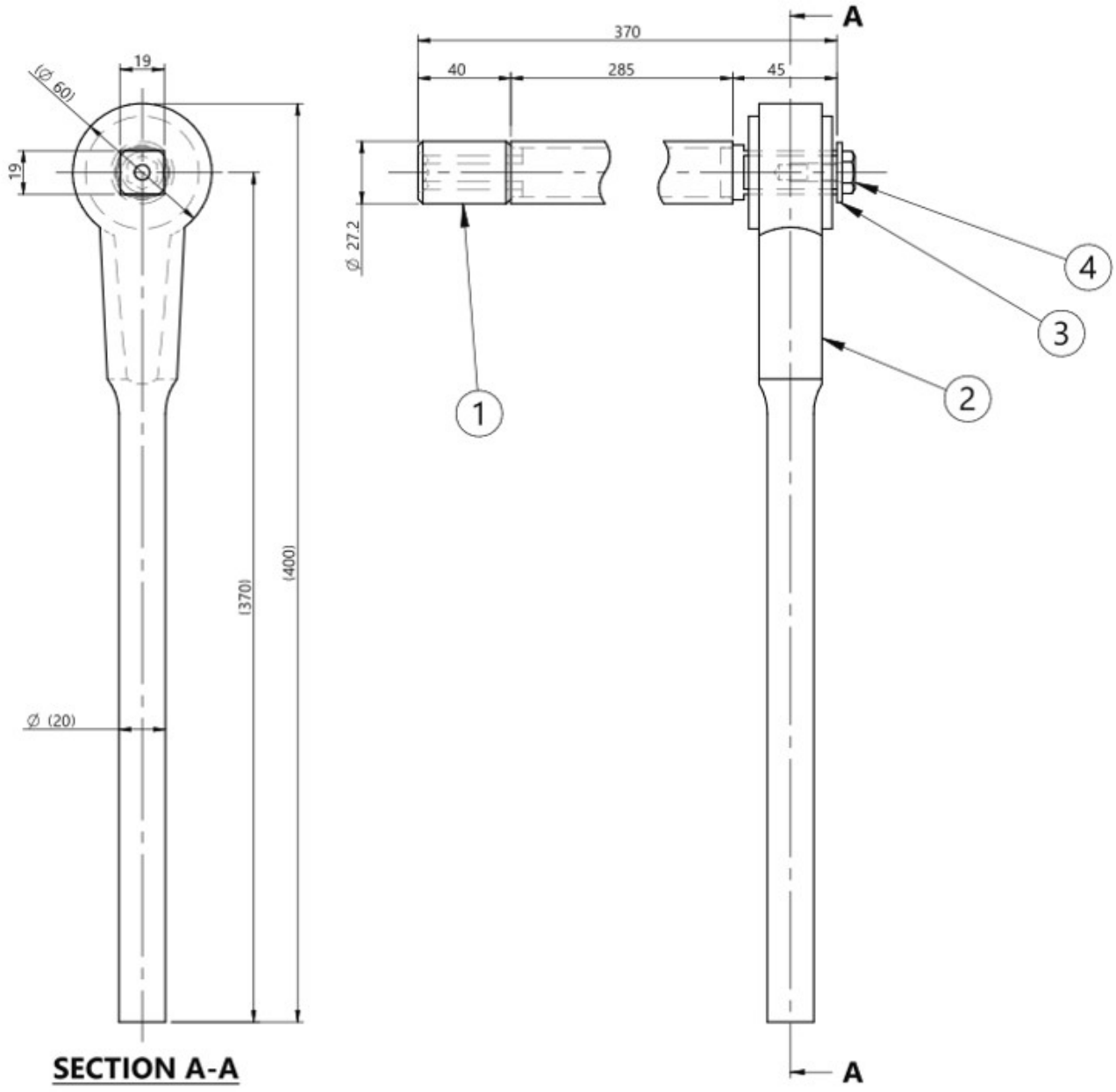


FIG. CB-11 MANUAL Handle of CB

INSTALLATION, OPERATION, MAINTENANCE MANUAL

PART B-3

OPERATION OF DISCONNECTOR & EARTH SWITCH

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4.3 Mechanical locking device (See FIG.OM-4) 8
4.4 Operation principle of DS operation (See FIG.OM-2) ... 오류! 책갈피가 정의되어 있지 않습니다.
4.5 Operation principle of ES operation ..... 오류! 책갈피가 정의되어 있지 않습니다.
4.6 Operation principle of ES operation ..... 오류! 책갈피가 정의되어 있지 않습니다.

1. GENERAL

HYOSUNG's 3-position (Combined with DS & ES) switch has three isolating chambers or one set filled with 4.5 bar DRY AIR gas and one driven operator.

This disconnector and earthing switch module functions as the disconnector and work-in-progress earthing switch.

After isolating the appropriate switchgear parts, one can establish an isolating distance for secure work on electrical systems and create the earthing and short-circuiting.

As result of the design of the three position switchgear devices, both functions are interlocked back-to-back for a positive no-slip drive.

2. RATINGS

Function	DS		ES	
Model No.	HDMO-E074E	HDMO-E074F	HEMO-E074D	HEMO-E074E
Operating method	Motor driven & manual			
Rated DRY AIR gas pressure	5.0 bar.G(72psig) at 20 deg.C			
Standard	IEC 62271-102			
Refer Drawing	Fig. 1 to 2	Fig. 3 to 4	Fig. 1 to 4	

3. CONSTRUCTION

3.1 Basic Construction

Recently, a GIS design concept trend is compactness and modular approach.
The 3-position switch is combines a DS with ES and accepted aluminum casting enclosure for this trend.

3.1.1 Disconnecting switch

The basic design of disconnecting switch generally supports no-load switching operations. As per system constitution, disconnecting switch can be applicable with capacitive charging current and loop current switching due to customer requirements.
The distance between poles is designed with basic insulation level as per IEC standards.
A mechanical indicator fixed to the operating shaft inside the operating mechanism box provides a visual means of checking operated position.

3.1.2 Earthing switch

Every earthing switch has a short time current endurance function. They are divided into two types with each one having its own particular function. The first one is the maintenance earthing switch which is operated motor driven and/or manually. The second one is high speed earthing switch operated automatically by motor drive spring charge and/or manually which makes the capacity of the fault current.
The distance between phase to ground is designed with basic insulation level as per IEC standards.
And a mechanical indicator fixed to the operating shaft inside the operating mechanism box provides a visual means of checking operated position.
The earthing switches can be used as primary injection terminals for checking voltages and currents. It is, therefore, possible to check the current transformer's ratio and contact resistance without degassing the DRY AIR gas.

3.2 Construction of DE & ES

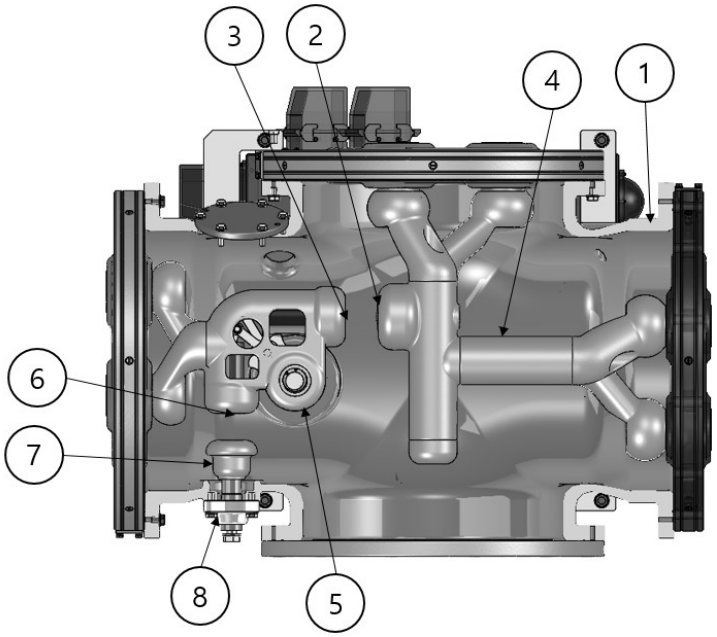
3.2.1 Disconnecting switch

Disconnecting switch (Model No. HDMO-E074E, HDMO-E074F) was combined with DS and ES(3-PDS) and is considered a combined operating mechanism.
The disconnecting switch consists of operating link mechanism, insulation rod, conductor, spring type current collector, moving contactor, spring type fixed contactor etc. as shown in FIG.1. And these parts are mounted in each phase of the isolated enclosure.
Disconnecting switches are to be classified into two types; HDMO-E074E and HDMO-E074F. First type, HDMO-E074F, has arc resistant metal on the moving

contactor and fixed contactor. Second type, HDMO-E074E, has no arc resistant metal on the moving contactor and fixed contactor.
The operating link mechanism and insulation rod or which is assembled in the enclosure are designed to give straight line motion of the moving contact and convert the motion of the operating mechanism to the proper isolating stroke.
The DRY AIR gas pressure in the enclosure is 5.0 bar.G(72psig) at 20℃.

3.2 2 Earthing switch

Earthing switches are two types; high-speed and maintenance function.
Maintenance Earthing switch is as shown in FIG 1 to 4. The high-speed earthing switch is shown in another report.
The maintenance ES of combined type has the model type, HEMO- E074D, HEMO-E074E
The earthing switch (maintenance ES) consists of spring type current collector, spring type fixed contactor, conductor, moving contactor and operating mechanism part. These parts are mounted with each phase enclosure.
The neutral ends of moving contactors are led into an outside terminal through bushing; refer to FIG 1.
The fixed contactor and moving contactor for earthing switch with making capacity are made of copper and arc resistant metal attached to the top of them. The operating mechanism part which is assembled in the enclosure is designed to give straight line motion of the moving contact and to convert the motion of the operation mechanism to the proper switch stroke.
In case of earthing switches maintenance, they are located at both sides of circuit breaker.
The DRY AIR gas pressure in the enclosure is 5.0 bar.G(72psig) at 20℃



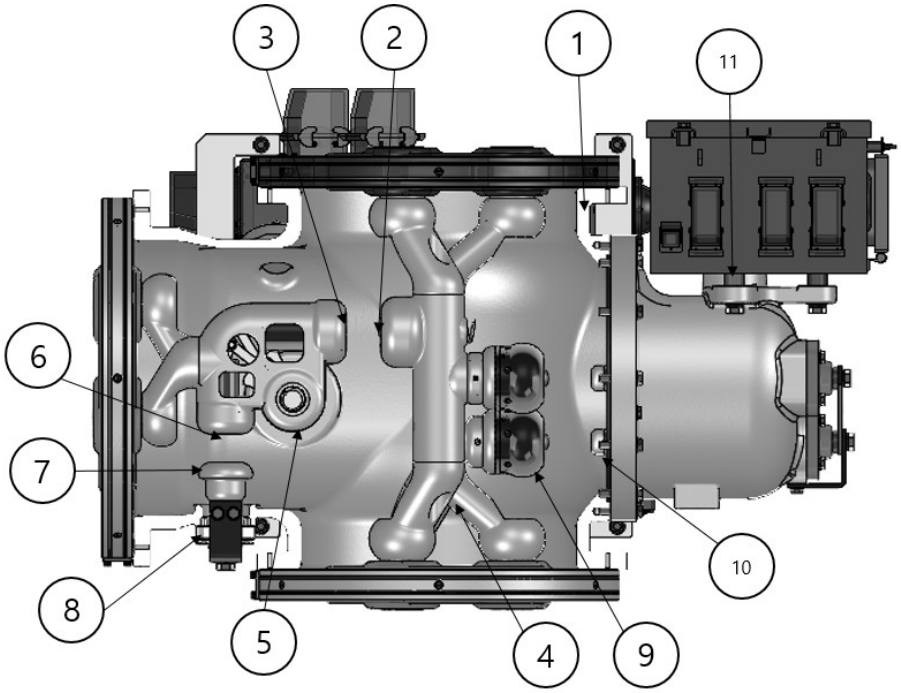
No.	DESCRIPTION
1	ENCLOSURE
2	CONTACT
3	MOVING CONDUCTOR
4	CONDUCTOR
5	OPERATION LINK MECHANISM
6	MOVING CONDUCTOR
7	CONTACT
8	INSULATOR BUSHING

FIG.1 CONSTRUCTION FOR DISCONNECTING SWITCH & MAINTENANCE EARTHING SWITCH

TYPE OF COMBINED DS(HDMO-E074E) AND ES(HEMO-E074D) FOR UG FEEDER

TYPE OF COMBINED DS & ES & H-ES FOR INCOMING

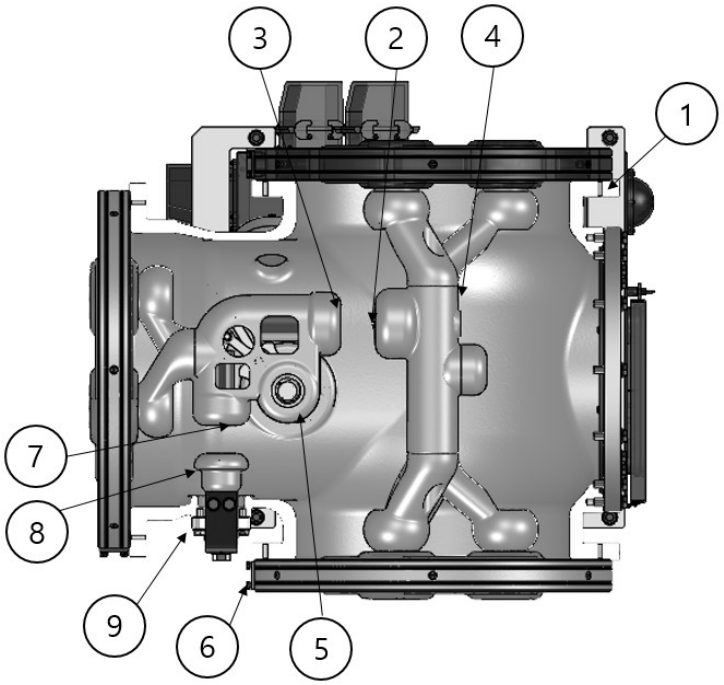
LINE SIDE AT UG FEEDER



No.	DESCRIPTION
1	ENCLOSURE
2	CONTACT
3	MOVING CONDUCTOR
4	CONDUCTOR
5	OPERATION LINK MECHANISM
6	MOVING CONDUCTOR
7	CONTACT
8	INSULATOR BUSHING
9	CONTACT
10	MOVING CONDUCTOR
11	OPERATION LINK MECHANISM

FIG.2 CONSTRUCTION FOR DISCONNECTING SWITCH & MAINTENANCE EARTHING SWITCH

TYPE OF COMBINED DS(HDMO-E074E) AND ES(HEMO-E074D) H-ES(HEMS-E074C) FOR UG FEEDER



No.	DESCRIPTION
1	ENCLOSURE
2	CONTACT
3	MOVING CONDUCTOR
4	CONDUCTOR
5	OPERATION LINK MECHANISM
6	SPACER
7	MOVING CONDUCTOR
8	CONTACT
9	INSULATOR BUSHING

FIG.3 CONSTRUCTION FOR DISCONNECTING SWITCH & MAINTENANCE EARTHING SWITCH

TYPE OF COMBINED DS(HDMO-074F) AND ES(HEMO-074E) FOR BUSBAR SIDE AT ALL FEEDER

4. Motor driven Operating Equipment for Combined DS & ES

4.1 Construction (See FIG. OM-1)

The mechanism may be applied as operating mechanism for disconnecting / earthing switch of gas insulated switchgear.
The mechanism consists of motor operating mechanism and control devices.
Manual operation is also available.

4.2 Functions

The following functions shall be equipped in the mechanism.

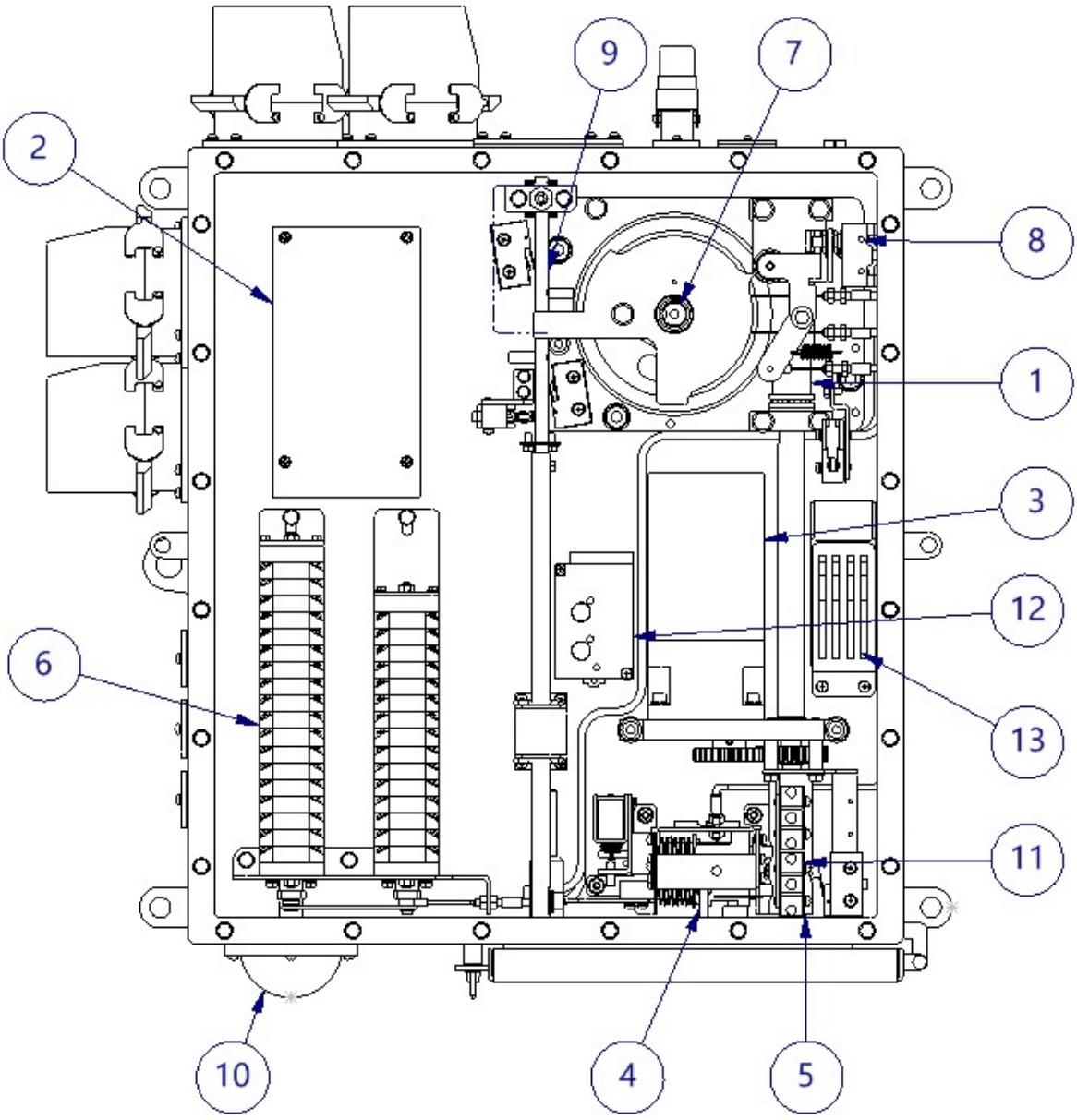
1) Electrical interlock of manual operation with CB status or necessary status.
2) Manual operating handle stop mechanism.
3) Limitation of handle draw-out position.
4) Mode selection device.

4.3 Electrical operating method (See FIG.OM-1, 2)

Construction and operating principle of the mechanism are shown in FIG. OM-1.

1) The motor drives the output shaft through the worm wheel as shown in FIG. OM-2.
   a. Operation principle of DS operation / Rotation direction
      - CLOSE : A → D
      - OPEN : D → E
   b. Operation principle of ES operation / Rotation direction
      - CLOSE : A → B
      - OPEN : B → C
2) The output shaft does not rotate by the load-side torque at the stop position.

Limit switch(LS1) acts and breaks control circuit of the motor at stop position



NO.	DESCRIPTION	NO.	DESCRIPTION
1	WORM GEAR	8	LIMIT SWITCH(LS1)
2	PCB	9	MODE SELECTION DEVICE
3	DC MOTOR	10	INDICATOR
4	MECHANICAL INTERLOCK	11	LIMIT SWITCH
5	HANDLE INSERT HOLE	12	THERMO-HYGROMETER
6	AUX SWITCH	13	HEATER
7	OUTPUT SHAFT		

FIG. OM-1 MOTOR DRIVEN OPERATING MECHANISM BOX & GEAR ASSEMBLY

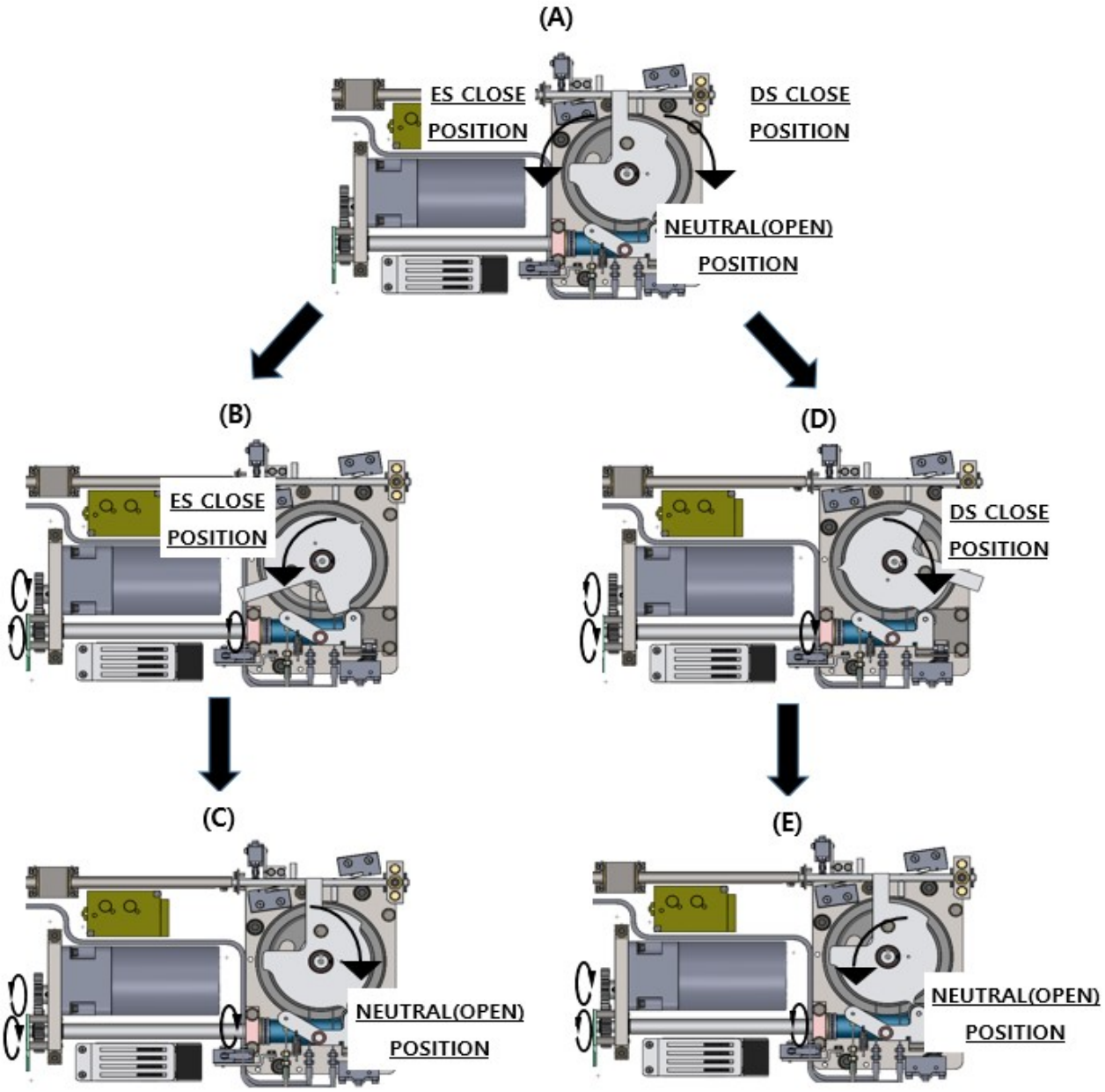


FIG. OM-2 MOTOR DRIVEN OPERATING MECHANISM

4.4 Manual Operating method



Danger

Before manual operation, the circuit must be cut by circuit breaker and Disconnect switch in both side of Circuit breaker. Although power source of motor shall be off when manual handle is inserted, Hyosung recommends MCB for motor power is off also.

4.4.1 Mode Selection device

The mode selection device is equipped to avoid wrong manual operation.
This device can limit the operation under two below modes.
DS mode : Only DS position can be operated to reach manually, because ES position is blocked.
ES mode : Only ES position can be operated to reach manually, because DS position is blocked.

4.4.2 Manual operating procedure (See FIG.OM-3)

1) Rotate the mode selection lever to the desired direction, either DS(A→D→E) or ES(A→B→C).
2) Pull to the left “Shutter lever”.
   The shutter lever is locked and can only be opened under allowable operating condition of interlock.
   Shutter lever is held at “open” after being pulled to the left side.
   A solenoid stopper are equipped to prevent abnormal operation under interlock condition.
3) Insert handle.
   The Limit switch on the manual handle insert hole side acts and breaks control circuit of the motor.
4) Rotate handle.
   Handle drawn-out action is prevented in half way.
   Rotation of manual operating handle is locked at stop position by “shutter lever” which returns to the right side automatically.
5) Pull to the left “Shutter lever”.
6) Draw out handle.
7) Slide “Release lever” upward.
   “Shutter lever” is released.

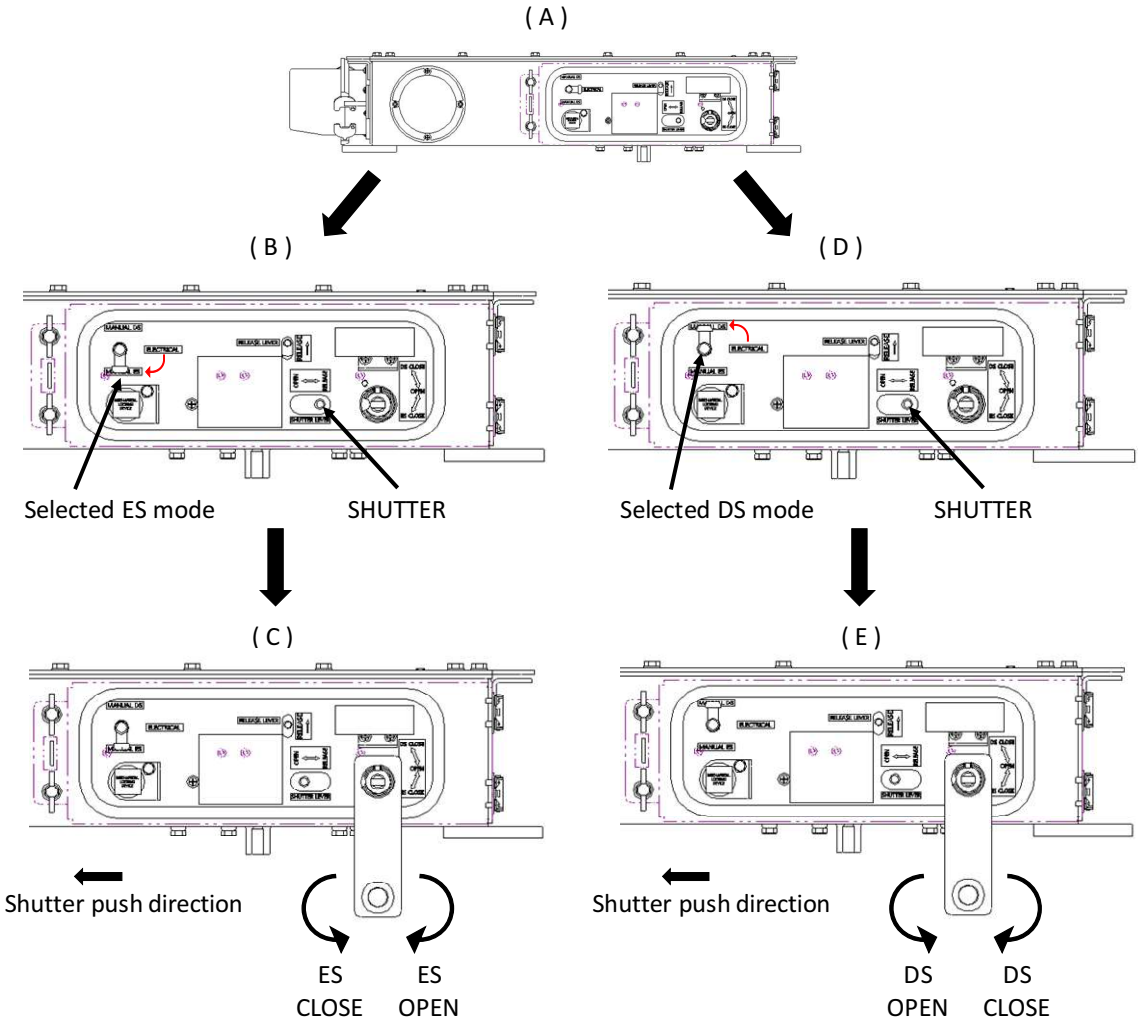


FIG. OM-3 OPERATING PRINCIPLE OF MANUAL OPERATION

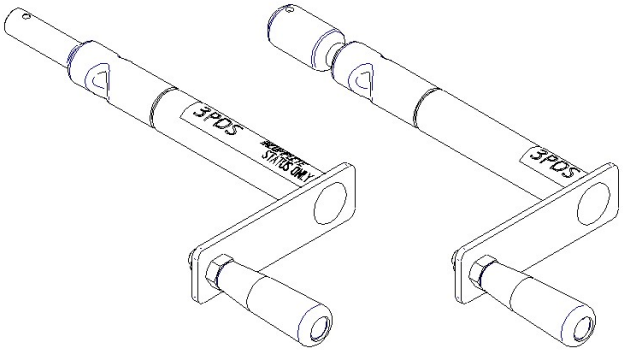


FIG. OM-4 MANUAL OPERATION HANDLE

INSTALLATION, OPERATION, MAINTENANCE MANUAL

PART B-4

OPERATION OF HIGH SPEED EARTH SWITCH

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1. GENERAL 2
2. RATINGS 2
3. CONSTRUCTION 3
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3.2 Construction 3
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4.5 Operation principle of H-ES-Closing Operation(See FIG. OM-4) (Motor Drive Spring Charged Equipment) 9
4.6 Operation principle of HES operation 9

1. GENERAL

HYOSUNG's Line earthing switch has three isolating chambers or one set filled with 5.0 bar DRY AIR gas and one driven operator.

This equipment is operated by motor charged-spring operation mechanism.

2. RATINGS

Function	HES
Model No.	HEMS-E074C
Operating method	Motor drive spring charged & manual
Rated Dry air pressure	5.0 bar.G(72psig) at 20oC
Standard	IEC 62271-102
Refer Drawing	Fig. 1

3. CONSTRUCTION

3.1 Basic design

The high-speed earthing switch has a short time current endurance function. It is automatically switch operated by charged motor drive spring and/or manually charged which has making capacity of fault current.

The distance between phase to ground is designed with basic insulation level as per IEC standards.

A mechanical indicator fixed to the operating shaft inside the operating mechanism box provides a visual means of checking operated position.

The earthing switches can be used as primary injection terminals for checking voltages and currents. It is, therefore, possible to check the current transformer's ratio and contact resistance without degassing the DRY AIR gas.

Electrical endurance of primary injection terminal is limited up to 10kV/min. If other voltage and duration levels are required on this terminal, confirmation from Hyosung HV GIS engineer is essential. Please contact us before testing.

3.2 Construction

The high-speed earthing switch is connected to the operating mechanism directly, as shown in FIG 1. So, there is no connecting link with operating mechanism.

The high-speed earthing switch consists of a tulip type current collector, tulip type fixed contactor, conductor, shield, moving contactor and operating mechanism part etc.

The neutral ends of moving contactors are led into an outside terminal through bushing as referred to in FIG 1.

The bushing has electrical characteristic of AC power frequency withstand voltage at 10kV for 10 minutes.

The fixed contactor and moving contactor for earthing switch with making capacity are made of copper and arc resistant metal attached on their tops. The operating mechanism part which is assembled in the enclosure is designed to give straight line motion of the moving contact and convert the motion of the operation mechanism to the proper switch stroke.

The Dry air pressure in the enclosure is 5.0 bar.G(72psig) at 20℃

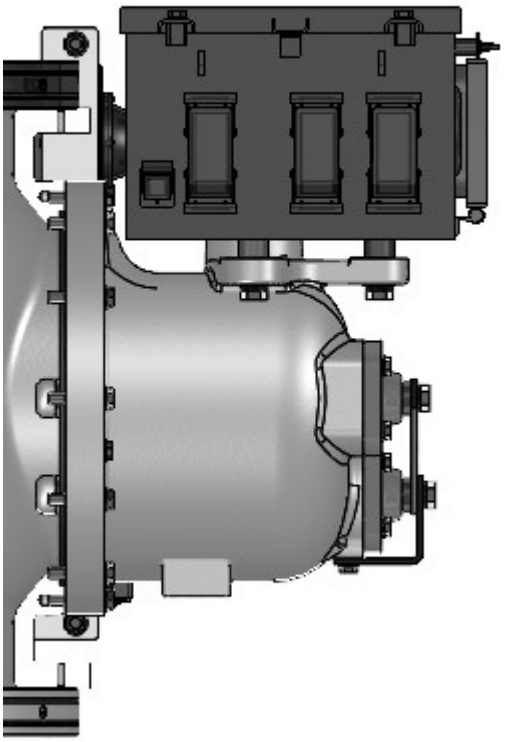


FIG-1. HEMS-E074C

4. MOTOR DRIVE SPRING CHARGED EQUIPMENT

4.1 Construction (See FIG. OM-1)

Motor drive spring charged equipment is adapted to high-speed earthing switch which is driven by DC motor. FIG. OM-1 shows the construction of the motor drive spring charged operating equipment.

It consists of operating mechanism, control circuit, mechanical indicator and interlock mechanism.

1) Operating mechanism

Operating mechanism consists of geared motor(1), worm gear(2), worm wheel(3) and driving shaft(4). And it can also be operated manually.

2) Control circuit

It consists of the geared motor(1) circuit controlled by open or close commands and for auxiliary contacts used for indication and interlock.

3) Mechanical indicator

An indicator(5) is linked to the high-speed ES mechanically.

It indicates the open or closed position of switching equipment.

4) Interlock mechanism

It consists of a mechanism to avoid remote operation during manual operation and manually operating the coil-LMG for the manual operating handle to prevent access during remote operation. The manual operating coil-LMG is energized and the manual handle insert hole is opened only when the interlock condition of related switching equipment is complete.

4.2 Operation

1) Operation by electrical command (See FIG. OM-1)

FIG. OM-1 shows the operation of motor drive spring charged device.

After receiving open or close commands, geared motor(1) starts. Its torque is transmitted to worm gear(1), worm wheel(3) and lever(6), then it charges the spring of switching equipment.

In case of the open operation, the geared motor keeps rotating and the driving shaft rotates at the same time. When the spring reaches a certain point, the spring slightly discharges in order to maintain the open state.

In case of the close operation, the geared motor rotates slightly, and when the spring reaches a certain point, the spring rapidly discharges. These operations cause the switching equipment to open or close through a lever linked to the driving shaft(4).

For the detail operation mechanism, refer to FIG. OM-3 & OM-4.

2) Operation by manual handle with DC power(See FIG. OM-2)

Mechanism of manual operation is shown in FIG. OM-1. Open the door and insert the manual handle a little into the insert hole(10) (Please handle softly). Then, the limit switch(11) attached to the insert hole turns on and the manual operating coil-LMG(12) is excited and allows the removal of the handle stopper(13). Insert the manual handle continuously until the handle can be inserted no further. If the interlock condition of related switching equipment is not complete, the Manual operating coil-LMG(12) is not energized and the insert hole is not opened.

3) Operation by manual handle without DC power(See FIG. OM-2)

Basically, operation method is the same as above. But in order to release the handle stopper, pull up the pin(14) and insert the manual handle at the same time.

4.3 Mechanical Locking device(See FIG.OM-4)

This is a switch to avoid incorrect operation by locking the handle at OPEN or CLOSED position. Before the maintenance or the inspection of switching equipment, the locking handle(15) of operating equipment must be locked both at OPEN and CLOSED positions. By carrying out the above operations, it becomes impossible to operate the switching equipment mechanically. And at the same time, limit switch(11) is open. Then remote operation of switching equipment cannot be carried out electrically. In normal operating condition, the lock handle is put in the "unlocked" position.

4.4 Operation principle of H-ES-Opening Operation (See FIG. OM-3) (Motor Drive Spring Charged Equipment)

1) Operating cycle : A → B → C → D → E → F

2) Electrical operation

Geared motor(1) rotational force is transmitted to hook(8) by worm wheel(3) and worm gear(2). And the hook(8) of worm wheel charges the connected operating spring(7). When the hook reaches the end of the lever's hole(6), worm wheel, lever, driving shaft(4) and driving lever(9) will rotate at the same time. The driving lever transmits rotational force to linear force by link structure.

When the charged spring goes over the central position, it expends the repulsive force. At this moment, driving shaft(4) is released from the hook(8) of worm wheel(3). When operation is finished, the driving shaft is stopped by equipment on the case, operating spring is charged, and mechanism waits for next signal.

3) Manual operation

Rotational force by manual handle is transmitted to bevel gear(16) assembled motor by manual shaft(17). Thereby, it is transmitted to bevel gear(18) and worm gear(2).

Rotational force of worm gear(2) is transmitted to hook(8) by worm wheel(3) and worm gear(2). And the hook(8) of worm wheel charges the connected operating spring(7).

Next process is the same as the electrical operation explained above.

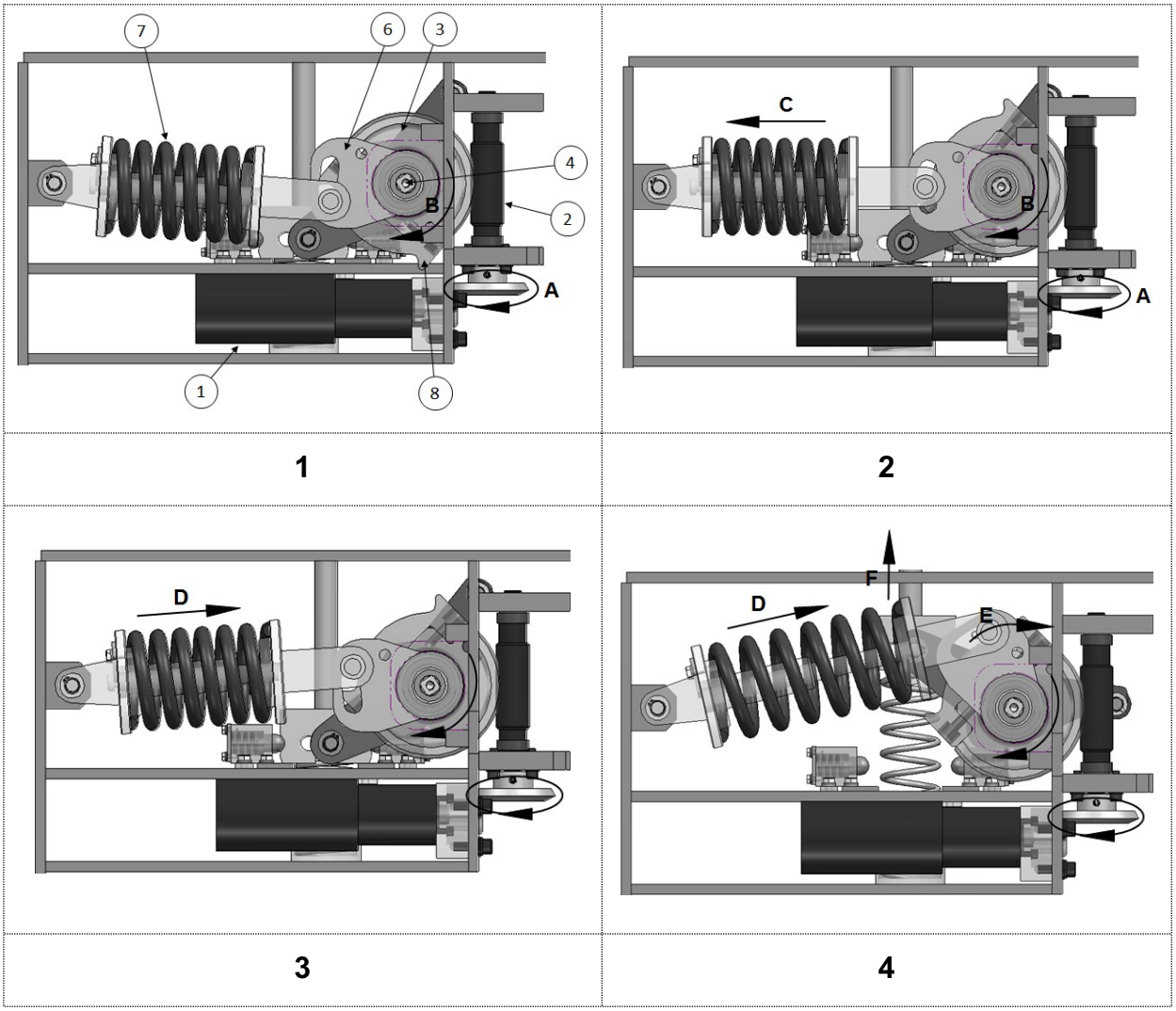


FIG. OM-4 OPERATING PRINCIPLE OF MOTOR DRIVE SPRING CHARGED OPERATING MECHANISM (CLOSING OPERATION)

4.5 Operation principle of H-ES-Closing Operation(See FIG. OM-4) (Motor Drive Spring Charged Equipment)

1) Operating cycle : A → B → C → D → E → F

2) Electrical operation

Geared motor(1) rotational force is transmitted to hook(8) by worm wheel(3) and worm gear(2). The hook(8) of worm wheel charges the connected operating spring(7) slightly.

When charged spring goes over the central position, it expends the repulsive force. At this moment, operating spring is connected with lever(6), driving shaft(4) and driving lever(9).

Its driving shaft(5) transmits rotational force to linear force by link structure.

When operation is finished, the driving shaft(5) is stopped by equipment on the case and mechanism waits for next signal.

3) Manual operation

Rotational force by manual handle is transmitted to bevel gear(16) assembled motor by manual shaft(17). Thereby, it is transmitted to bevel gear(18) and worm gear(2).

Rotational force of worm gear(2) is transmitted to hook(8) by worm wheel(3) and worm gear(2). And the hook(8) of worm wheel charges the connected operating spring(7). Next process is the same as the electrical operation explained above.

4.6 Operation principle of HES operation



Danger

Before manual operation, the circuit must be cut by circuit breaker and Disconnect switch in both side of Circuit breaker. Also HES operation shall be considered with status of another substation line connection to avoid making live line grounded (Fault). Although power source of motor shall be off when manual handle is inserted, Hyosung recommends MCB for motor power is off also.

Manual Operation proceed by insert and rotate manual handle after opening small door front side of mechanism

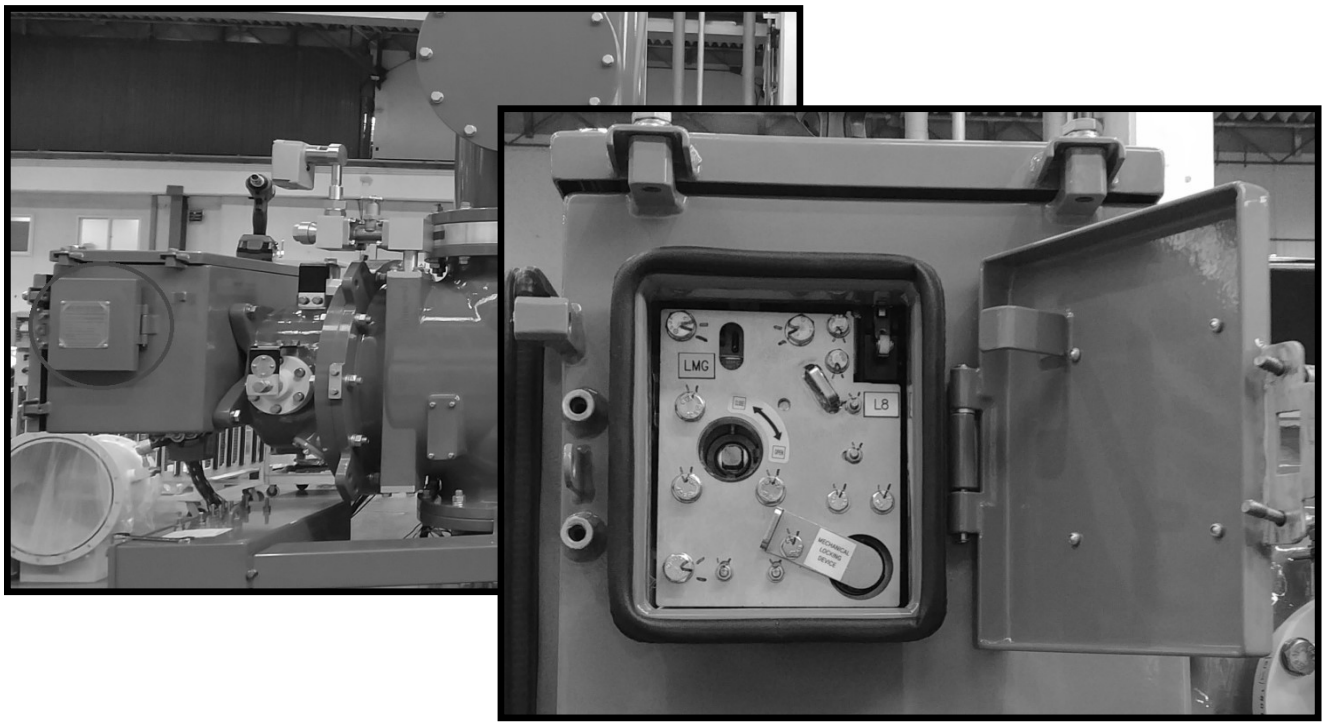


FIG. OM-5 STRUCTURE FOR MANUAL OPERATION

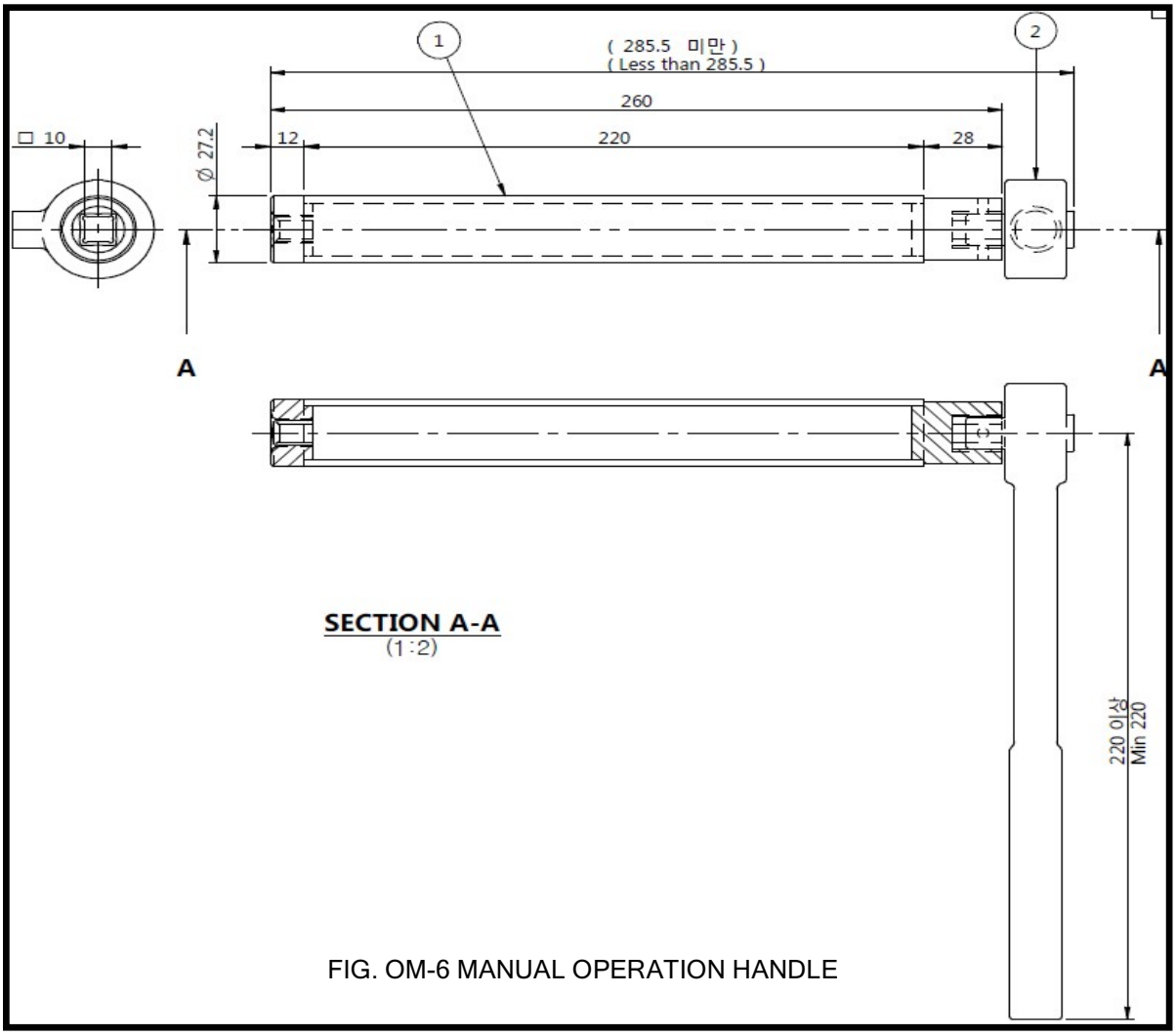


FIG. OM-6 MANUAL OPERATION HANDLE

INSTALLATION, OPERATION, MAINTENANCE MANUAL

PART B-5

OPERATION OF CURRENT TRANSFORMER

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1. GENERAL 2
2. CONSTRUCTION 2
3. POLARITY AND CONNECTION 2
4. INSTALLING LOCATION 3
5. SPECIFICATION OF CURRENT TRANSFORMER 3
6. CONSTRUCTION OF CT TERMINAL WITH GAS SEALING 3

1. GENERAL

The type of current transformer is Bushing-Type CT(called BCT) which secondary windings are distributed around a core and installed in Gas Insulated Switchgear(GIS).

The CT is insulated completely against primary winding by the earthed shield or earthed enclosure of GIS, while the CT itself has completely insulated permanently assembled toroidal secondary winding.

The current ratio, accuracy class and other characteristics of CT are shown on its name-plate and submitted technical schedule. The detail test procedure is described on “Part B-14 (Configuration of CT Primary Injection Test)”.

2. CONSTRUCTION

The construction of CT is shown as FIG. CT-1.

Low loss, high permeability, and annealed grain-oriented silicon-steel is used for the core of the CT. The core(1) is covered with several insulation material(2,3,5). It is wrapped with rubber and PE(Polyethylene) tape for core insulation and the proper number of turns of enamel-coated magnet wire are wound over the core(1). When the secondary windings(4) need to be wound on more than two layers, it is wrapped with rubber, epoxy glass laminate and PE taped properly for layer insulation(2).

Lead wires are connected to taps, and the end of the winding with connection is insulated by sleeves.

The material of the finish insulation(3) of the CT uses PE tape and glass filament adhesive tape to protect from the absorption of moisture.

The dimension of the CT is designed by the required characteristics as proposed data.

3. POLARITY AND CONNECTION

The identification system of terminals of the CT is marked according to IEC 61869, i.e. P1, P2, etc. for primary side and s1, s2, etc. for secondary terminals as shown on single line diagram and nameplate.

The connection of CT wiring lead to the corresponding terminals of outlet box as shown on the CT wiring diagram in schematic drawings.

The following caution must be observed in connection and in service.

1) Insulate all leads so that they will not make contact with any other leads or ground parts.

2) Ground one side of the secondary circuit unless doing so will interfere with the proper operation of instruments.

3) Never open the secondary circuit while the CT is in operation because the core will be permanently saturated and induce dangerously high voltages on secondary circuit.

4) The secondary terminals must be closed through a burden or by the short-circuiting lead.

4. INSTALLING LOCATION

The construction of the CT case with the arrangement of the CT is shown as FIG. CT-2.

The CT is installed internal or external of enclosure and the secondary wiring is connected through the sealing terminal block to the local control panel (cubicle).

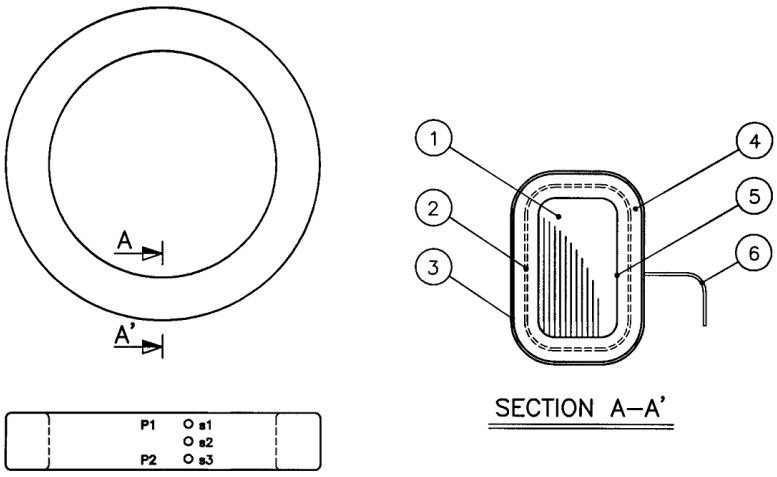
5. SPECIFICATION OF CURRENT TRANSFORMER

For specification of current transformer, refer to the submitted technical schedule and single line diagram drawing.

6. CONSTRUCTION OF CT TERMINAL WITH GAS SEALING

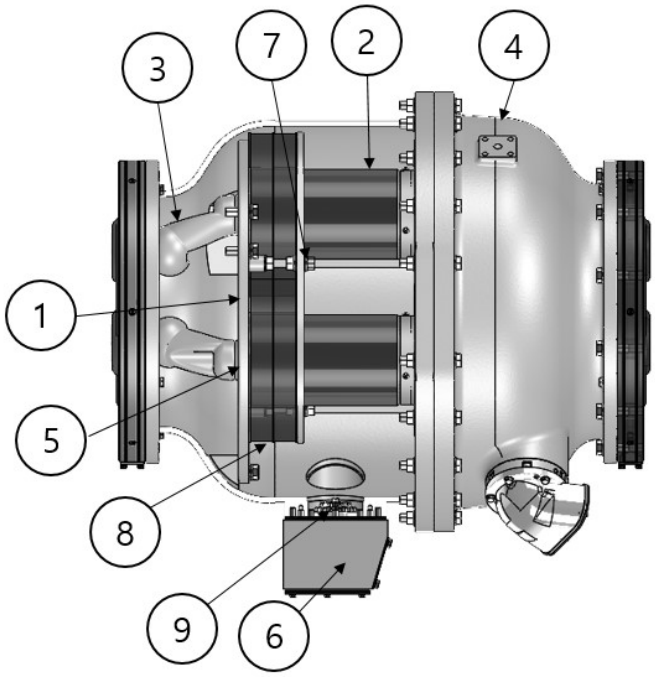
The construction of terminal is the same as shown in FIG.CT-2 and CT-3.

The number of poles depends upon required current ratio; single or multi ratio.



NO.	DESCRIPTION
1	CORE
2	LAYER INSULATION
3	FINISH INSULATION
4	SECONDARY WINDING
5	CORE INSULATION
6	SECONDARY LEAD

FIG. CT-1 CONSTRUCTION OF CURRENT TRANSFORMER



No.	DESCRIPTION
1	BASE PLATE
2	SUPPORT ASSEMBLY
3	CONDUCTOR
4	ENCLOSURE
5	CONDUCTOR
6	CASE ASSEMBLY PANEL
7	BOLT
8	CURRENT TRANSFORMER
9	CT TERMINAL BOX

FIG. CT-2 CONSTRUCTION OF CT CASE

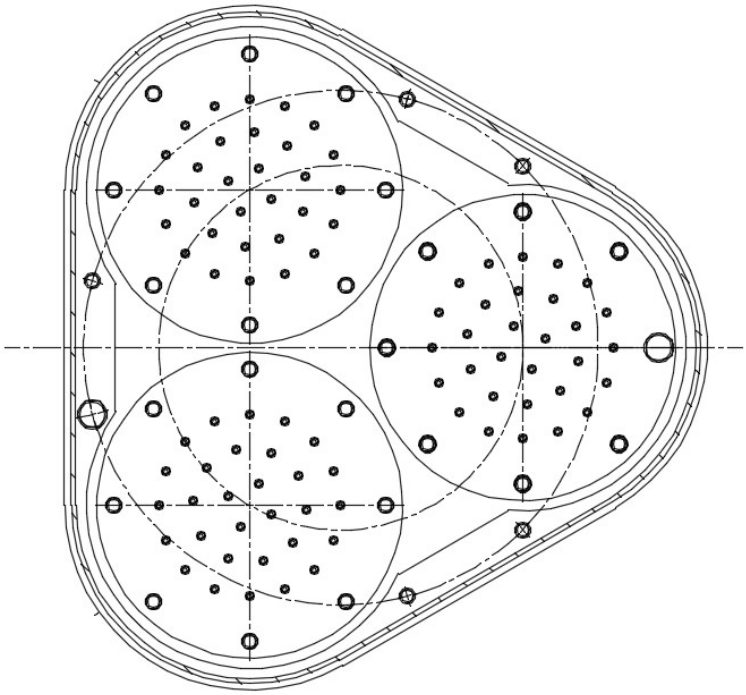


FIG. CT-3 CONSTRUCTION OF CT SECONDARY TERMINAL BOX

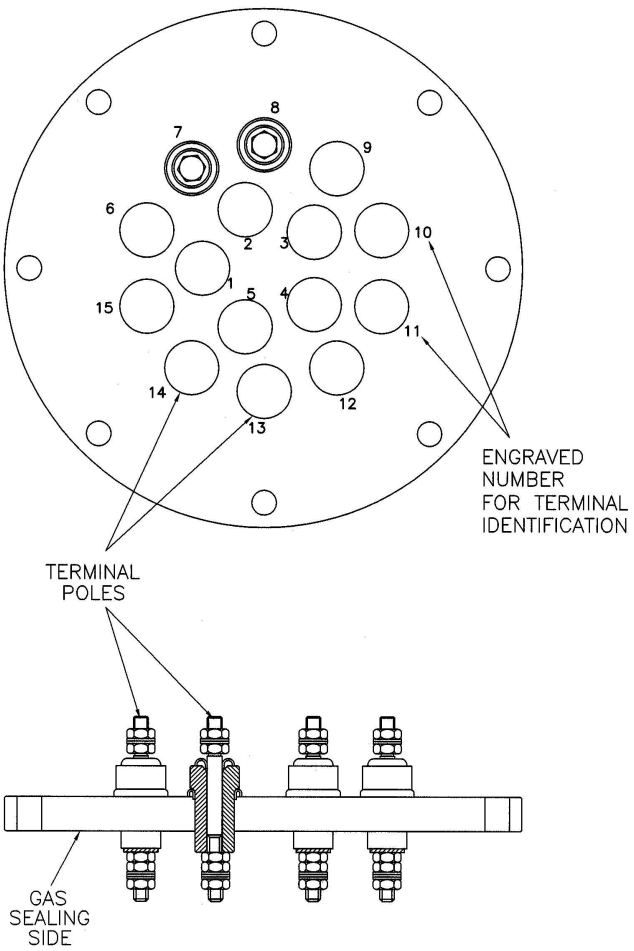


FIG. CT-4 CONSTRUCTION OF GAS SEALING TERMINAL

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-6

OPERATION OF INSULATOR

CONTENTS

1. Structure of Insulator 2
2. Configuration of Insulator 2
2.1 Spacer 2

1. Structure of Insulator

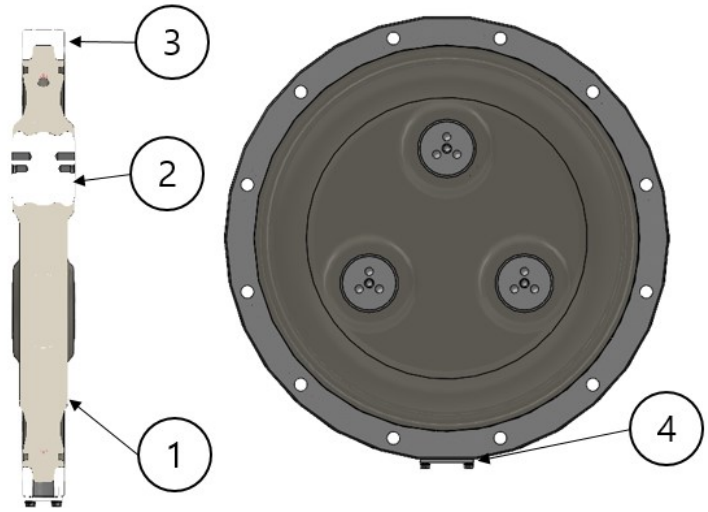
The insulator had been applied with a spacer and post insulator at the GIS(HSG-074B). The spacer is designed as a gas tight barrier type(stop spacer) for separate gas section and gas through barrier(normal/hole type spacer) for support of conductor in the enclosure. There are applied metal flanges (Ring-Flanges) outside of the spacer for electrically continuous connection on both sides of enclosures as shown FIG. IN-1.

Three types of post insulators ae designed for supported of conductor in the enclosure as shown FIG. IN-2.

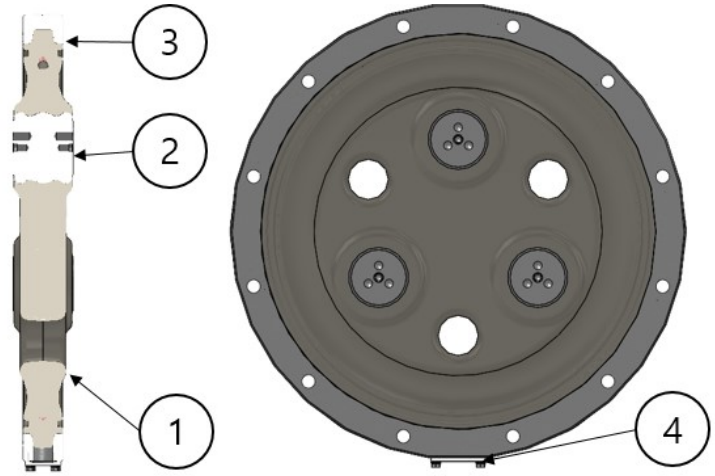
2. Configuration of Insulator

2.1 Spacer

Stop type SPACER



Hole/Normal type SPACER



1. INSULATION SPACER (EPOXY RESIN)
2. CONDUCTOR
3. METAL FLANGE (RING-FLANGE)
4. COVER

FIG. IN-1 CONFIGURATION OF SPACER

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-7

OPERATION FOR DRY AIR GAS

CONTENTS

Contents

1. Properties of DRY AIR Gas 2

4.8.1 Dry - Air

(1) Dry-Air consists of O2, N2, Ar and other impurities in regular operation status, The gas life of the device must be equal or greater than the device life.
Gas composition and management standards must be presented at the time of delivery. The standards for impurities are as follows.

Table 6. Standards for impurities in gas

classification	CO	CO_2	Total hydrocarbon(THC)	Nitrogen oxides(NOx)	Sulfur oxides(SOx)
Content(ppm)	< 1	< 1	< 1	-	-

(2) Annual gas leakage rate is 0.5% or less, moisture content in gas is 2.6ppmv or less (surrounding environment 0Mpa.G, 20℃) and the condensation point should be below –70℃.

(3) There should be no problem with the device even if O3 gas is temporarily generated during internal arc.

(4) When delivering, mark (paint) the Dry-Air component on the surface of the gas storage container or attach a printed label. It must be identifiable from the outside, and a method for detecting leaks must be provided.

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-8

OPERATION OF RELIEF DEVICE

CONTENTS

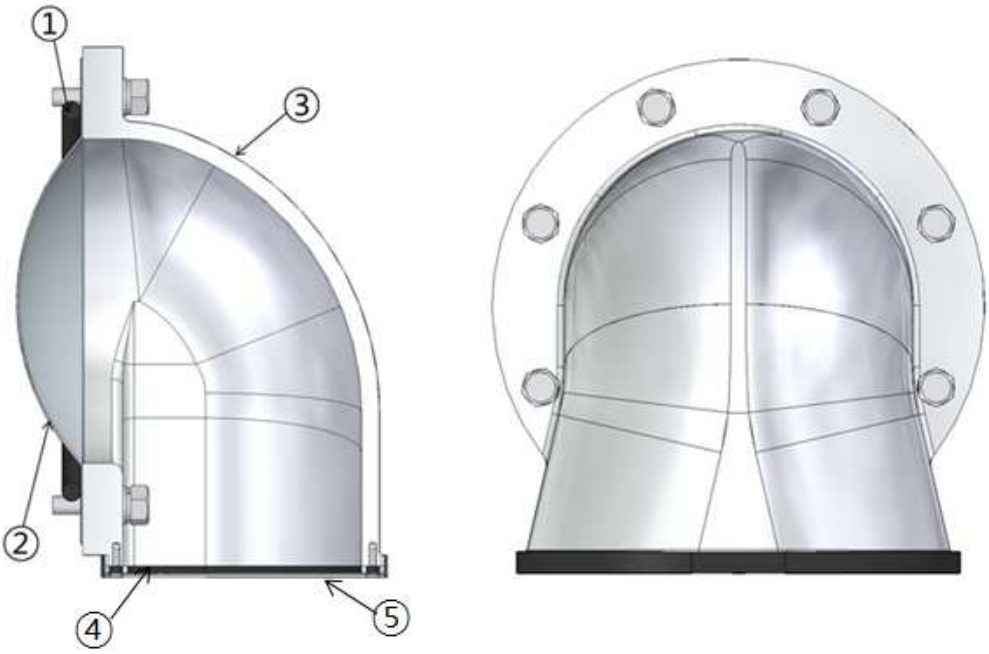
1. General 2
2. Construction 2

1. General

To prevent the destruction of the enclosure due to the unexpected internal pressure rise, the pressure relief devices are located in each gas section, including the circuit breaker gas section. The devices operate at 12 ± 0.6 bar pressure and the gas flows out at sonic-speed.

2. Construction

The construction of the pressure relief device is shown Fig. RD-1



No.	DESCRIPTION
1	O-RING
2	RUTURE DISC
3	HOLDER
4	PACKING
5	PROTECTIVE COVER

FIG. RD-1 CONSTRUCTION FOR PRESSURE RELIEF DEVICE

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-9

OPEARTION OF ABSORBENT

CONTENTS

1. General 2
2. Construction 2

1. General

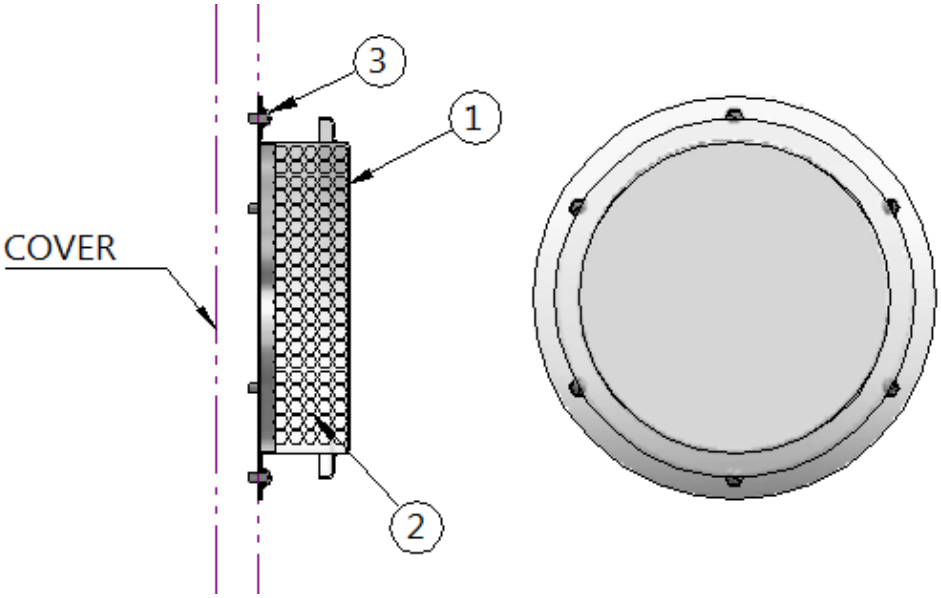
The absorbent serves as moisture control in the enclosure and absorbent changing procedure works as follows:

Detach fixing bolts form absorbent case and detach absorbent case form hand hole cover.

Replace absorbent with new absorbent as quickly as possible, just before hand hole cover is closed, so that the absorbent may not absorb moisture in the atmosphere. Don't expose the absorbent to the atmosphere for more than 10 minutes.

2. Construction

The construction of the absorbent case is shown Fig. AB-1 and absorbent detail is in the attached catalog.



No.	DESCRIPTION
1	DESICCANT CASE
2	DESICCANT
3	BOLT

FIG. AB-1 CONSTRUCTION FOR DESICCANT CASE

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-10

OPEARTION OF CABLE SEALING END

CONTENTS

1. General 2
2. Construction 2

1. General

The cable sealing end design and connections were F bushing type.

2. Construction

The construction of the Cable Sealing End is shown in Fig. CSE-1.

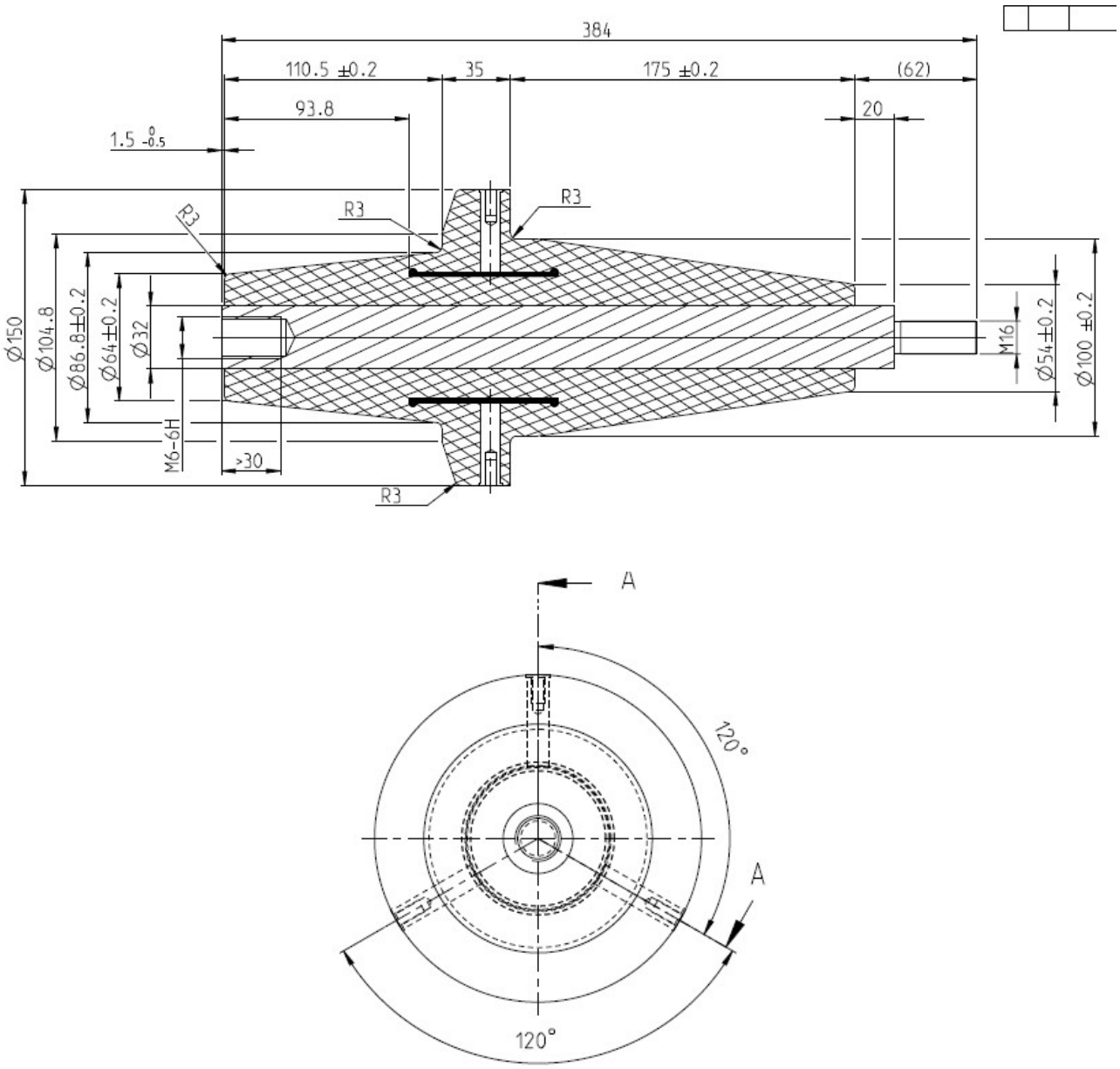


FIG. CSE-1 CONSTRUCTION OF F BUSHING

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-11

OPERATION OF GAS DENSITY DETECTOR

CONTENTS

1. General 2
2. Explanation of Gas Density Monitor 3
2.1 Alarming pressure and locking pressure 3
2.2 Construction of gas pressure detector 3

1. General

The entire Dry air system of the GIS, including the gas section, is shown as Gas System Diagram.

The enclosure of GIS is filled with Dry air to 5 bar for the CB compartment and other compartments based on 20℃. The gas density monitor with pressure switch is installed in each compartment and continuously monitors Dry air pressure.

If gas pressure reduces to 4.7 bar in the CB, then No.1 pressure contact of gas density monitor operates and will produce an alarm.

If gas pressure reduces to 4.5 bar, No.2 contact operates and will block the trip and close operations of the circuit breaker and will produce an alarm.

For other compartments, in case of gas pressure drop, the gas density monitor will produce the appropriate alarm to circuit with 2 stages; i.e. 1st stage at 4.7 bar and 2nd stage at 4.5 bar.

For the outline of gas monitoring device, please, refer to the attached manufacture catalog.



Caution

1.. Don't remove the end covers of piping until ready to install the piping.

2. Use dry nitrogen gas or dry air to blow out the piping so as to completely remove the moisture and foreign substance before installing the piping.

3. Be particularly careful not to allow ingress of dust and foreign substances into piping during the work.

4. Keep the stop valve closed after piping until Dry air is ready.

2. Explanation of Gas Density Monitor

2.1 Alarming pressure and locking pressure

Mostly the gas system is monitored and divided into two systems:

a. Gas Circuit Breaker

b. Bus and Isolator (others)

In the event of Dry air pressure drop, an alarm will be operated by the gas density detector at the 1st leakage level. If the leakage reached the 2nd level, the circuit breaker is to be locked by the relaying sequence.

2.2 Construction of gas density detector

For more details, refer to attached catalogue of Gas Density Monitors.

Gas density monitor
Model GDM-100

Applications

- Medium and high-voltage instruments
- Monitoring of the density of gas in closed tanks
- Raising an alarm when defined limit values have been reached

Special features

- Case and wetted parts from stainless steel
- On-site display with switch contact
- Temperature-compensated and hermetically sealed, therefore no influence of temperature fluctuations, differences in level and atmospheric pressure fluctuations
- Compensation for gas mixtures possible
- Traceability by serial number



Gas density monitor model GDM-100

Description

Gas density is a crucial operating parameter for high-voltage equipment. If the required gas density is not present, safe operation of the plant cannot be guaranteed.

The WIKA gas density measuring instruments provide reliable warnings against dangerously low gas levels, even in extreme environmental conditions. Electrical switch contacts warn the plant operator when the gas density drops below defined levels due to leakage.

Numerous fields of application
The WIKA gas density monitor is hermetically sealed and temperature-compensated. Measured value fluctuations and erroneous alarms caused by changes in either ambient temperature or air pressure are therefore prevented.

Via the on-site display, the system pressure based on 20 °C can be read directly on the instrument. With the integrated switch contacts, simple switching tasks can be realised quickly and without complication.

WIKA
Part of your business

Gas density monitor

Nominal size
100

Calibration pressure P_E
To customer specification

Accuracy specifications
- ±1 % at ambient temperature +20 °C
- ±2.5 % at ambient temperature -20 … +60 °C and with calibration pressure in accordance with reference isochor (reference diagram KALI-Chemie AG, Hanover, prepared by Dr. Döring 1979)

Scale range
Vacuum and overpressure range with measuring span of 1.6 ... 25 bar (with an ambient temperature of 20 °C and gaseous phase)

Permissible ambient temperature
Operation: -20 ... +60 °C (-4 ... +140 °F), gaseous phase
Storage: -50 ... +60 °C (-58 ... +140 °F)

Process connection
G ½ B per EN 837, lower mount
Stainless steel, spanner flats 22 mm

Other connections or connection locations on request.

Pressure element
Stainless steel, welded
Gas-tight: leak rate ≤ $1 \cdot 10^{-8}$ mbar · l / s
Test method: helium mass spectrometry

Movement
Stainless steel
Bimetal link (temperature compensation)

Dial
Aluminium
The scale range is subdivided into red, yellow and green ranges

Pointer
Aluminium, black

Case

Selectable versions	
Option 1	Stainless steel, with gas filling
Option 2	Stainless steel, with filling liquid

Gas-tight: leak rate ≤ $1 \cdot 10^{-5}$ mbar · l / s

Window

Selectable versions	
Option 1	Laminated safety glass
Option 2	Clear non-splintering plastic

Ring
Bayonet ring, stainless steel, secured by means of 3 welding spots

Permissible humidity
≤ 90 % r. h. (non-condensing)

Ingress protection
IP 65 per EN 60529 / IEC 529

Weight
With gas filling: approx. 0.8 kg
With filling liquid: approx. 1.2 kg

High-voltage test 100 %
2 kV, 50 Hz, 1s

Switch contacts

Electrical connection
Cable socket with compression fitting M20 x 1.5
Wire cross-section max. 2.5 mm²

Number of switch contacts

Selectable versions	
Option 1	1 magnetic snap-action contact
Option 2	2 magnetic snap-action contacts
Option 3	3 magnetic snap-action contacts

Switching directions

Selectable versions	
Option 1	Falling pressure
Option 2	Rising pressure

Switching functions

Selectable versions	
Option 1	Normally open
Option 2	Normally closed
Option 3	Change-over contact (max. 2 switch points)

Circuits

Selectable versions	
Option 1	Galvanically connected (not for change-over contact)
Option 2	Galvanically isolated

Switching accuracy

Switch point = calibration pressure P_E:	see accuracy specifications
Switch point ≠ calibration pressure P_E:	Shifted parallel to calibration pressure

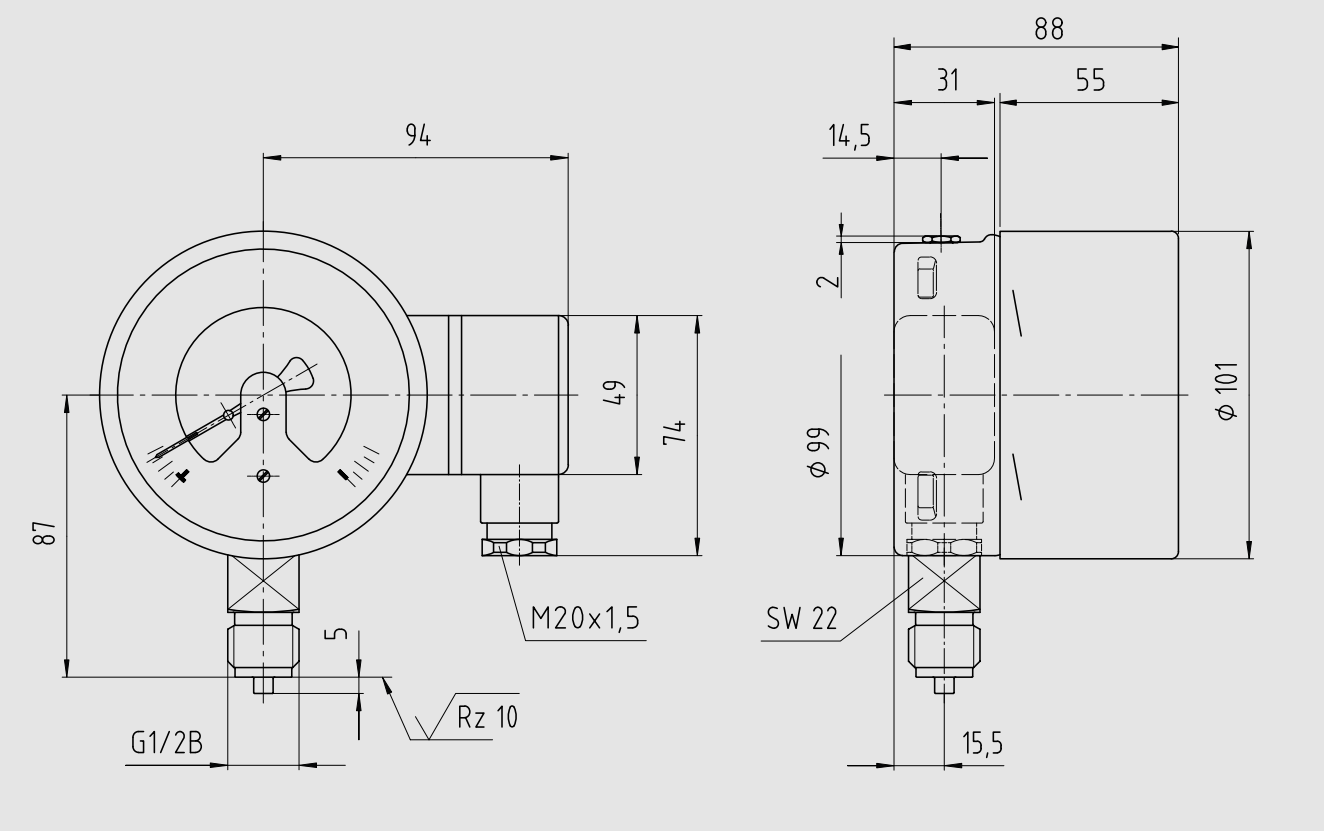
Max. switching voltage
AC 250 V

Switching power
With gas filling: 30 W / 50 VA, max. 1 A
With filling liquid: 20 W / 20 VA, max. 1 A

Material of switch contacts
80 % Ag / 20 % Ni, gold-plated

Further information on magnetic snap-action contacts in data sheet AC 08.01

Dimensions in mm



Approvals

Logo	Description	Land
CE	**EC declaration of conformity** Low voltage directive 2006/95/EC, EN 61010-1	European Community

Manufacturer‘s information and certifications

- RoHS conformity 2011/65/EC

Approvals and certificates, see website

Ordering information

Model / Process connection / Pressure unit / Measuring range / Filling pressure / Switch configuration / Gas mixture / Options

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The specifications given in this document represent the state of engineering at the time of publishing.
We reserve the right to make modifications to the specifications and materials.

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08/2015 EN

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-12

LPIT AND MU

Install, Operation & Maintenance Manual

Low Power Instrument Transformer

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7. Maintenance 28

1. Preface



The instructions and procedures included in this manual are intended to provide general guidance to trained personnel, with experience and expertise in the safe and careful performance of their job. These instructions and procedures cannot and do not cover all details of every task nor can they cover all possible situations that may be encountered during the performance of the tasks.

The user is solely responsible for ensuring that all work is performed safely and without damage to the LPIT

If any additional guidance is required, contact HYOSUNG

It must be noted that the instructions and procedures in this manual cannot consider all possible site conditions and circumstances. As experts in the design and construction of the equipment, HYOSUNG reserves the right for HYOSUNG's Field Service Supervisors to modify the instructions and procedures herein to meet the intent of the requirements under the specific conditions or circumstances that may arise.

All work performed on the LPIT covered under this manual must be performed in compliance with all site, local, state, provincial and national regulations. If any such regulations conflict with any instructions or procedures in this manual, contact HYOSUNG for clarification.

1.1 Safety Notations

The following notations are used in this manual to alert the user to potential safety hazards.

Kinds of Mark	Meaning of Mark
	Danger indicates an imminently dangerous situation which, if not avoided, results in death or serious injury to personnel. This signal word is limited to the most extreme situation.
	Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
	Caution indicates a potentially hazardous situation which, if not avoided, may result in equipment or installation damage. It may also be used to alert against unsafe practices.
	Electrical Hazard warning.

1.2 Safe Working Practices



These warnings apply to every part of this section and should be considered as applicable to each line in this section.

Workers who use this manual should be trained by their company's Safety organization in the company's Safe Working Practices. Workers who have not been trained in Safe Working Practices or their company's Safety Program, or companies without a Safety Program should delegate or contract all work on this equipment to individuals or companies who have been properly trained. This HYOSUNG manual is not intended to replace the user's Safety Program or any policies of the user's Safety Program.

This section is provided to help remind trained, qualified workers of the risks that may be present when working on power transformers and to provide suggestions in some cases to mitigate those risks. This manual cannot anticipate all conditions that might occur at every jobsite and must be used as a general reference and not as a procedure for working safely. The contents of this section are presented as "Thought Joggers" intended to help the user recognize the various risks associated with this type of work.

Workers must follow all local, state, provincial and federal safety requirements and the user's site-specific Safety Program requirements. It is the User's sole responsibility to be aware of all applicable requirements.

Failure to properly mitigate the risks associated with this type of work could result in serious injury or death.

Communication is critically important when working with others. Every job should be thoroughly discussed with the full crew before starting work to ensure that everyone understands the work that will be performed by each worker and the risks associated with that work. When multiple crews are working at a site, each crew leader should understand the scope of the other crews' work as well. When circumstances change, everyone who might be affected should be informed.

Every worker should have the proper PPE to protect them from all expected risks. The site or worker's Safety Co-ordinator should determine the risks that exist at the site and during the tasks performed by the worker.

2. Introduction

2.1 Application

Low-Power Instrument Transformers offer advantages in terms of size, power consumption, safety, accuracy and signal reliability. With the introduction of digital communication in substations according to the IEC61850-9-2 standard, LPCT(Low Power Current Transformer) and LPVT(Low Power Voltage Transformer) measures voltage and current from a gas-insulated switchgear. And the measured data is collected by Merging Unit(MU) and can be transmitted via IEC 61850-9-2 protocol to further protection, control and measuring systems.

LPCT sensor structure is simple, robust and less complex than a conventional CT. The core does not saturate, and the coil produces an undistorted, hysteresis-free output signal with a wide measuring range. Homogeneously manufactured Rogowski coils are insensitive to external magnetic fields (proximity effects). The secondary output is a relatively safe, low voltage signal that does not require special shorting and grounding considerations.

LPVT uses coaxial capacitive voltage divider to transform the measured voltage. And it is Compact and robust design, can be easily integrated in GIS enclosures.

The secondary converter is used to calibrate output signals of LPCT and LPVT.

Fully making use of the characteristics of GIS gas insulation design, this device has features of a simple and reliable insulation design, small size, relatively light weight, good linearity, etc., and as a result, the size of GIS is reduced effectively.

LPCT satisfies the test items of IEC 60044-8 type test and guarantees an accuracy level of 0.2S/5TPE. LPVT satisfies the test items of IEC 60044-7 type test and guarantees an accuracy level of 0.2/3P.

2.2 Function

LPIT is installed to Gas-insulated switchgear (GIS) with rated voltage of 72.5kV and frequency of 50Hz or 60Hz for measuring the primary current and voltage and providing the current and voltage information for the digitalized metering devices, BCU and the protection relays. It can be installed both outdoor and indoor.

3. Technical Data

A. Power Supply For Secondary Converter

Classification	Description
Nominal operating voltage	85-264V_{AC}, 85-370V_{DC}
Frequency	50/60Hz, DC
Power consumption	MAX 6W
Connector	3pin: positive (L), negative (N) and ground(F.G)

B. Dimensions and Weight

Classification	Description
Height	735mm
Width	410mm(W/O Spacer)
Depth	570mm
Weight	110kg
Enclosure color	As per customer Requirement
Enclosure material	Aluminum

C. Environmental Conditions

Classification	Description
Operating temperature	-40°C~+60°C
Relative humidity	<95%, non-condensing
Altitude	<1000m
Transport and storage temperature	-40°C~+60°C

D. Insulation Level

Classification	Description
Max. voltage of equipment	72.5kV
Power-frequency withstand voltage	140kV
Lightning impulse withstand voltage	325kV
Rated gas pressure	0.5MPa.G(Min 0.45Mpa)

E. LPIT rating

Classification	Description
Nominal frequency	50Hz, 60Hz
Rated primary voltage(Upr)	66kV/√3
Voltage Factor (Fv)	1.9/8h
Rated primary current(Ipr)	250A
Rated extended primary current factor(Kpcr)	25.2
Accuracy limit primary current	63kA
Rated symmetrical short-circuit-current factor(Kssc)	680

F. Accuracy

Classification	Description
Voltage transformer	0.2/3P
Current transformer	0.2S/5TPE

G. Protection Class

Classification	Description
Enclosure	IP65

4. Operation Theory

1. LPCT and LPVT

LPCT converts the current signal of the primary conductor and consists of two Rogowski coils per phase to improve product reliability. LPVT adopts the coaxial capacitive voltage dividers to convert the primary voltage signal. LPVT also consists of two capacitive voltage dividers per phase to improve product reliability

2. Secondary convertor

Secondary converter including integrator and compensating circuits for temperature, gas pressure, etc., processes the output signals of LPCT/LPVT. The operation power of secondary convertor is 85-264V AC, 85-370V DC supplied from the GIS marshalling cubicle.

Both LPCT/LPVT and the secondary convertor are located at the low voltage side. The construction diagram is shown in Figure 1.

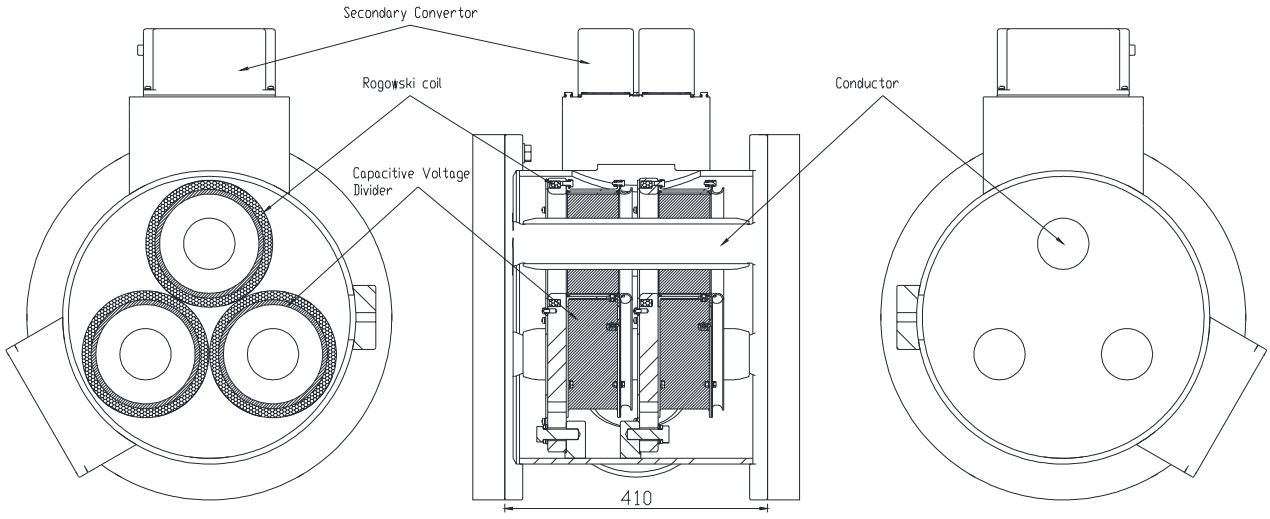


Figure 1. Construction diagram of LPIT

LPCT (Rogowski coil) measures the current induced by current flows through the primary conductor. The primary conductor, intermediate level and the grounded metal-clad constitute the LPVT (coaxial capacitor voltage divider) to measure the induced voltage from primary conductor. Dry-air is filled-in the space between the different voltages as insulation. Secondary converter compensates output signals.

4.1 Low Power Current Transformer

PCB-type Rogowski coil are used in this device to transform measured primary current. The operation principle of Rogowski coil is same as that of the conventional CT. The toroidal coil is a solenoid wound on a non-magnetic skeleton as shown in Figure 2.

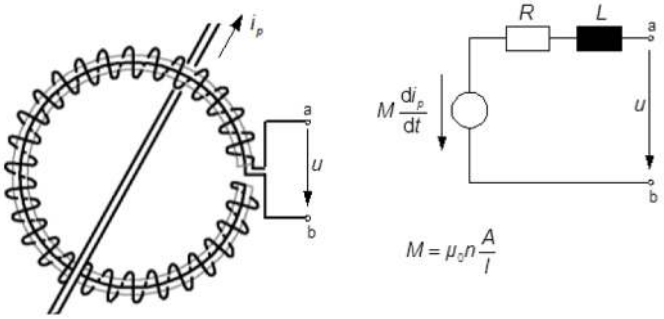


Figure 2. Rogowski coil

The Rogowski coil output signal u and the measured current i_p have a relation follows:

$$u = M\frac{di_p}{dt}$$

Where M is mutual inductance of Rogowski coil

According to above expression, the measured current ip can be obtained from the rogowski coil output signal after integral transform by secondary converter.

Rogowski coil has no iron core and hence has a very good linearity. And its performance is susceptible to influence of the temperature variation and external field, etc. The effect by these interferences can be minimized by printing its winding on circuit board (PCB-type Rogowski coil). PCB Rogowski coil effectively enhances device compactness and structural stability.

4.2 Low Power Voltage Transformer

The coaxial capacitive voltage divider is adopted for measuring the voltage. As shown in Figure 3, a cylinder-shaped conductor is connected in parallel at the output of the capacitor voltage divider to enhance the accuracy and improve the transient characteristic of voltage measurement.

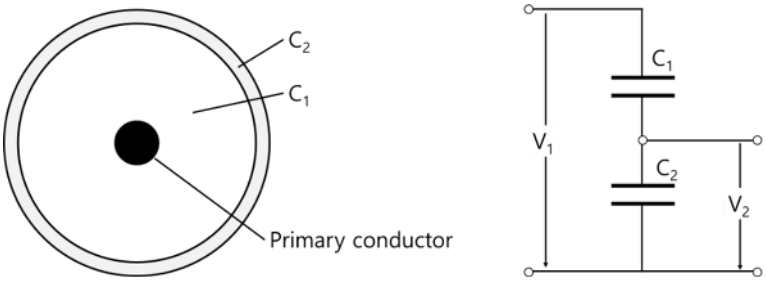


Figure 3. Coaxial capacitive voltage divider

The output signal of capacitor voltage divider V2 and the measured voltage V1 has the following relation:

$$V_2 = \frac{C_1}{C_1 + C_2} V_1$$

Where C1 is high voltage capacitance and C2 is low voltage capacitance.

Based on the above expression, the measured voltage can be obtained from the output signal of voltage transformer by secondary converter.

4.3 Interface Board

The Interface Board has two input terminals that receive analog voltage signals generated from the Rogowski coil and capacitive voltage divider per each phasor. The signal from the Rogowski coil is for measurement and protection signals, and the signal from the CVD is divided to an appropriate magnitude.

The output of the Rogowski coil and capacitive voltage divider is connected to the input terminal of the Interface Board through an RG316 cable and SMA connector. Each sensor and the Interface Board are connected with a vacuum connector to maintain Dry-air tightness. The output of the primary converter is connected to the input of the secondary converter through the D-sub connector 37pin.

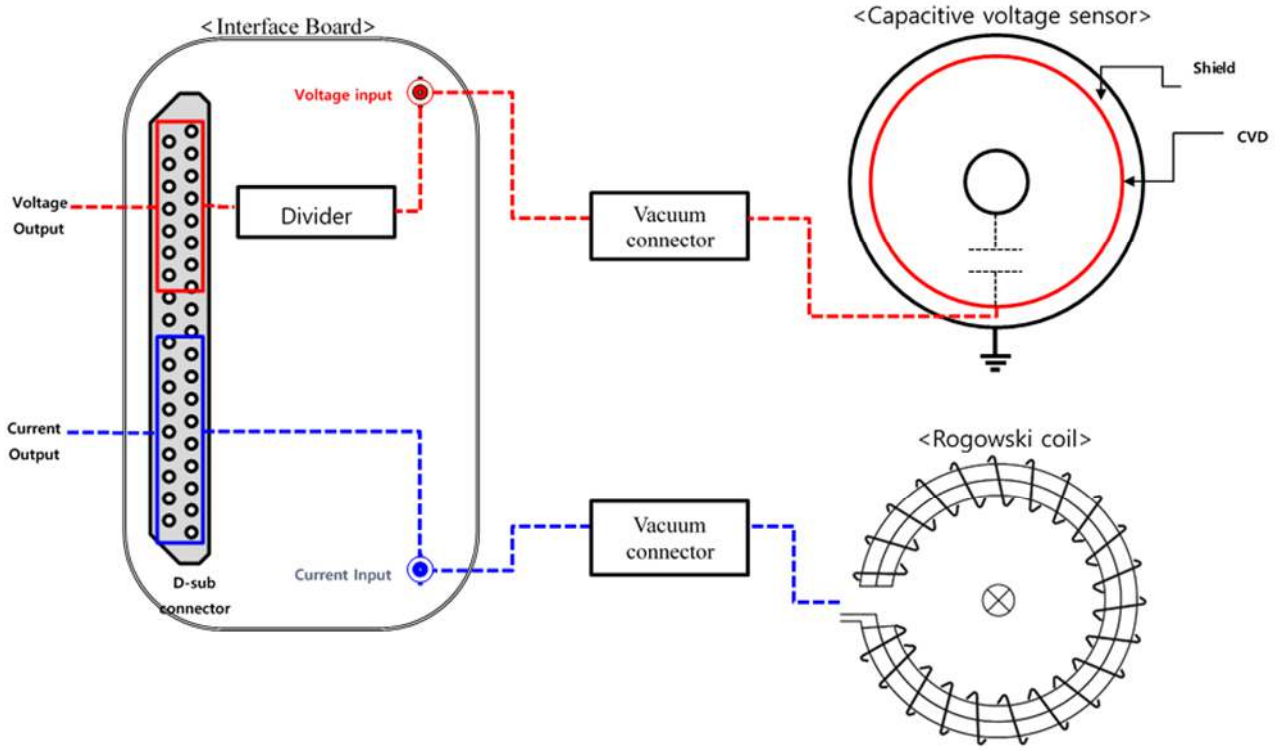


Figure 4. simple diagram of sensor and primary converter

5. Secondary Converter

5.1. Introduction

5.1.1. Overview

Secondary Converter is a device for digital substation that digitizes the analog output value of LPIT and transmits it to MU

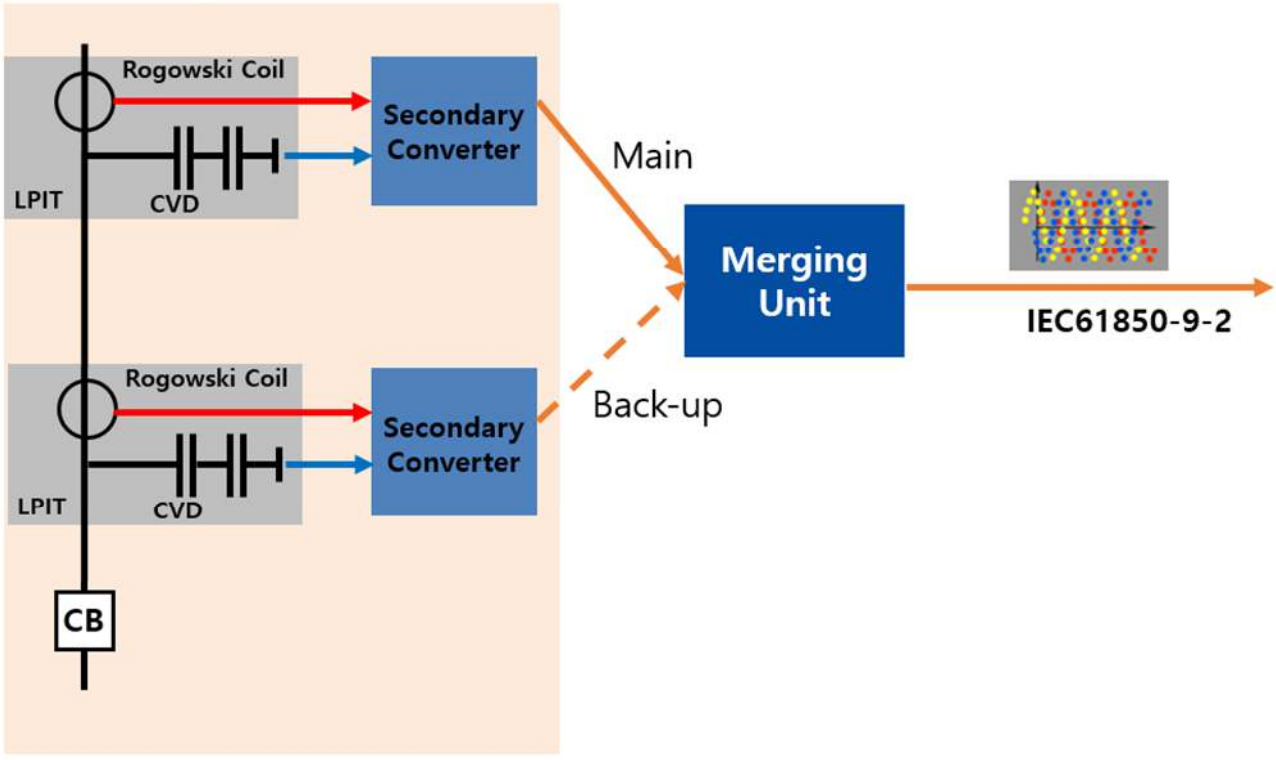
- Obtained IEC61869-6 certification according to LPIT standard
- Confirmed performance that satisfies measurement accuracy 0.1Class by securing analog to digital converter accuracy design technology

5.1.2. Features

- Guaranteed voltage/current measurement accuracy of 0.1 Class
- LPCT 3, LPVT 3 connection
- Fiber Optic 10Mbps duplex communication support
- GIS pressure, density sensor connection

5.1.3. Connection Diagram

- The followings are configuration diagrams showing the general connection of SC.



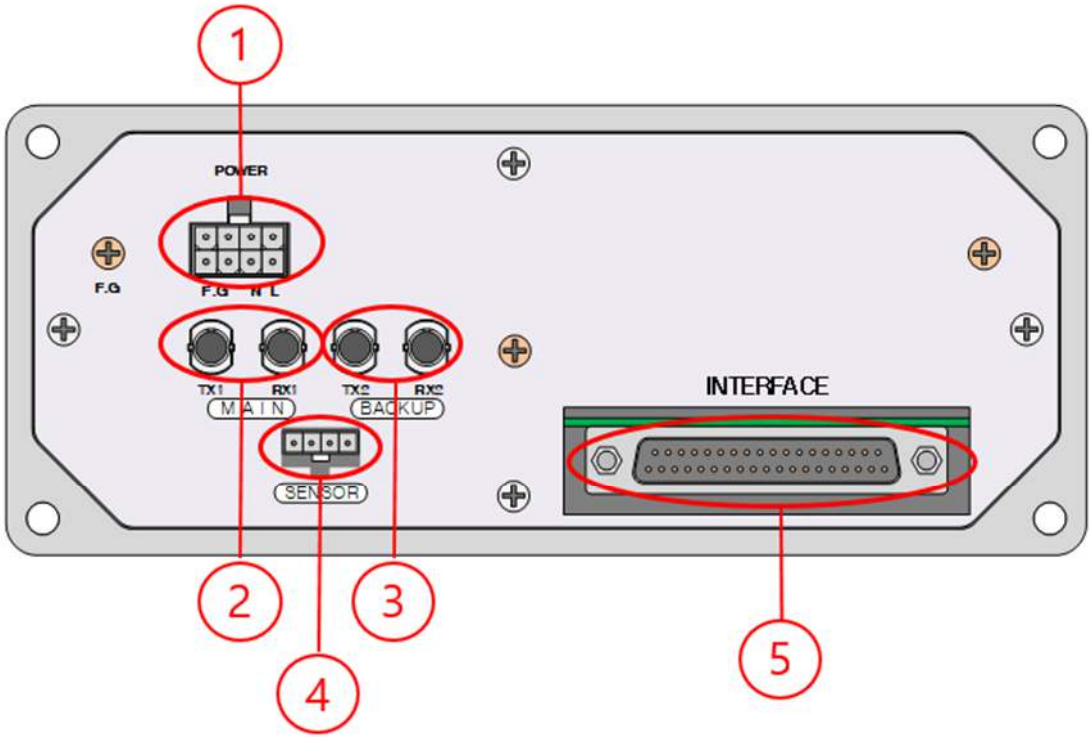
5.1.4. Specifications

Classification	Item	Specifications	Note
Condition of Use	Ambient temperature	-40…+80ºC (continuous)	
	Relative humidity	<93%, non-condensing	
	Height	<1,500m	
Rating	Rated frequency	50Hz, 60Hz Selected	
	LPVT	83.7kVrms	
	LPIT Model Protection LPCT	76,400Arms /108kApeak	
	LPIT Model Metering LPCT	3150A RATED / 6300A Max	
	Supplied Power	85Vac ~ 264Vac / 85Vdc ~ 370Vdc / 6W	
Appearance of Product	Dimension (W x H x D)	205 * 85 * 101mm	
	Weight	1.7Kg	
	Material	Aluminum	
	Type of Installation	Bolt tightening Method	

5.2. Appearance and Wiring

5.2.1. Appearance

- Appearance of rear side



<Back side of SC>

① **Power Supply Unit** connects the power cable of S/C(Secondary Converter) Unit.
② **Main communication** connects IM2 to main communication.
③ **Sub Communication** connects IM2 to preliminary communication.
④ **Sensor Unit** connects cable of the GIS pressure, density sensor.
⑤ **Interface Board Insertion** connects S/C Interface Board.

- Appearance of side of SC



<Side of SC>

① **USB to USART Comm. Console Plug** is connected to plug for maintenance communication after removing screw.

5.2.2. Wiring Features

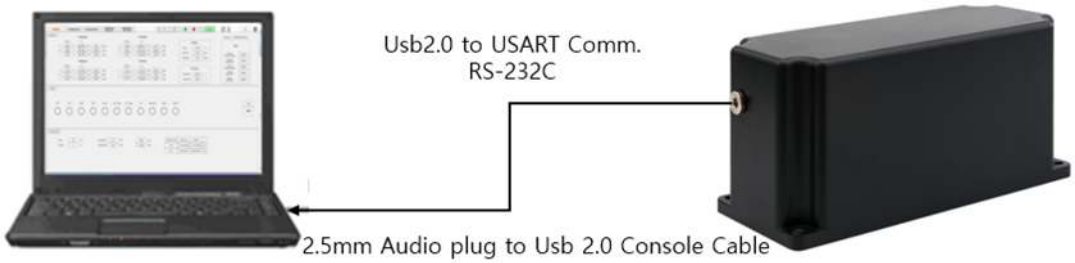
Wiring cables used on the back side should be cables equal to or higher than the following standards.

- Vinyl chloride insulated cable less than 450/750V that meets KSC C IEC 60227-3(2005) or IEEE 383
- Cable for power and ground-related circuit: copper cable of 1.5㎟ or thicker
- Cable for optical communication: Multi-mode, 1310nm
- The solderless terminals must be certified by an authorized agency or conform to KSC 2620 standard.

5.3. Maintenance

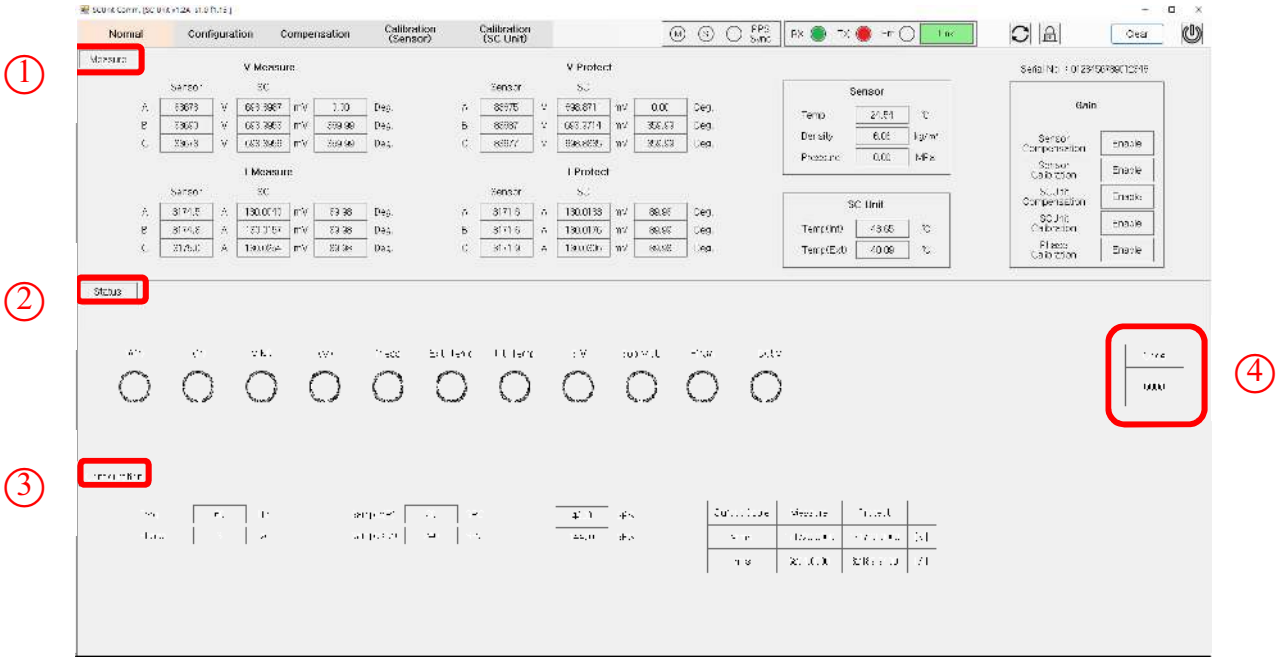
5.3.1. Introduction

The status and alarms of SC can be checked using the PC Interface software. To check the details of SC, the user needs to connect to the SC interface software installed PC to SC USB to USART COMM. port located at the side of the SC. The communication between the SC interface software and SC is shown below.



<Interface software and SC>

5.3.2. SC Interface Software



<SC Interface Software at PC>

① **Measure** section shows real time voltage, current, phase, temp, and etc.
② **Status** section alarms H/W failure to user.
③ **Configuration** section shows the settings of SC, such as sampling rate, frequency, and output scale..
④ **Code** shows the SC failures.

The details of Measure and Status section are shown below.

Section	Component	Description
Measure	Sensor (left)	Primary voltage & current
	SC	CVD and Rogowski coil voltage and current sensors output
	Sensor(right)	LPIT internal measure sensor (Temperature/Density/Pressure)
	SC Unit	SC Unit internal PCB temperature
	Gain	Calibration and compensation function key (Normally, it should be all enabled)
Status	V(P)	Protect voltage circuit measure error or failure
	I(P)	Protect current circuit measure error or failure
	V(M)	Measure voltage circuit measure error or failure
	I(M)	Measure current circuit measure error or failure
	Pressure	LPIT internal pressure/density/temperature sensor & RS485 communication error
	SV	SC Unit failure
	Sub MCU	Analog H/W maintenance sub MCU Failure
	FPGA	Communication between MCU and FPGA failure
	-±DC5V	Analog circuit power supply failure

5.3.3 Alarm

If the user notices the alarms from the merging unit, the status of the SC should be checked by the error code at the PC interface software to browse the details of the error. The description of the error code is shown below.

Code	Category	Description
0x01	SV Fail	Serial Number
0x02		Communication Error
0x03		Calibration Scale Protect 0~2 Settings
0x04		Calibration Scale Protect 3~4 Settings
0x05		Calibration Scale Measure 0~2 Settings
0x06		Calibration Scale Measure 3~4 Settings
0x07		Calibration Save Code Protect 0 Settings
0x08		Calibration Save Code Protect 1 Settings
0x09		Calibration Save Code Protect 2 Settings
0x0A		Calibration Save Code Protect 3 Settings
0x0B		Calibration Scale Code Protect Settings
0x0C		Calibration Save Code Measure 0 Settings
0x0D		Calibration Save Code Measure 1 Settings
0x0E		Calibration Save Code Measure 2 Settings
0x0F		Calibration Save Code Measure 3 Settings
0x10		Calibration Scale Code Measure Settings
0x11		Output Scale Settings
0x12		Integral Compensation Settings
0x13		Electrical Resistance Phase Protect Settings
0x14		Electrical Resistance Phase Measure Settings
0x15		Bias Protect Settings
0x16		Bias Measure Settings
0x17		Rogowski Protect Gain Settings
0x18		Rogowski Measure Gain Settings
0x19		CVD Protect Gain Settings
0x1A		CVD Measure Gain Settings
0x1B		Sensor Rogowski -40~10 Degree Gain Settings
0x1C		Sensor Rogowski 20~80 Degree Gain Settings
0x1D		Sensor Rogowski -40~10 Degree Phase Settings

0x1E		Sensor Rogowski 20~80 Degree Phase Settings
0x1F		Sensor CVD -40~10 Degree Gain Settings
0x20		Sensor CVD 20~80 Degree Gain Settings
0x21		Sensor CVD -40~10 Degree Phase Settings
0x22		Sensor CVD 20~80 Degree Phase Settings
0x23		SCUnit Rogowski -40~10 Degree Gain Settings
0x24		SCUnit Rogowski 20~80 Degree Gain Settings
0x25		SCUnit Rogowski -40~10 Degree Phase Settings
0x26		SCUnit Rogowski 20~80 Degree Phase Settings
0x27		SCUnit CVD -40~10 Degree Gain Settings
0x28		SCUnit CVD 20~80 Degree Gain Settings
0x29	H/W Fail Analog Circuit Digital Potentiometer i2c Communication Fail & ADC Fail	SCUnit CVD -40~10 Degree Phase Settings
0x2A		SCUnit CVD 20~80 Degree Phase Settings
0x2B		Phase Offset Settings
0x30		Sub MCU Communication
0x31		Sub MCU Register Settings 0
0x32		Sub MCU Register Settings 255
0x33		FPGA Initiating
0x34		FPGA Communication
0x35		+5V
0x36		-5V
0x37		Internal MCU Board Temperature Sensor
0x38		Internal ADC Board Temperature Sensor
0x39		Pressure Sensor
0x40		MCP45 VAP Failure
0x41		MCP45 VAN Failure
0x42		MCP45 VBP Failure
0x43		MCP45 VBN Failure
0x44		MCP45 VCP Failure
0x45	MCP45 Analog Circuit Digital Potentiometer i2c Communication	MCP45 VCN Failure
0x46		MCP45 IAP Protect Failure
0x47		MCP45 IAN Protect Failure
0x48		MCP45 IBP Protect Failure
0x49		MCP45 IBN Protect Failure

0x4A	Fail	MCP45 ICP Protect Failure
0x4B		MCP45 ICN Protect Failure
0x4C		MCP45 IAP Measure Failure
0x4D		MCP45 IAN Measure Failure
0x4E		MCP45 IBP Measure Failure
0x4F		MCP45 IBN Measure Failure
0x50		MCP45 ICP Measure Failure
0x51		MCP45 ICN Measure Failure
0x52		FPGA ADC VA Protect Error
0x53		FPGA ADC VB Protect Error
0x54		FPGA ADC VC Protect Error
0x55		FPGA ADC IA Protect Error
0x56		FPGA ADC IB Protect Error
0x57		FPGA ADC IC Protect Error
0x58		FPGA ADC VA Measure Error
0x59		FPGA ADC VB Measure Error
0x5A		FPGA ADC VC Measure Error
0x5B		FPGA ADC IA Measure Error
0x5C		FPGA ADC IB Measure Error
0x5D		FPGA ADC IC Measure Error
0x60		MCP45 VA Settings 0
0x61		MCP45 VB Settings 0
0x62		MCP45 VC Settings 0
0x63		MCP45 IA Protect Settings 0
0x64		MCP45 IB Protect Settings 0
0x65		MCP45 IC Protect Settings 0
0x66		MCP45 IA Measure Settings 0
0x67		MCP45 IB Measure Settings 0
0x68		MCP45 IC Measure Settings 0
0x69		MCP45 VA Settings 255
0x6A		MCP45 VB Settings 255
0x6B		MCP45 VC Settings 255
0x6C		MCP45 IA Protect Settings 255
0x6D		MCP45 IB Protect Settings 255

0x6E		MCP45 IC Protect Settings 255
0x6F		MCP45 IA Measure Settings 255
0x70		MCP45 IB Measure Settings 255
0x71		MCP45 IC Measure Settings 255
0x80	ADC Failure	VA Protect Code Low
0x81		VB Protect Code Low
0x82		VC Protect Code Low
0x83		IA Protect Code Low
0x84		IB Protect Code Low
0x85		IC Protect Code Low
0x86		VA Measure Code Low
0x87		VB Measure Code Low
0x88		VC Measure Code Low
0x89		IA Measure Code Low
0x8A		IB Measure Code Low
0x8B		IC Measure Code Low
0x8C		VA Protect Code High
0x8D		VB Protect Code High
0x8E		VC Protect Code High
0x8F		IA Protect Code High
0x90		IB Protect Code High
0x91		IC Protect Code High
0x92		VA Measure Code High
0x93		VB Measure Code High
0x94		VC Measure Code High
0x95		IA Measure Code High
0x96		IB Measure Code High
0x97		IC Measure Code High
0x98		VA Protect Saturation
0x99		VB Protect Saturation
0x9A		VC Protect Saturation
0x9B		IA Protect Saturation
0x9C		IB Protect Saturation
0x9D		IC Protect Saturation

0x9E		VA Measure Saturation
0x9F		VB Measure Saturation
0xA0		VC Measure Saturation
0xA1		IA Measure Saturation
0xA2		IB Measure Saturation
0xA3		IC Measure Saturation
0xB0	Config Fail	Frequency Settings Failure
0xB1		MU Config Failure
0xF0	Index Number Fail	Protect Index Failure
0xF1		Measure Index Failure

6. Installation

1. Installation

During assembling, attention shall be paid to the following matters.

Don't separate secondary convertor to the plate without permission.

2. Wiring

Number of LPCT/LPVTs to be configured for the LPIT depends on whether the duplex configuration is made for the relevant protection device and composite unit. The wiring mode of LPIT is given below.

1) Wiring of secondary convertor

LPIT is provided with two secondary convertors. The wiring diagram of primary convertor is shown below.

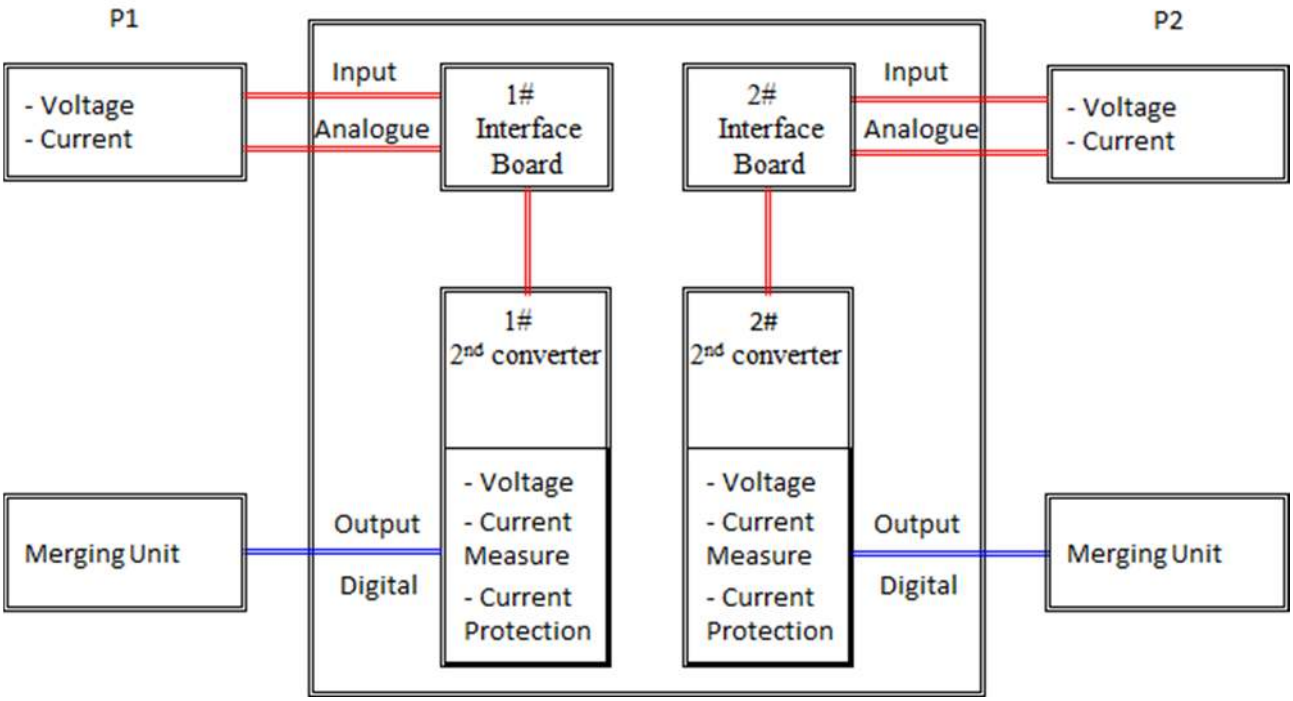


Figure 5. Wiring of Interface Board & secondary convertor

2) LPIT connection with MU(Merging Unit)

The merging unit is installed locally in the marshalling cubicle or in the protection cubicle nearby the cubicle, the optic cable from the secondary convertor will be led into the cubicle where the merging unit.

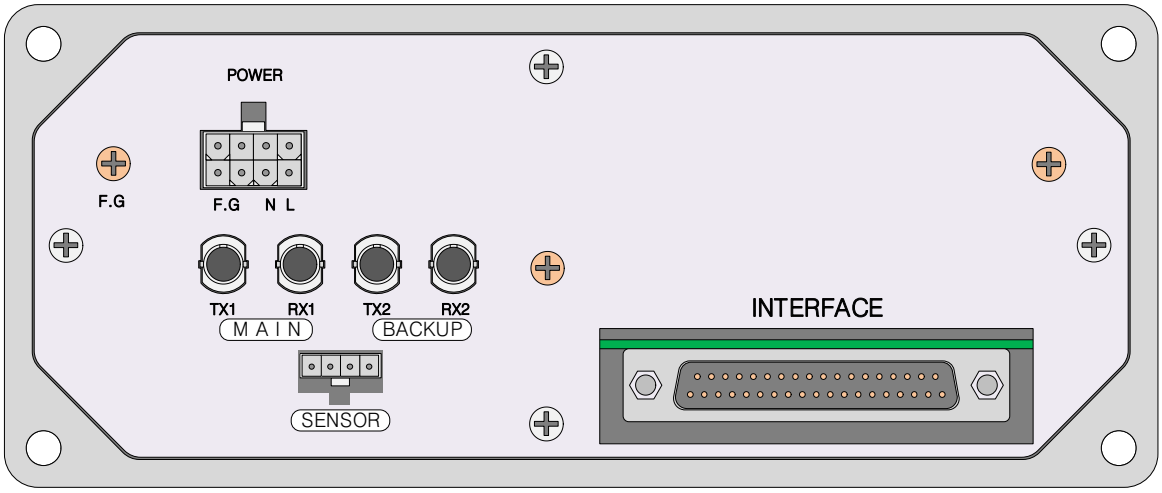


Figure 6. Secondary converter

The Secondary converter has two optical communication connectors, MAIN and BACKUP, for redundant to the merging unit. The communication cable is made with two pairs of optical(ST-type) connectors to connect MAIN and BACKUP merging unit. It is also possible to connect to only MAIN merging unit. Specifications for optical communication cable are listed in the table below.

Classification	Description
Number of Port	2 (physical)
Characteristics	Glass optical fiber
Connector type	Duplex ST(to SC), Duplex LC(to MU)
Fiber type	Multi-mode (62.5 μm/125 μm optical cable)
Transmission distance	Maximum 2km
Wave length	850nm
Bit Rate	50 Mbps
Protocol	Manufacturer's own protocol

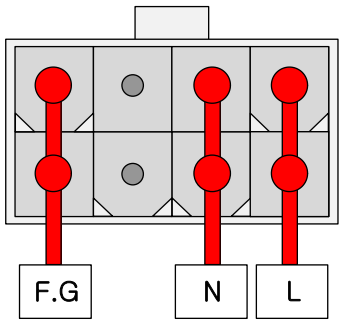


Figure 7 Power cable Connection

The secondary converter power terminal consists of three wires, each connected to L, N, and F.G., and the power rating is listed in 3.A Power Supply. There is a terminal for F.G. on the power line, but use another F.G. line and fasten it with a bolt to the F.G. connection terminal of the secondary converter.

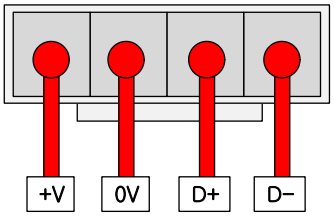


Figure 8 Temperature sensor cable Connection

The connection terminal for the temperature sensor consists of two power lines and two communication lines.

7. Maintenance

WARNING **Do not remove any protective covers if an assembly is energized**

Assemblies of the product are energized with hazardous voltages. Contact with live parts can lead to death or severe injuries.

Check the readings of Dry-air pressure gauge in the routine inspection. Please check whether there is no gas leaking.

No recalibration is needed after the LPIT is assembled. When recalibration of secondary convertor is needed, it should be replaced as calibrated secondary convertor from Hyosung. The old secondary convertor should be shipped back to Hyosung for recalibration.

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-13

VIEWPORT OF GIS

CONTENTS

1. General 2
2. Construction 2

1. General

To check contact status of disconnecting switch and grounding switch physically, there is viewport on GIS module

2. Construction

The construction of viewport is shown Fig. VP-1

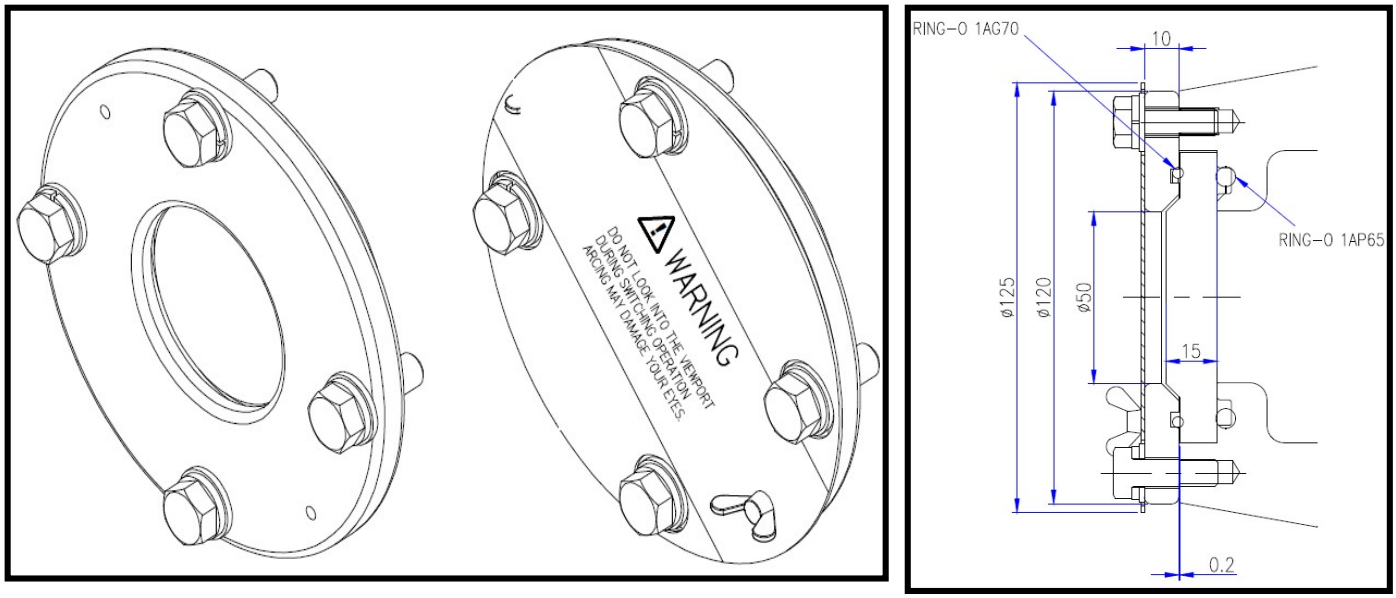


Fig. VP-1. Feature of viewport

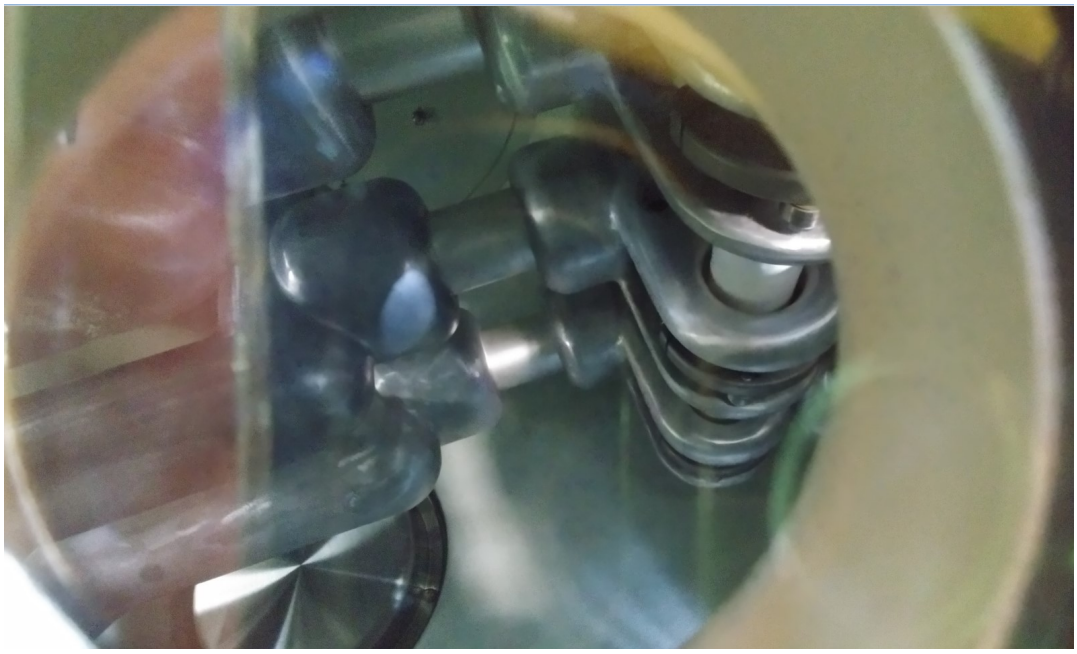


Fig. VP-2. Example of Contact status check through viewport

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART B-14

Local Control Panel of GIS

CONTENTS

1. General 2
2. Construction 2

1. General

Local control panel (LCP) is used for controlling GIS device for testing and maintenance. Each LCP has interlocking circuit arrangement and operation is following the interlocking scheme

2. Construction

The construction of LCP is shown on Fig. LCP-1

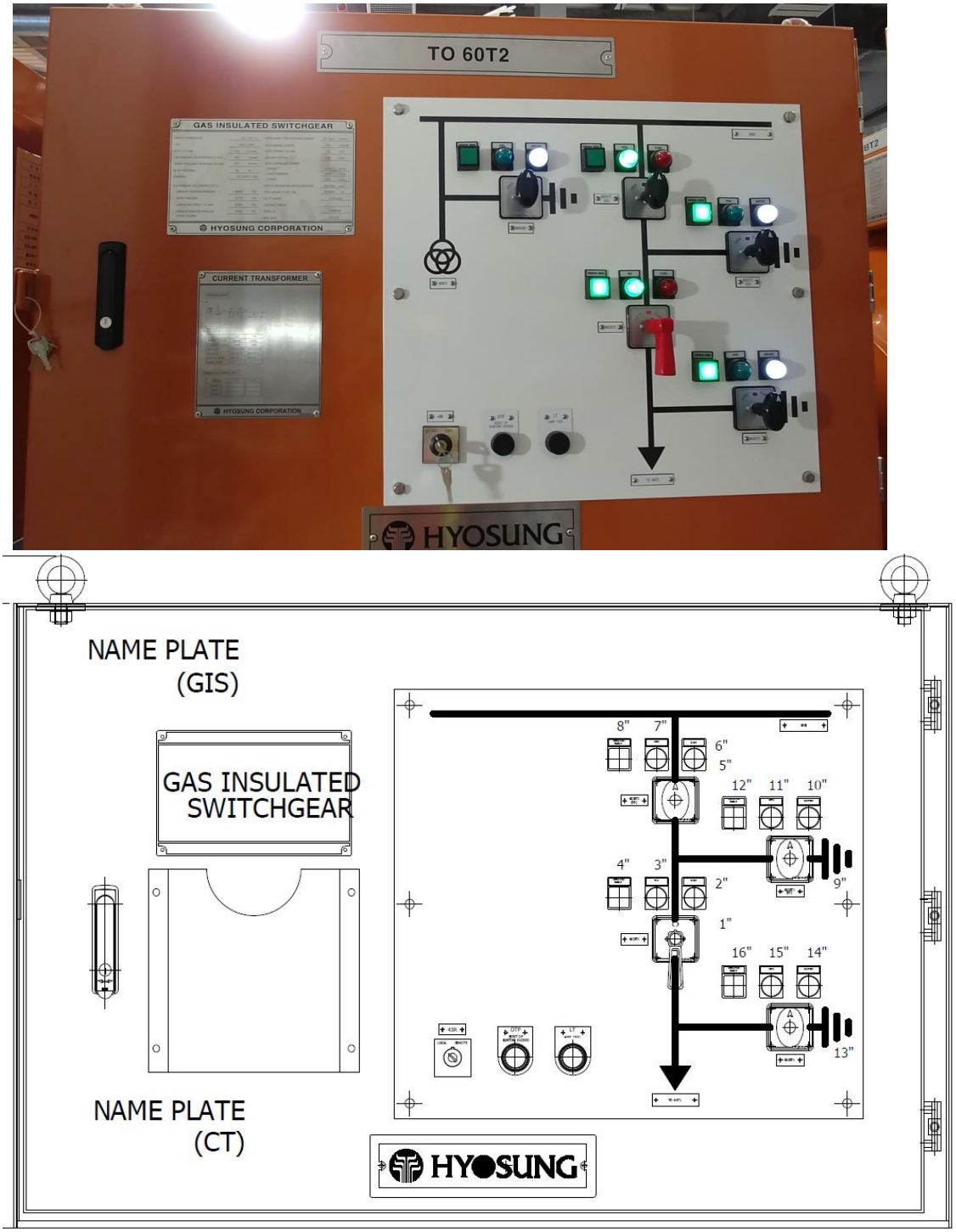
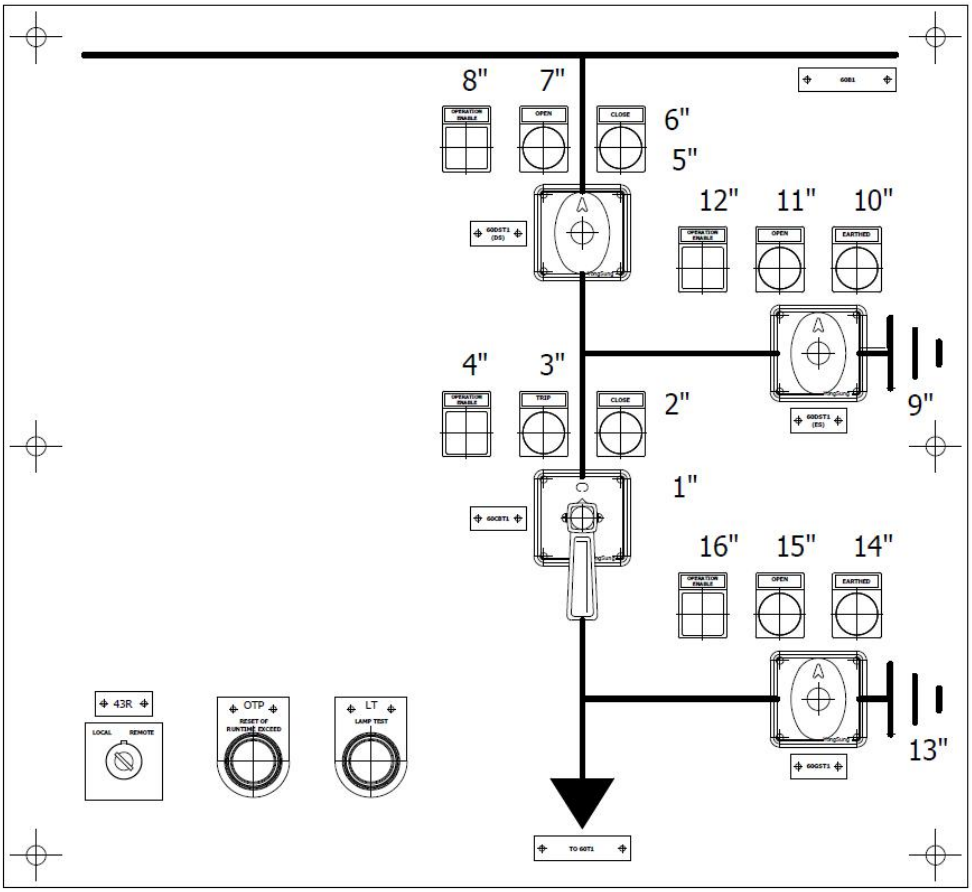


Fig. LCP-1. Example Structure of LCP

Each LCP has MIMIC that has single line of GIS and switch for controlling the GIS equipment and lamp showing status of the equipment as below. Fig. LCP-2



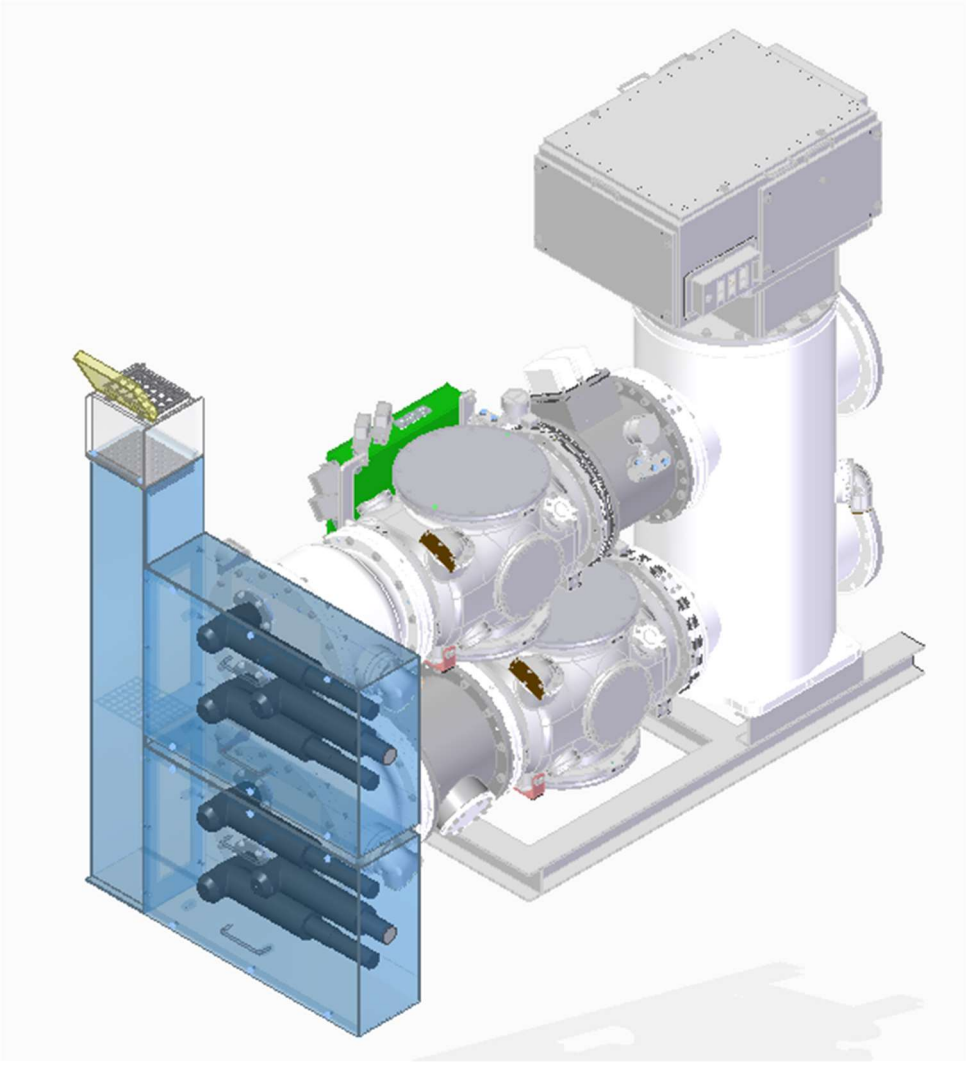
ITEM	DEVICE TAG	NAMEPLATE	FACEPLATE	FUNCTION
1	CS1	60CBT1	TRIP/CLOSE	SELECTOR SWITCH FOR 60CBT1 CONTROL
2	CLOSE1	-	CLOSED	PILOT LAMP FOR 60CBT1 CLOSE RED INDICATOR
3	TRIP1	-	TRIP	PILOT LAMP FOR 60CBT1 TRIP GREEN INDICATOR
4	OE1	-	OPERATION ENABLE	PILOT LAMP FOR 60CBT1 OPERATION ENABLE GREEN INDICATOR
5	CS2	60DST1(DS)	OPEN/CLOSE	SELECTOR SWITCH FOR 60DST1(DS) CONTROL
6	CLOSE2	-	CLOSED	PILOT LAMP FOR 60DST1(DS) CLOSE RED INDICATOR
7	OPEN2	-	OPEN	PILOT LAMP FOR 60DST1(DS) OPEN GREEN INDICATOR
8	OE2	-	OPERATION ENABLE	PILOT LAMP FOR 60DST1(DS) OPERATION ENABLE GREEN INDICATOR
9	CS3	60DST1(ES)	OPEN/EARTHED	SELECTOR SWITCH FOR 60DST1(ES) CONTROL
10	EARTHED3	-	EARTHED	PILOT LAMP FOR 60DT1(ES) EARTHED RED INDICATOR
11	OPEN3	-	OPEN	PILOT LAMP FOR 60DT1(ES) OPEN WHITE INDICATOR
12	OE3	-	OPERATION ENABLE	PILOT LAMP FOR 60DT1(ES) OPERATION ENABLE GREEN INDICATOR
13	CS4	60GST1	OPEN/EARTHED	SELECTOR SWITCH FOR 60GST1 CONTROL
14	EARTHED4	-	EARTHED	PILOT LAMP FOR 60GST1 EARTHED RED INDICATOR
15	OPEN4	-	OPEN	PILOT LAMP FOR 60GST1 OPEN WHITE INDICATOR
16	OE4	-	OPERATION ENABLE	PILOT LAMP FOR 60GST1 OPERATION ENABLE GREEN INDICATOR

Fig. LCP-2. Structure of MIMIC

Detail function and circuit arrangement of LCP to refer to scheme drawing set of the GIS.

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART C-1 PERIODIC INSPECTION AND MAINTENANCE



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1. PERIODIC INSPECTION AND MAINTENANCE PROCEDURE

1.1.1 General

Among GIS equipment, inspection works on Gas Circuit Breaker shall be the most important works because GCB is the key component and has heavier duties than any other component mechanically and electrically.

Therefore it is important to follow the procedures about Gas Circuit Breaker including

Dry air, and the description about it is detailed mainly.

Concerning about the components except Gas Circuit Breaker, it is recommended that they are inspected at the same inspection period as Gas Circuit Breaker, however so detailed procedure as Gas Circuit Breaker are not described because

they are basically maintenance-free components, and the required procedure for them are almost same as what will be described in Gas Circuit Breaker.

- For Inspection Criteria, refer to Table C1-1.
- For Contact Inspection criteria, refer to Table C1-2.
- For Concept for Inspection and Maintenance recommendation, refer to Table C1-3

According to of algorithm of Fig.C1-1~C1-3, it is recommended that the section of GIS is inspected and maintained. If any problem during each step of inspection, preventive maintenance is needed

- For Patrolling Inspection Procedures, refer to Table C1-4.
- Table C1-5 ~ C1-6 shows the Inspection Point of GIS.
- Table C1-7 ~ C1-10 shows the recording format of each component of CB at the inspection for the customer's convenience.

No.	Inspection Item	Inspection Period	After start of service	Contents	Remarks
1	Patrolling Inspection	-	-	Recommend to as per customer practice	See Table C1-4,5
2	Ordinary Inspection	-	Every 5 years	Conduct maintenance and inspection by utilizing service interruption with-out discharging Dry air.	See Table C1-6
3	Detail Inspection	Every 2,000 operation	Every 20 years	Conduct maintenance and inspection discharging Dry air.	-

Table C1-1 INSPECTION CRITERIA

a) Circuit breaker

Rated interrupting current	40000A (40kA)	Once every 10 operations
Interrupting current	10000-15000A (10~15kA)	Once every 30 operations
Interrupting current	5000A (5kA)	Once every 100 operations
Rated current	2000A	Once every 2,000 operations
No-load operation	-	Once every 10,000 operations

b) Disconnecting switch

No load switching	Once every 10,000 operations
Switching	Once every 2,000 operations

c) Earthing switch

With making capacity (High Speed ES Only)	Once every 2 making operations Or Once every 2,000 operations
Others	Once every 10,000 operations Once every 2,000 switching

Table C1-2 CONTACT INSPECTION CRITERIA

Ordinary inspection (Every 5 year)				
	Detail inspection (Every 20 year)			
		Contact inspection		
			Overhaul after 40 years	
				Dry air check
X	X		X	Gas pressure with gauge
X	X		X	Gas piping and valve
X	X		X	Gas pressure with tool
X	X		X	Local point gas leak test(If more than one alarm per year)
X	X		X	Moisture
X	X		X	Measurement of SO2 content
X	X		X	density switch check
				Structure check
X	X		X	Tightness of bolts and nuts
X	X		X	Check external damage of insulator and bushings
X	X		X	Check paint and corrosion
X	X		X	Abnormal Noise
	X	X	X	Replacement of Dry air gaskets(quad-ring, O-ring, packing)
X	X		X	Check condition of Rupture disk(damage, corrosion)
			X	Replacement of rupture disk
				Circuit breaker
X	X	X	X	Operation with Manual tool and electric power
X	X	X	X	Operating characteristic
X	X	X	X	Function check of trigger circuits
X	X	X	X	Function check of closing lockout
X	X	X	X	Check anti-pump function
	X	X	X	Contact inspection
	X	X	X	CB linkage adjustment
	X	X	X	Cleaning of insulator
	X	X	X	Some metal material inside tank
				Spring mechanism
X	X	X	X	Operation Counter
X	X	X	X	Indicator
X	X		X	Dashpot oil leakage
X	X		X	Solenoid coil
X	X		X	Lever and link, pins
	X		X	Spring
X	X		X	Spacer heater

X	X		X	Auxiliary switch
X	X		X	Limit switch
X	X		X	Wiring
X	X		X	lubrication(if applicable)

Ordinary inspection (Every 5 year)				
	Detail inspection (Every 20 year)			
		Contact inspection		
			Overhaul after 40 years	
				Disconnecting and Earthing switch
X	X	X	X	Visual window check
X	X	X	X	Operation with Manual tool and electric power
X	X	X	X	Operating characteristic
	X	X	X	Contact inspection
	X	X	X	Cleaning of insulator
	X	X	X	DS&ES linkage adjustment
	X	X	X	Some metal material inside tank
				DS&ES Mechanism
X	X	X	X	Indicator
X	X		X	Lever and link, pins
X	X		X	Gear box linkage adjustment
X	X		X	Spacer heater
X	X		X	Auxiliary switch
X	X		X	Wiring
X	X		X	Limit switch
X	X		X	lubrication(if applicable)
				High speed earthing switch
X	X	X	X	Visual window check
X	X	X	X	Operation with Manual tool and electric power
X	X	X	X	Operating characteristic
	X	X	X	Contact inspection
	X	X	X	Cleaning of insulator
	X		X	HES linkage adjustment
	X	X	X	Some metal material inside tank
				HES Mechanism
X	X	X	X	Indicator
X	X		X	Shock absorber leakage
X	X		X	Lever and link, pins
	X		X	Spring

X	X		X	Spacer heater
X	X		X	Auxiliary switch
X	X		X	Limit switch
X	X		X	Wiring
X	X		X	lubrication(if applicable)
				Others
X	X		X	Optical lamp of local control panel
X	X		X	function test of local control panel (interlock, operating, Lamp)
X	X		X	Wiring of CT & local control panel
X	X		X	Insulation resistance
	X	X	X	Replacement of absorbent

Table C1-3 INSPECTION AND MAINTENANCE RECOMMENDATIONS

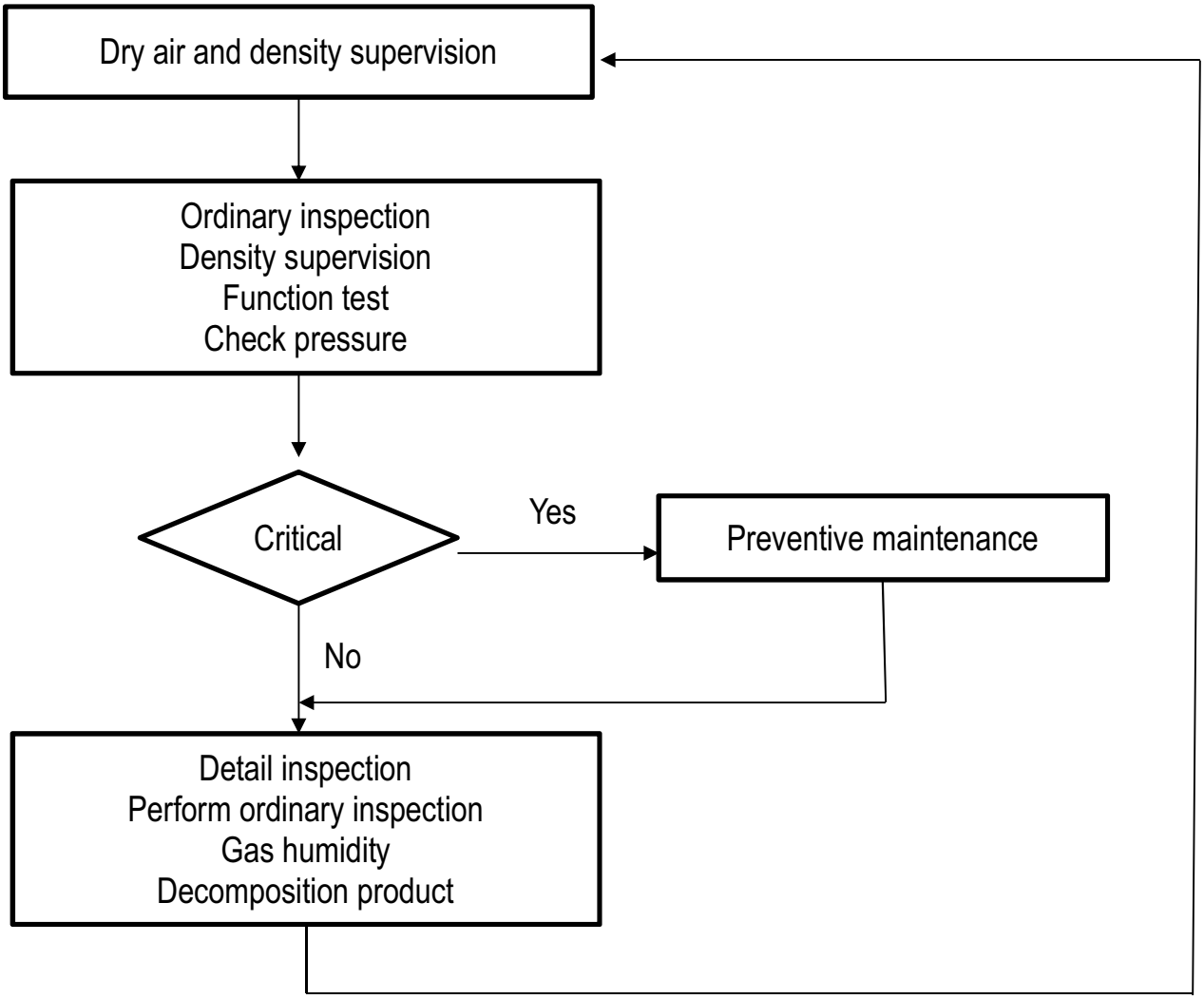


Fig. C1-1 MAINTENANCE PROCEDURE OF GAS AND DENSITY SUPERVISION

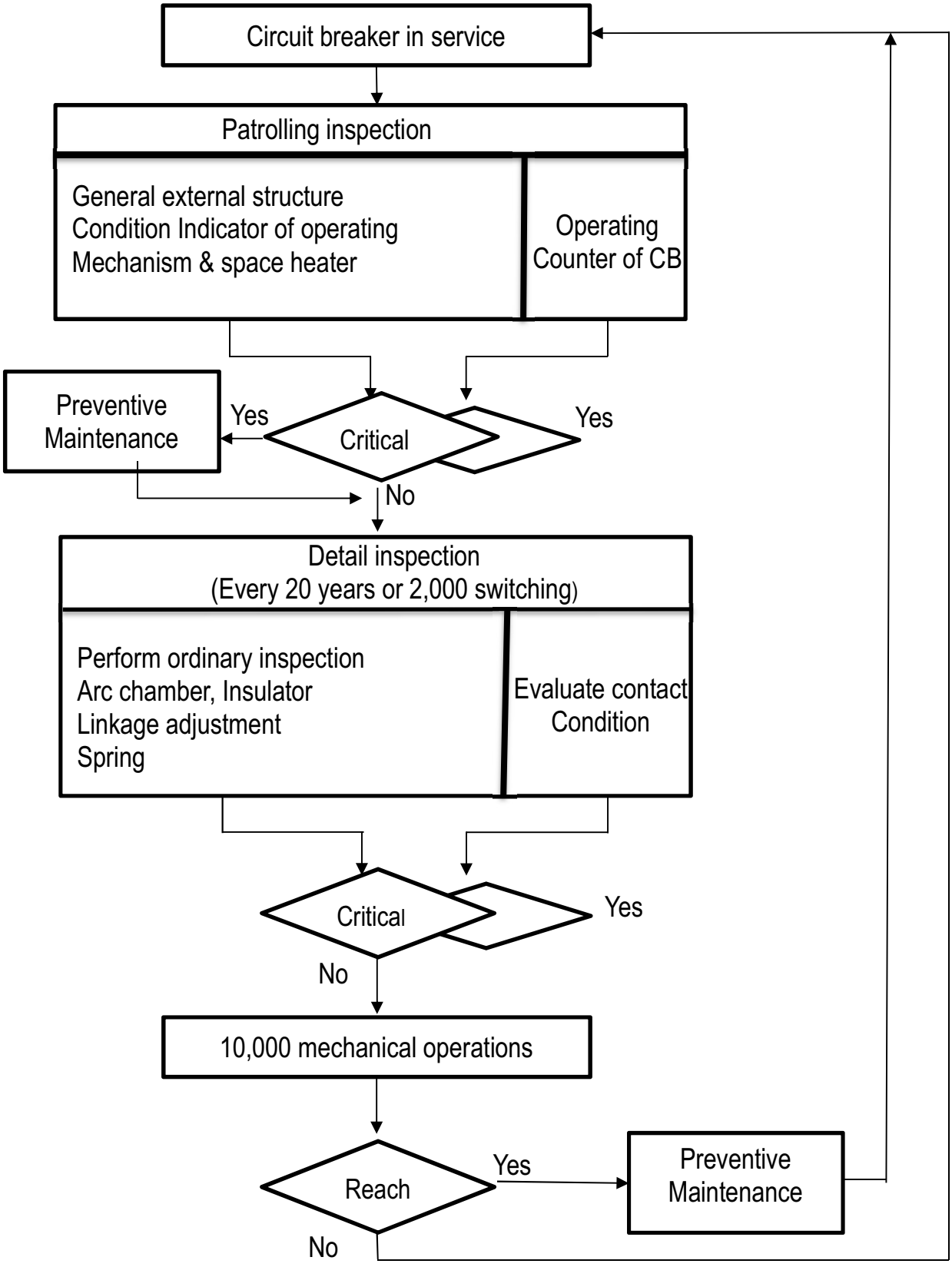


Fig. C1-2 MAINTENANCE PROCEDURE OF CIRCUIT BREAKER

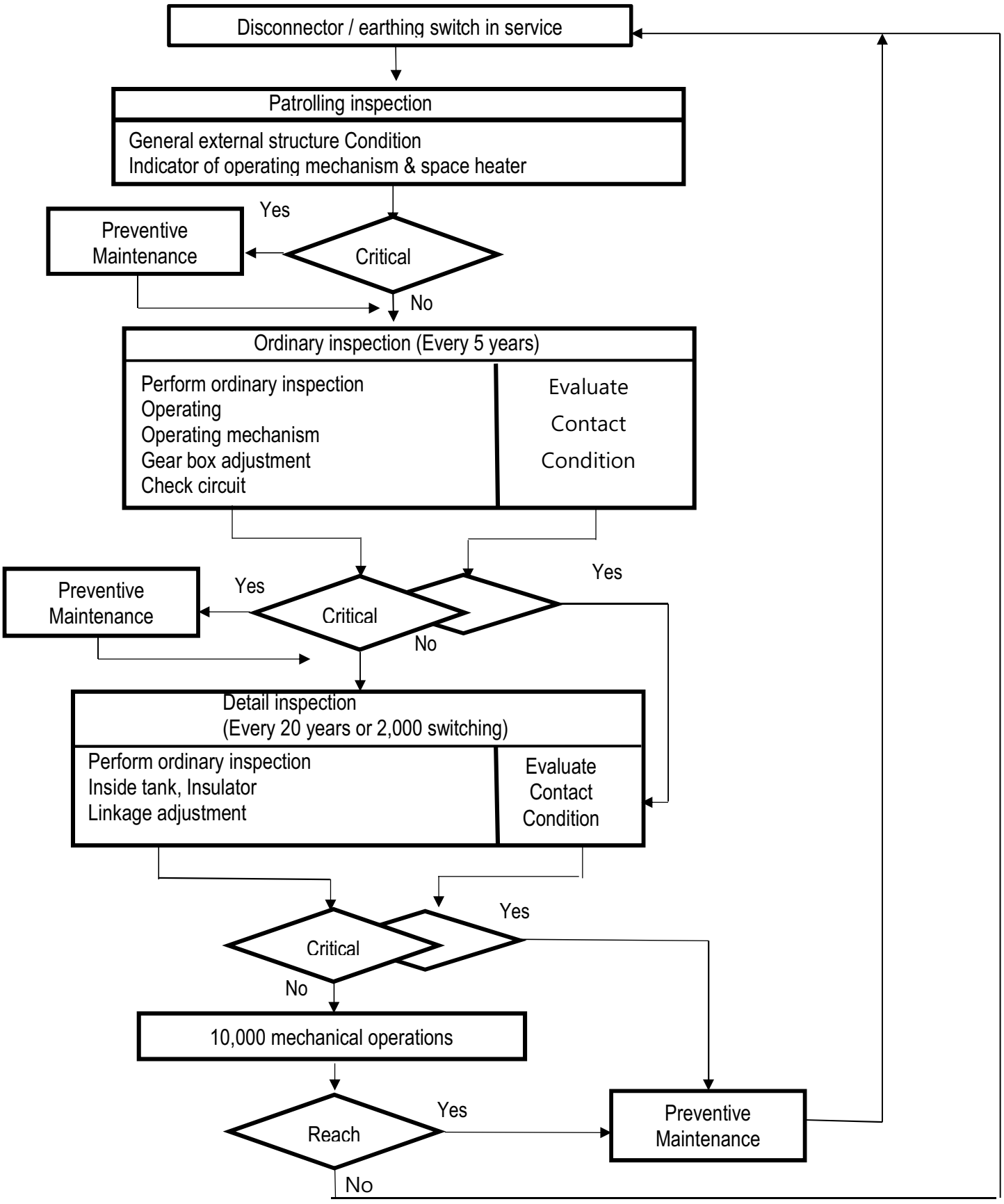


Fig. C1-3(a) MAINTENANCE PROCEDURE OF DISCONNECTOR & EARTHING SWITCH

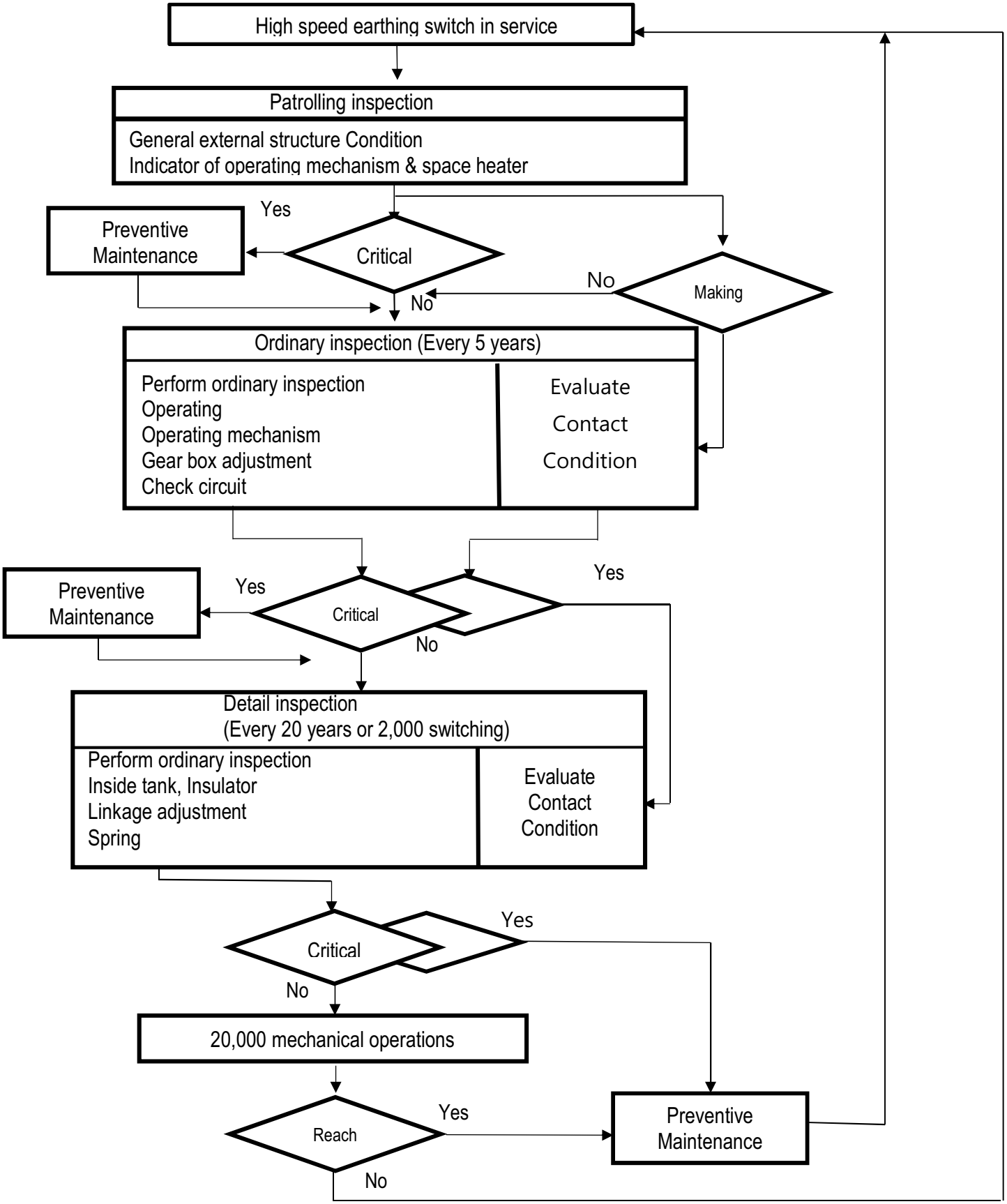


Fig. C1-3(b) MAINTENANCE PROCEDURE OF HIGH SPEED EARTHING SWITCH

1.1.2 Patrolling Inspection

▪ Conduct a Patrolling Inspection in order to check to faulty or improper operating condition of device.
Important checking point is gas pressure.
▪ For the procedure, refer to Table C1-4.
▪ For the checking items, refer to Table C1-5.

No.	Descriptions items	Inspection procedure
1	Gas pressure	Read pressure on gas pressure gauge(1) in Gas System Diagram Record the gas pressure, ambient temperature. If any Dry air leakage is detected, supply the Dry air according to the procedure described in before the gas pressure drops to the alarm pressure.
2	Operation counter	Check and record the number of operation.
3	Space heater	When the check the operations of heaters as bellows humidity is high, the temperature drops sharply or the ambient temperature is low, the heater in the control cubicle is operated to turn on
4	Closing spring	Check that charged / discharged indicator shows charged.
5	Others	Check if abnormal noise occurring.

Table C1-4 PATROLLING INSPECTION PROCEDURE

Inspection Item	No.	Main points of inspection	Reference	Result
DRY AIR	1	Gas pressure with gauge	Gas System Diagram	
			Gas System Diagram	
	2	Gas piping and valve	Tightness	
Structure	3	Bolt and nuts in Tank	Tightness	
	5	Bolt and nuts between bushings and terminal	Tightness	
	6	Bolt and nuts between frame and tank	Tightness	
	7	Bolt and nuts in operating mechanism box	Tightness	
	8	Bolt and nuts in grounding terminal	Tightness	
	9	Bolt and nuts in CT	Tightness	
	10	Paint and corrosion	Paint (no rusty)	
	11	Bushings and insulator	No damage	
	12	Abnormal noise	Normal	
Mechanism & local control panel	13	Operation counter of CB	-	
	14	Optical indicator of spring mechanism	Charged/ Discharged	
	15	Optical indicator of GIS	Close/Open	
	16	Spacer heater	Normal	
	17	Optical lamp, lens, button of local control panel	Normal	

Table C1-5 PATROLLING INSPECTION POINT

1.1.3 Ordinary Inspection

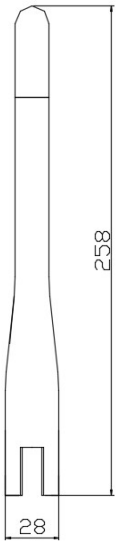
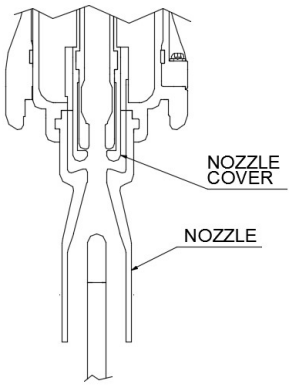
- Conduct an ordinary inspection at not live condition of objective equipment, without discharging gas.
- The following caution should be paid before inspection starts.
- Ordinary inspection point, refer to Table C1-6 .

Inspection Item	No.	Main points of inspection		Reference		Result
DRY AIR	1	Patrolling inspection (related to 1, 2)		Table C1-5		
	2	Gas piping and valve		Tightness		
	3	Gas pressure with tool		Gas System Diagram		
				Gas System Diagram		
	4	Local point gas leak test (If more than one alarm per year)		0.5%/year, Table C1-9		
	5	Check moisture of gas		CB : 150ppm (max 300)		
				Others: 300ppm (max 500)		
	6	Measurement SO2 content		Below 1ppm		
	7	Density switch check of CB	Leak stage 1	Make	Gas System Diagram	
				Break		
			Leak stage 2	Make	Gas System Diagram	
				Break		
	8	Density switch check of other	Leak stage 1	Make	Gas System Diagram	
				Break		
			Leak stage 2	Make	Gas System Diagram	
				Break		
Structure	9	Patrolling inspection (related to 3~12)		Table C1-5		
	10	Check condition of rupture disk		Normal		
Circuit breaker & Spring mechanism	11	Patrolling inspection (related to 13, 14, 16)		Table C1-5		
	12	Operation with manual tool		Close spring charged		
Circuit breaker & Spring mechanism	13	Operation with manual button		Normal operating		
	14	Operation with electric power		Normal operating		
	15	Function of trigger circuit		Normal		

	16	Function of closing lockout	Normal	
	17	Anti-pumping	Normal	
	18	Estimate condition of contact	Table C1-2,	
	19	Dashpot oil	No leak	
	20	Solenoid coil resistance	1) DC 125V - TRIP COIL : 30.7 Ω ± 5% at 20 C - CLOSE COIL : 36.5 Ω ± 5% at 20 C 2) DC 220V - TRIP COIL : 96.4 Ω ± 5% at 20 C - CLOSE COIL :112.2 Ω ± 5% at 20 C	
	21	Link, lever, pins, bolts and nuts	Normal, Tightness	
	22	Auxiliary switch of contact	Normal	
	23	Auxiliary switch of lever	No damage	
	24	Contact of limit switch	Normal	
	25	Wiring in spring mechanism	Tightness	
	26	Lubrication (If applicable)	Table C1-14	
Disconnector & Earthing switch &operating mechanism	27	Patrolling inspection (related to 15, 16)	Table C1-5	
	28	Visual window	No damage	
	29	Condition check contact in visual window	No damage	
	30	Operation with manual tool	Normal operating	
	31	Operation with electric power	Normal operating	
	32	Estimate condition of contact	Table C1-2,	
	33	Link, lever, pins, bolts and nuts	Normal, Tightness	
	34	Gearbox worm wheel position (close/open)	Normal position	
	35	Condition of gearbox worm wheel	No damage	
	36	Auxiliary switch of contact	Normal	
	37	Auxiliary switch of lever	No damage	
	38	Contact of limit switch	Normal	
	39	Wiring	Tightness	

High speed Earthing switch &operating mechanism	40	Patrolling inspection (related to 15, 16)		Table C1-5	
	41	Visual window		No damage	
	42	Condition check contact in visual window		No damage	
	43	Operation with manual tool		Normal operating	
	44	Operation with electric power		Normal operating	
	45	Estimate condition of contact		Table C1-2	
	46	Link, lever, pins, bolts and nuts		Normal, Tightness	
	47	Shock absorber		No leak	
	48	Auxiliary switch of contact		Normal	
	49	Auxiliary switch of lever		No damage	
	50	Contact of limit switch		Normal	
	51	Wiring		Tightness	
	52	Lubrication (If applicable)		Table C1-14	
Others	53	Patrolling inspection (related to 17)		Table C1-5	
	54	Function test of local control panel (interlock, operating, lamp, alarm)		Normal	
	55	Wiring of CT & local control panel		Tightness	
	56	Insulation resistance	Main circuit	Over 1,000MΩ	
			Auxiliary circuit	Over 2MΩ	
			Refer to Table C1-9		

Table C1-6 ORDINARY INSPECTION POINT

No.	Inspection item	Inspection and repair procedure	Disassembly procedure	Person and hour
1	Stationary arcing contact	When contact surface is found uneven, remove it from interrupter, and contact it with sandpaper. When the wear has become 2mm or over, replace the contact with a new one. Apply thin coat of Rubchem grease to the contacts	Take off the upper enclosure and conductor as shown Fig. C-13, loosen M10 bolts and exchange stationary arcing contact 	2 persons X 12 hours (This item Includes the Dry air collecting and refilling Dry air.)
2	Moving arcing contact	When surface is found uneven, polish the surface with a smooth cut file. When the amount of wear become 2mm or over, replace the contact with a new one. Apply thin coat of Rubchem grease to the contacts	Dimension of arcing contact to be measured are indicated below. 	

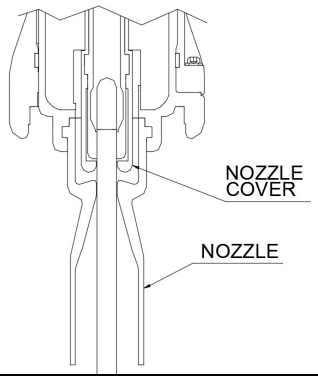
No	Inspection item	Inspection and repair procedure	Disassembly procedure	Person and hour
3	Insulation nozzle and Insulation cover	Use lint free cloth to clean up the interior and exterior. When the nozzle's or cover's inner diameter is enlarged by 1mm or more, replace it with a new one.	The nozzle and cover can be removed together with the moving contact. Dimensions of nozzle can be measured as picture below. 	
4	Insulation material	Use lint free cloth to clean up the surface. When any crack or color change of nozzle is found (with camera), replace it with a new one.		
5	CB linkage adjustment	When linkage of CB is adjustment, refer to below Open gap 10mm Stroke 120±1 mm Wipe 29.2±1 mm		

Table C1-7 CONTACT INSPECTION CRITERIA

No	Inspection item	Inspection and repair procedure	Disassembly procedure	Person and hour
1	Absorbent	Replace with a new one. Exchange it quickly just before vacuum drying.	Remove the hand hole cover, and take out the absorbent case to replace absorbent with a new one.	

Table C1-8 ABSORBENT REPLACE CRITERIA

No.	Check items	Measured value	Check marks
1	Confirm that each insulation resistance exceeds 1,000 MΩ by 1000V Megger. - Main circuit to ground - Between poles		
2	Confirm that each insulation resistance exceeds 2 MΩ by 500V Megger. - CT's secondary wiring to ground - Between CT's secondary wirings - Control and auxiliary circuit to ground		

Table C1-9 INSULATION RESISTANCE CHECK CRITERIA

Check items					
Using a gas leak detector, confirm that gas leakage is less than 200ppm for ten hours by accumulation method, after covers the portions to be measured with polyethylene (or vinyl) cloths					
No	Portion	H (Hr)	Pi (ppm by volume)	10 X pi / H (ppm)	Check mark
1	Man-holes				
2	Stop valve				
3	Gas piping				

Table C1-10 GAS LEAKAGE CHECK SHEET

* H : Operating time (minimum duration time should be more than 4 hours)

* pi : Gas amount accumulating in the vinyl cloths

* 10 X pi / H : Gas leakage of ten hours

1.2 MAINTENANCE PROCEDURE

1.2.1 Safety for Manual Operation

The GIS has the mechanisms moving very fast and filled with pressurized Dry air, so most care should be taken to operate the GIS every time.
Besides, since very high voltage is applied to the main circuit, so understand clearly to which portion it is applied or not.
The conditions of the GIS should be confirmed prior to the operations at the Inspection and/or maintenance.
Typical means for safety are shown Table C1-11, but not limited to them;
The correct understanding is really required every time.

No.	Item	Operation	Explanation
1	Closing spring force	Closing circuit breaker.	Before you start maintenance, close Circuit Breaker, for discharging closing spring.
2	Electric power	Switch off.	Before you start maintenance, cut off electrical power.
3	Gas	Keep oxygen density.	Before you start maintenance, hand hole put in air up to 0 bar.G
			Before you enter to inside of tank, you need measure density of oxygen.
			Do not charge gas in the low plate part. It is easy to stay in the low place.

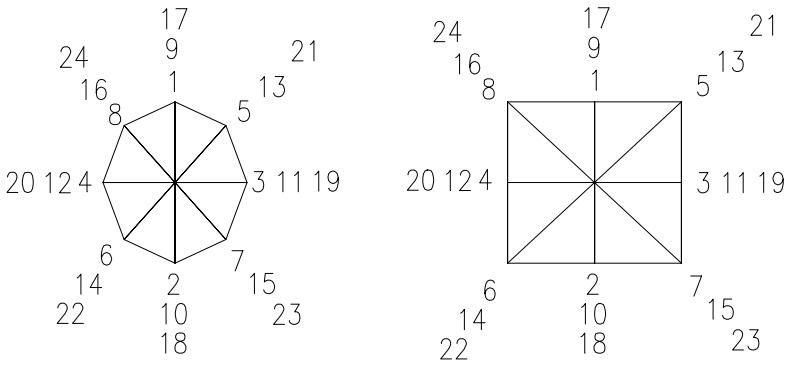
Table C1-11 SAFETY FOR MANUAL OPERATION

1.2.2 Tightening and Re-tightening

The torque required to tighten and re-tighten bolts and nuts should be applied the values specified in Table C1-12.
When tightening by more than 2 bolts, tighten bolts not only but more than 2 times in order shown in below 'BOLT TEIGHTENING ORDER'.
Don't forget to tighten all bolts and/or nuts fully.

Kind of screw thread	Proper torque(kgf·cm)					
	Steel or stainless steel bolts			Copper, brass or aluminum alloy bolt		
	Upper limit	Standard	Lower limit	Upper limit	Standard	Lower limit
M4	18	15	12	12	10	8
M5	36	30	24	24	20	16
M6	90	75	67	36	30	24
M8	216	180	160	95	80	65
M10	360	300	270	145	120	95
M12	810	675	610	360	300	240
M16	1710	1425	1280	700	600	500
M20	3240	2700	2420	1300	1100	900
M24	5000	4200	3400	2300	1900	1600
M30	8400	7000	5800	4500	3800	3200
M36	14000	12000	10000	8000	6600	5600
M42	23000	20000	16000	13000	11000	9000
M48	35000	30000	24000	19000	16000	13000

Table C1-12 PROPER TORQUE FOR TIGHTENING BOLT AND NUT



BOLT TIGHTENING ORDER

1.2.3 DRY AIR Gas System

Whole DRY AIR gas system of the GIS including the gas section is shown in Gas System Diagram.
Enclosure of GIS is filled with DRY AIR gas as specified in gas system diagram
And the gas density detector with pressure gauge which is installed in each compartment always monitors DRY AIR gas pressure.
If the gas pressure of CB section drops to the gas specified in gas system diagram at 20℃, then Low pressure contact is made and alarm is given.

And if it drops the gas specified in gas system diagram at 20℃. Blocks trip and close operation of the circuit breaker.

1) Insulation at atmospheric pressure

The insulation strength is designed to withstand the normal operation voltage even when the DRY AIR gas pressure drops to the atmospheric pressure(0 bar.G).

2) Alarming pressure and locking pressure

Mostly the gas system is monitored as divided into two systems:

ⓐ Gas Circuit Breaker

ⓑ Bus and Isolator

In the event of the DRY AIR gas pressure drop, an alarm will be operated by the gas density detector at about 10% leakage, if the leakage reached about 20%, Circuit Breaker is to be locked by the relaying sequence then.

3) Construction of gas density detector

Fig. C1-4 and C1-5 shows an outline of the gas density detector. Since the DRY AIR gas is sealed in containers, the DRY AIR gas pressure varies along with the surrounding temperature. The pressure will read what higher by general pressure gauges even though there were no change of gas quantity as such (no gas injection). Thus a special pressure switch, so called density detector, which has the temperature compensating function so that the pressure compensated to a certain standard temperature (20℃) can be checked, I.e. the same meaning of the gas density Gas density detectors are provided with each reasonably divided compartment.

1.2.4 DRY AIR Gas Refilling(See Fig. C1-4)

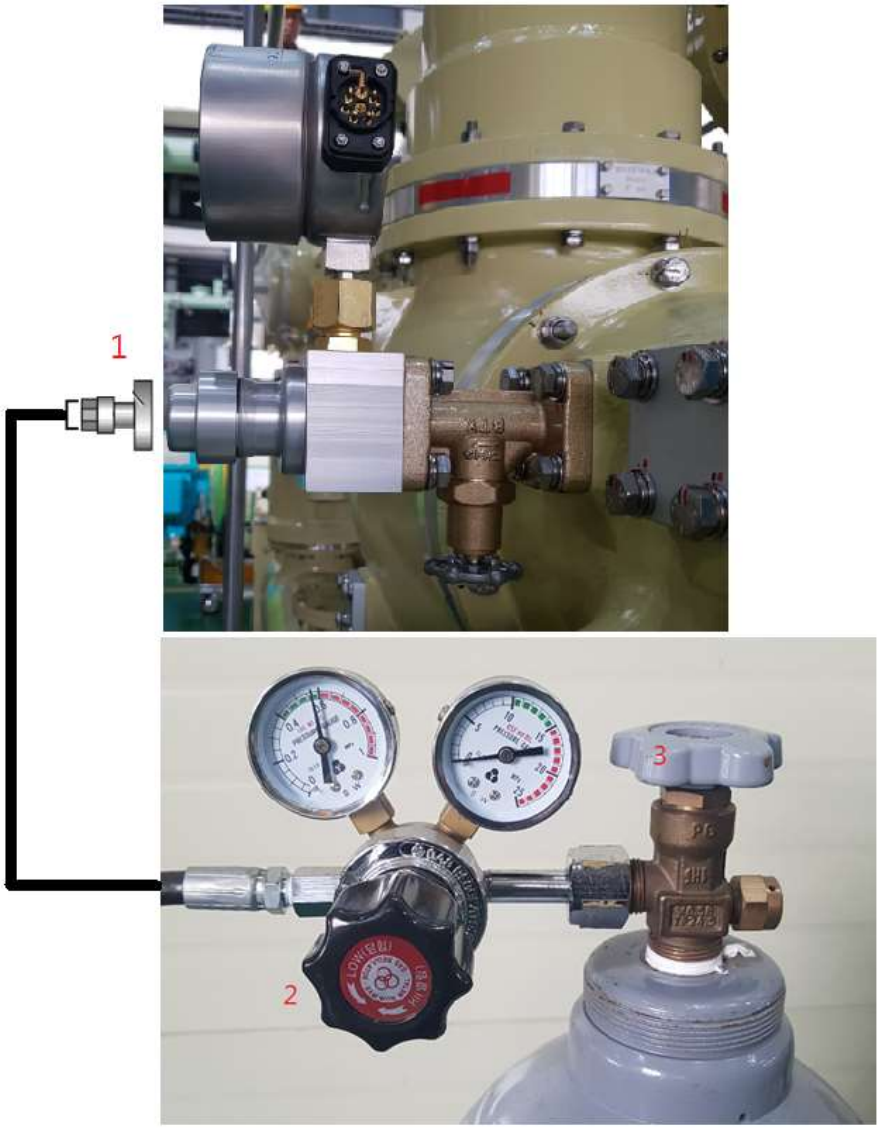


Fig. C1-4 GAS REFILLING DEVICE

1. Injection valve
2. Reducer valve
3. Gas valve

1) Connect Injection valve (1) to GIS valve
2) Open the Gas valve (3) carefully
3) Open the Reducer valve (2) and control with appropriate pressure to inject

1.2.5 Gas Density Detector Check (See Fig. C1-5)

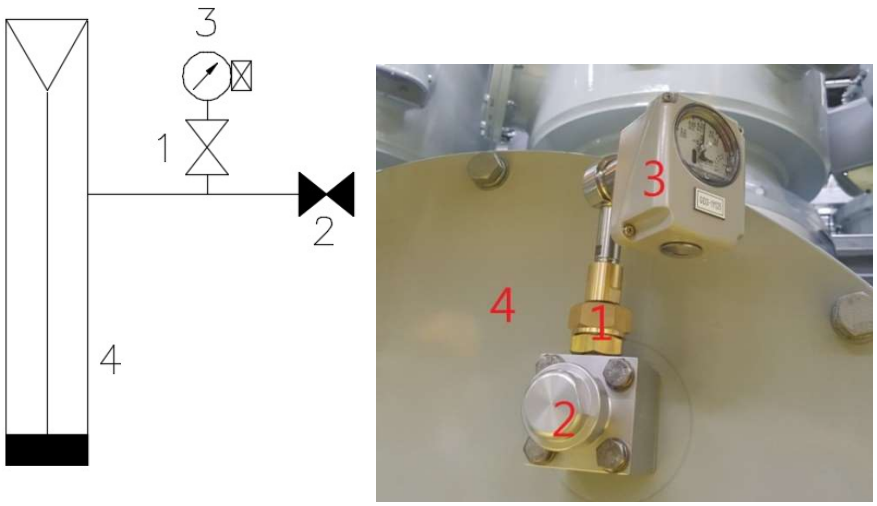


Fig. C1-5 (a) EXAMPLE OF CB GAS PIPING

1) Untie the union of valve (No.1) and pull out GD (gas density monitor, No.3)
2) Connect GD(No.3) to Test Jig and carry out GD calibration Test
3) Re-assemble GD into the valve (No.1) after test

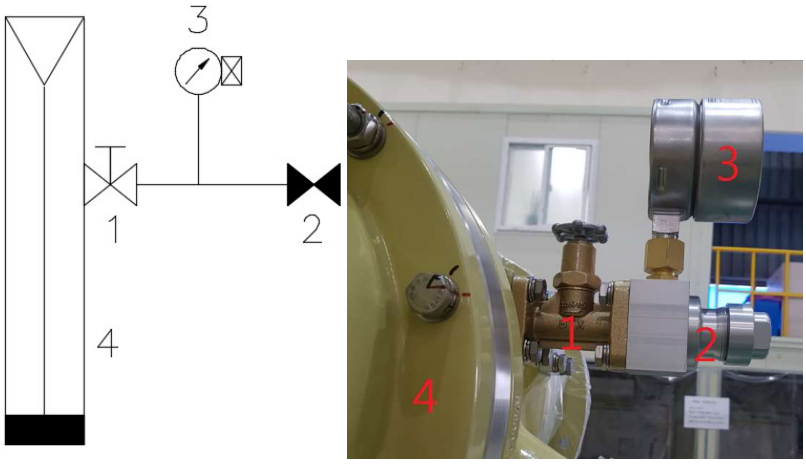


Fig. C1-5 (b) EXAMPLE OF CB GAS PIPING

1) Turn valve (No.1) as much as possible in Close direction
2) Connect Test Jig to valve (No.2)
3) Carry out GD calibration Test
4) Pull out JIG from valve (No.2) after Test
5) Turn valve (No.1) as much as possible in Open direction

1.2.6 Dry – Air

(1) Dry-Air consists of O2, N2, Ar and other impurities in regular operation status, The gas life of the device must be equal or greater than the device life.
Gas composition and management standards must be presented at the time of delivery. The standards for impurities are as follows.

Table 6. Standards for impurities in gas

classification	co	co_2	Total hydrocarbon(THC)	Nitrogen oxides(NOx)	Sulfur oxides(SOx)
Content(ppm)	< 1	< 1	< 1	-	-

(2) Annual gas leakage rate is 0.5% or less, moisture content in gas is 2.6ppmv or less (surrounding environment 0Mpa.G, 20℃) and the condensation point should be below –70℃.

(3) There should be no problem with the device even if O3 gas is temporarily generated during internal arc.

(4) When delivering, mark (paint) the Dry-Air component on the surface of the gas storage container or attach a printed label. It must be identifiable from the outside, and a method for detecting leaks must be provided.

1.2.7 Operation Test of CB

Perform the operation test in accordance with the following procedures.
The standard procedure on operation test items to be check is shown in Table C-13 below.

No.	Procedure	Description	Remarks
1	Construction	1) Check tightening conditions of each part 2) Confirm that tools and foreign substances are not left unremoved in each part	Connecting bolts, Base piping. etc. The interior of control mechanism box and the interior of local control panel etc.
2	Gas pressure check	1) Check the stop valve of gas piping	Check results referring to "Dry air pressure" Normal gas pressure is 5.0 bar.G(72psig) at 20℃
3	Opening and Closing characteristic test Measurement of opening and closing time Measurement	1) Set the operating time measuring instrument for CB 2) Measure the closing time, opening time and the difference between three phase 3) Check the control voltage.	Confirm that measured values are almost equal to those on routine test data.

Table C1-13 CHECK PROCEDURE FOR TEST OPERATION

1.2.8 Resistance Measurement at Earthing Switch

The insulation resistance can be measured at the Earthing switch.
When measuring, operate the Earthing switch in the closed condition.
Remove the earthing bars.
Use the 2500V Megger for the resistance measuring, the earthing bars must be reassembled,
and operate the Earthing switch to make it in the "OPEN" position.



Warning

1. Shut down the power line of main circuit.
2. The test and inspection are allowed to the qualified person ONLY.

1.2.9 Lubrication

Table C1-14 shows lubrication time the kind of lubricating oil.
Avoid using greases not specified in Table C1-14.
Coat grease smoothly by fingers to such an extent that finger prints remain.

Portion	Name of parts	Lubricated time		Kind of lubricating oil	Part No.
		Ordinary inspection	Detail inspection		
Control mechanism box	Operating rod		O	Multemp grease	
	Hook	O	O	Turbine oil	
	Oil		O	Multemp grease	
	Roller		O		
	Link	O	O		
Control mechanism assembly	Oil dashpot	O	O	Oil (Transformer oil)	
	Link, pin	O	O	Multemp gress	
Interrupter assembly	Stationary arcing contact		O	Rubchem	
	Moving arcing contact		O	Rubchem	

Switching Assembly (DS/ES/HES)	Stationary contact		O	Rubchem	
	Moving contact		O	Rubchem	

Table C1-14 LUBRICATION STANDARD

1.2.10 Maintenance Procedure of Gas Circuit Breaker

Safety precaution

• Before attempting to install, operate, inspect and repair, read and understand this manual sufficiently.

• Due to need knowledge of the GIS using safely, Only qualified personnel are authorized to install, operate, inspect and repair

• We will not accept any liability whatever for damage arising either directly or in directly from the incorrect operation of our product.

• The recipient will not without our prior written approval make this document available neither in part nor in whole to any third party or copy it for any purpose other. Be punished for violation as relevant laws and regulations.

• The information in manual can be changed without prior notice.

• This manual indicate basic of GIS. If you need more information or doing operation except this manual, please contact the below address.

• This IOM Manual is written for explain basic instruction. So it is not always corresponding with offered product. If operating is unable or breakdown is occur ;

1. Time of the occurrence of an accident
2. Type disordered condition
3. Mentioned item of plague of abnormal applicant

(Names of goods, type, capacity, manufacture number)



Warning

Before installation, operation, maintenance and inspecting, Read the contents of the instruction manual carefully. And we strongly recommend that you prepare safe instruction and preventive measure.
In this manual, symbols of particular importance are marked as followed,
The symbols are divided into three danger stages and information.

 **DANGER**	Indicates a imminently hazardous situation which, if not avoided, will result in serious injury or death.
 **Warning**	Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.
 **Caution**	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Contains information of particular importance. Additionally, a hazardous situation which may result in equipment malfunction.



DANGER

• Inspection and Assembly/Disassembly work requires basic familiarity with these equipment. Therefore it must be operated by qualified person only. If someone who has scant knowledge operates these equipment, there is a possibility of bodily harm or damage of products.
• Do not touch on busing terminal of high-voltage and live wire. A loss of lives from electrical shock can occur.
• Opening, disassembly and movement of high-pressure container (gas tank, gas pipe, accumulator, hydraulic actuators, and high-pressure pipeline) must be performed after reducing pressure to air pressure. If not, a loss of live can occur from explosion of container.



Warning

• Use replacement part which is offered by Hyosung. If not, it can be damaged to safety of operator and capability of appliance.
• Every time you inject Dry air, Use decompressor (Regulator) and inject slowly with low pressure less than 5MPa·G. If not, it can be damaged to body and instrument by high-pressure of gas container.
• To prevent injuries caused by filling over pressure of gas, KEEP standards recorded in tags.
• To prevent injuries or damage of instruments, DO NOT shock gas pipe, hydraulic pipe, insulator, bushing or HTH.
• To prevent injuries caused by fractions of bushing(Porcelain) that filled gas, Should decrease gas pressure in bushing under 5 bar.G(72psig)
• To prevent injuries caused by breaking of spacers with accidental shock, Should decrease gas pressure of working section under 5 bar.G(72psig) at inside enclosure working.
• To prevent injuries caused by electric shock, Should disconnect by opening DS, and ground by making ES at inside enclosure working.
• In case of GIS is under operation or current is isolated, GIS gas should exhaust after neutralization at the surface on the earth level in opened conditions



Caution

• Check the ground condition before applying main circuit. If ground wire and ground bond is leave out, there is a possibility of a shock and it can adversely affect the proper functioning of this instrument.
• When checking up the operating part of breaker, Inspector has to carry out an inspection after remove all of oil pressure by using stop-valve. (Oil pressure should be 0 bar.G) When inspects from the condition where the if oil pressure becomes filling, there is a possibility of injury with the physical contact which is accidental
• Operational angle, length and gap etc. of link, lever and hook of breaker electronic hook organization does not regulated with option. If do regulate with option there is a possibility of accidental occurrence operation of the breaker.
• When operate in manual operation by using Shutter open button for Motor-spring operator, relationship without interlock condition is possible. Therefore, please make sure interlock condition with other instrument before operation
• Do not open the secondary circuit of the BCT (Bushing Current Transformer). If the secondary circuit is opened, operator may have injury because of the electric shock.
• Do not approach or touch Link and Lever which is connected to operating mechanism, while the GIS equipment is being operated. If not avoided, could result in moderate injury
• When the main body pulling up, certainly confirm a weight which is marked on the plate and use the proper rope and method. If it is not like that the equipment could be damaged which is caused by falling and dropping.

▪ PREPARATION

- Before disassembling the above equipment, be sure to carry out the following procedure.

1. Confirm that the above equipment concerned are de-energized (CB : Open).
2. Cut off the power source of the control cable connected to the CB.
3. Disconnect the power cable.
4. Evacuate SF6 gas from the gas compartments of CB and connected equipment.

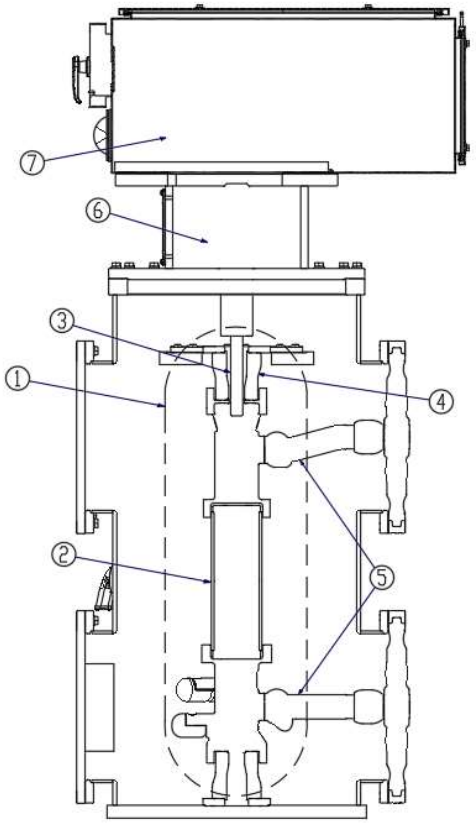


FIG. C1-6 STRUCTURE OF CIRCUIT BREAKE

No	DESCRIPTION
1	INTERRUPTER ASSEMBLY
2	VACCUM INTERRUPTER
3	INSULATED OPERATING ROD
4	INSULATION SUPPORT
5	CONDUCTOR
6	CONTROL ASSEMBLY
7	OPERATING MECHANISM BOX

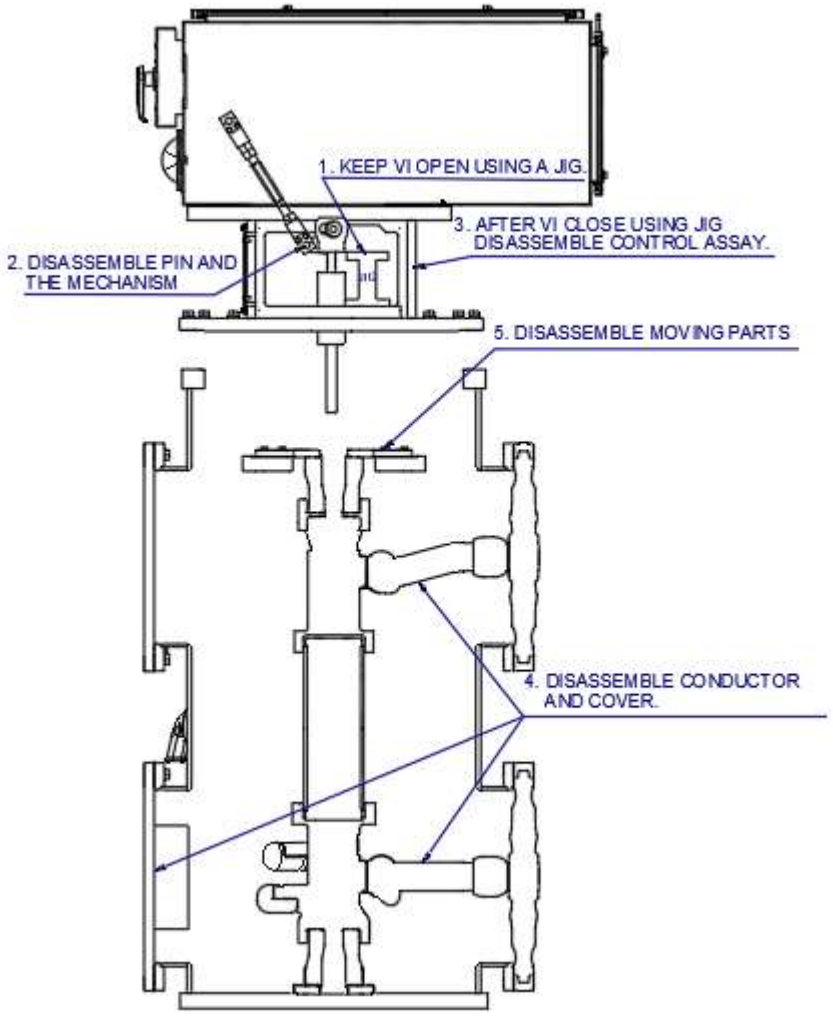


FIG. C1-7 PROCEDURE OF DISASSEMBLY OF CIRCUIT BREAKER

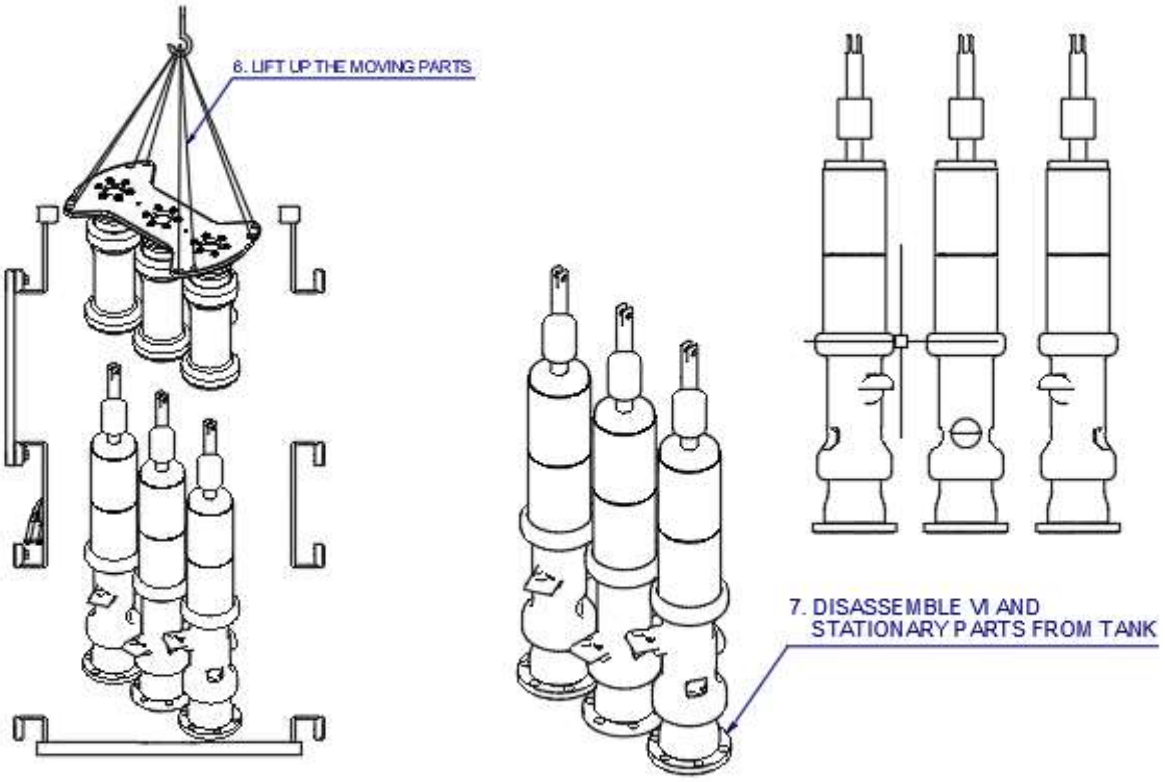
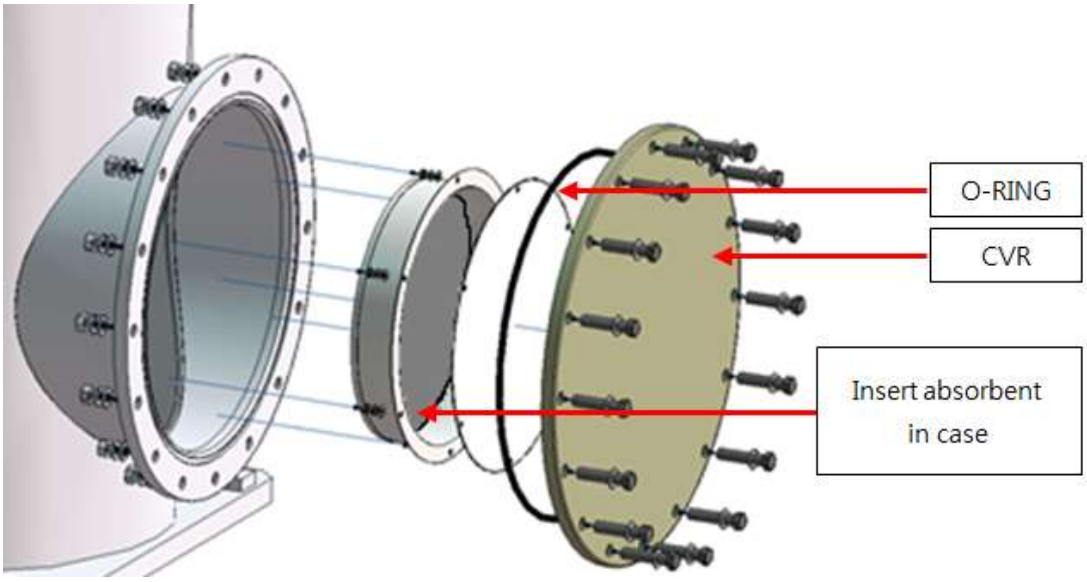
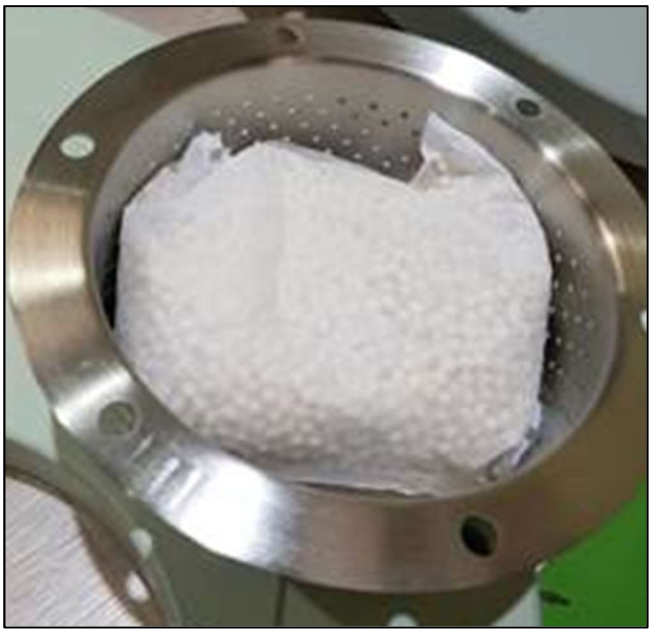


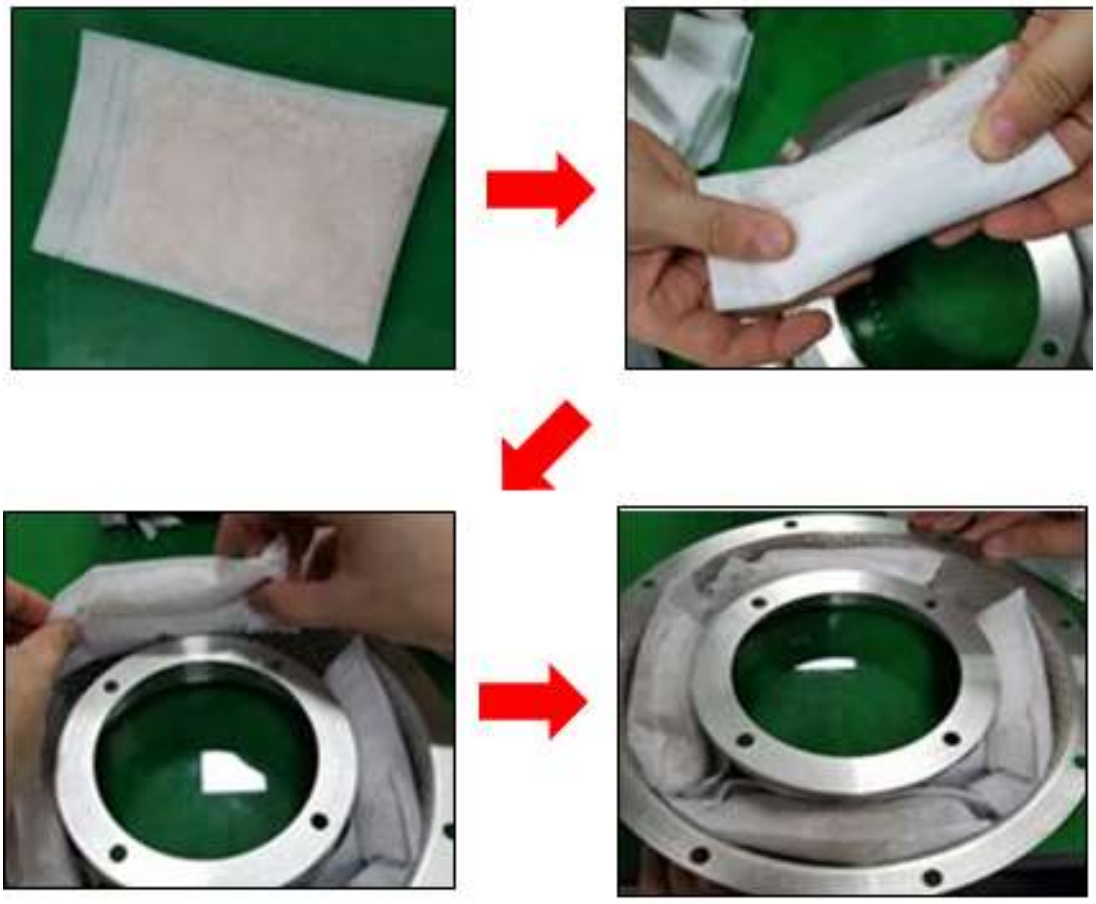
FIG. C1-8 PROCEDURE OF DISASSEMBLY OF INTERRUPTER



(1) Absorbent attached in Cover Plate



(2) Absorbent attached in Pressure Relief Device



(3) Caution for replacing absorbent

- 200 g of absorbent is suitable for Plain Cover.
- 70 g of absorbent is suitable for Pressure Relief Device
- Alcohol and vacuum cleaning should be carry out so that there is no foreign substance in cover, mounting surface and absorbent case

Fig. C1-8 PROCEDURE OF CHANGING ABSORBENT

	1/16" Pellets	1/8" Pellets	TRISIV™ Pellets	8x12 Beads	6x8 Beads	4x8 Beads
Bulk density (lbs/ft³)	38	38	36	40	40	40
Particle diameter (mm)	1.6	3.2	3.2	2.0	3.0	4.0
Crush strength (lbs)	7	15	15	8	12	18
Equilibrium CO_2 capacity(1) (wt-%)	18.5	18.5	18.5	18.5	18.5	18.5
Equilibrium H_2O capacity(2) (wt-%)	27	27	27	27	27	27
Water content, as shipped (wt-%)	<1	<1	<1	<1	<1	<1

(1) Measured at 250 mm Hg and 25 °C
(2) Measured at 17.5 mm Hg and 25 °C

Fig. C1-9 SPECIFICATION OF ABSORBENT

▪ CHANGE AND ASSEMBLE GCB

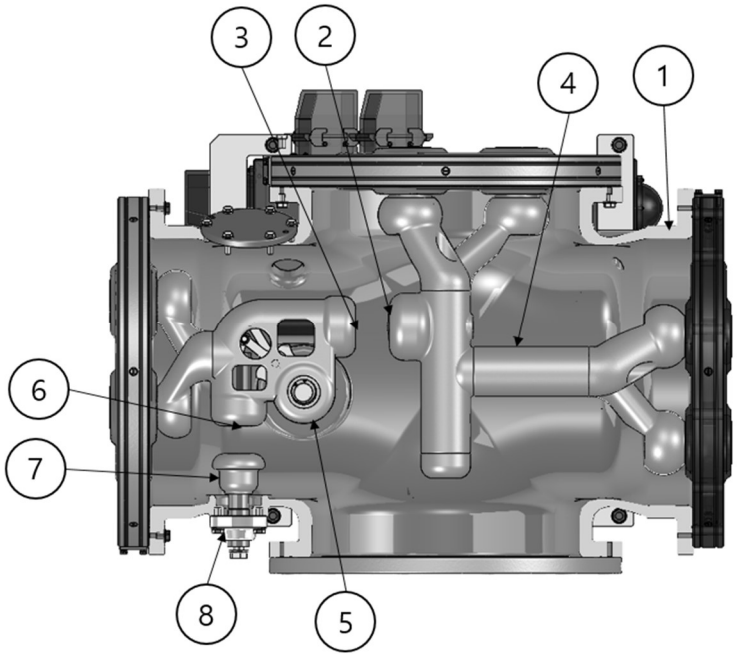
1. Change the Arcing contact, Cover, Nozzle, Spring and Main contact as Table C1-7 CONTACT INSPECTION CRITERIA.
2. Assemble Interrupter of GCB in reverse procedure of disassembly.

1.2.11 Maintenance Procedure of DS&ES

▪ PREPARATION

- Before maintenance the above equipment, be sure to carry out the following procedure.

1. Confirm that the above equipment concerned are de-energized (DS: Open, ES : Closed).
2. Cut off the power source of the control cable connected to the DS & ES.
3. Disconnect the power cable.
4. Evacuate DRY AIR gas from the gas compartments of DS & ES and connected equipment.
5. Following procedure is assembling procedure.



No.	DESCRIPTION
1	ENCLOSURE
2	CONTACT
3	MOVING CONDUCTOR
4	CONDUCTOR
5	OPERATION LINK MECHANISM
6	MOVING CONDUCTOR
7	CONTACT
8	INSULATOR BUSHING

Fig. C1-10 STRUCTURE OF DS & ES.

▪ ASSEMBLE 3PDS TANK AND OPERATION MECHANISM.

1. Assemble the fixed conductor to moving conductor tank.
2. Attach the mechanism box to 3PDS tank.
3. Disassemble 3PDS in reverse procedure of disassembly
4. Change the contact and shield on disassembly procedure.

1.2.12 Maintenance Procedure of others

1. Confirm that the above equipment concerned are de-energized
   (CB: Open, DS: Open, ES : Closed).
2. Cut off the power source of the control cable connected to the CB, DS & ES for maintenance section.
3. Disconnect the power cable.
4. Evacuate DRY AIR gas from the gas compartments of DS & ES and connected equipment.
5. Loose the bolt both side enclosure for maintenance.
6. Change the contact and clean the inside of enclosure.
7. Connect the enclosure to another enclosure.

1.2.13 Checking procedure for gas system

1. Connect the inlet valve of measuring instrument to GIS gas valve.
2. Measure moisture content through outlet valve of measuring instrument.
3. Standard of moisture content

- Section of CB : more than -13℃
- Others : more than -8℃
- Graph shows dew point and moisture content for DRY AIR Gas

Graph Dew point vs. pressure and moisture content for DRY AIR

4. Testing equipment (DILO or Parametric: Dew point meter)

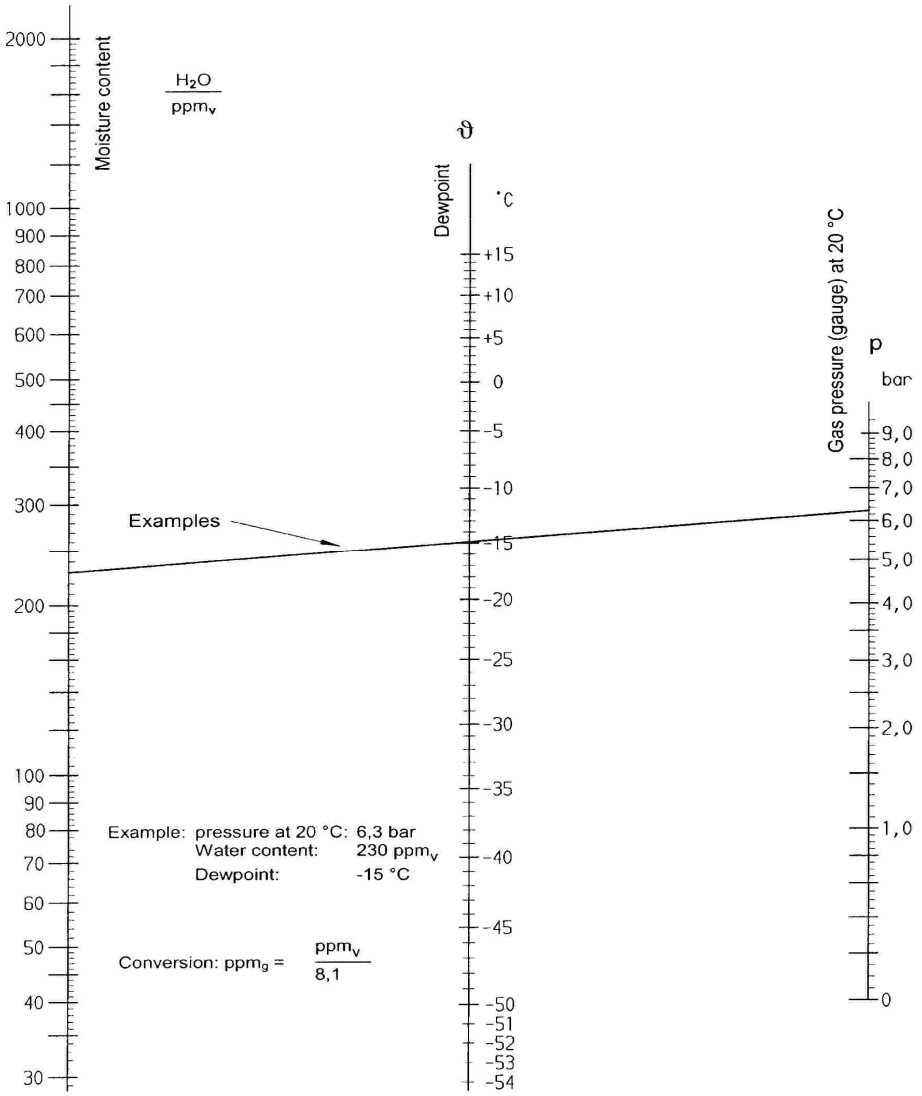




Fig. C1-23 Testing Equipment (MULTI ANALYZER)

1.2.14 Earthing system

1. Earthing system for LCC

1) Earthing between body and door for LCC

- Bolt the 22SQ cable in LCC as below Fig. C1-25.



Fig. C1-25 Earthing between body and door for LCC

2) Main earthing for LCC

- Install the Earthing plate as below Fig. C1-25
- Specification of earthing plate

a) The both side of LCC : TWL 5 X 30 X 370

b) The back side of LCC

- TR, UG, B/C BAY : TWL 5 X 30 X 560
- B/S BAY : TWL 5 X 30 X 810
- Connect the main earthing cable

: The LCC have earthing terminal of 4type (100SQ, 150SQ, 180SQ, 200SQ)

: Select the earthing terminal as earting cable specification

: Connect the earthing cable to the earthing terminal.

2. Earthing system for Cable sealing end

1) Earthing between cable sealing end and base as below Fig. C1-26

- Bolt the earthing bond on earthing seat.
- Specification of earthing bond : TWL 5 X 50 X 373
- Specification of earthing seat : TWL 22 X 55 X 55

2) Main earthing for cable sealing end as below Fig. C1-26

- connected electrical continuously by aluminum flange of spacer, as below Fig. C1-27

2. Earthing system for main body

1) Earthing for bus.

- All Enclosure of components is connected electrical continuously by aluminum flange of spacer, as below Fig. C1-27

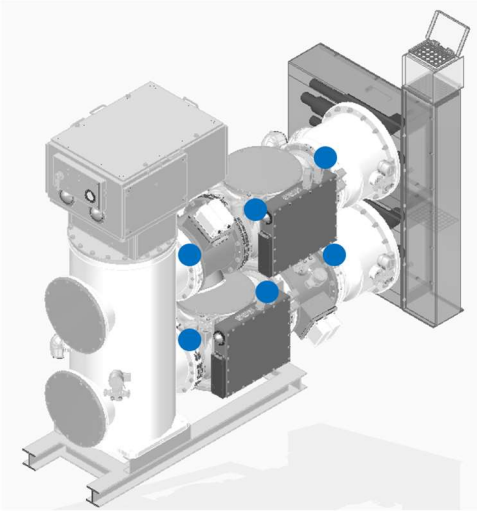
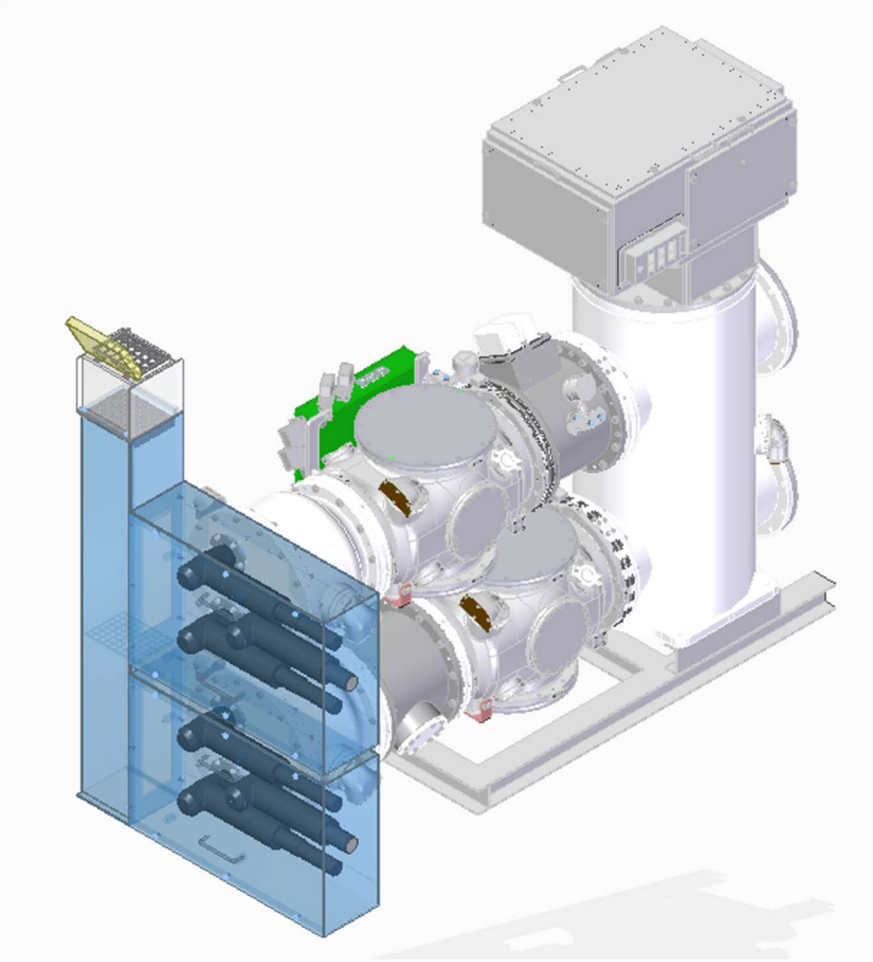


Fig. C1-27 Earthing system for main body

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PART C-2 FAULT DIAGNOSIS



CONTENTS

1. FAULT DIAGNOSIS....3
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1.3 SURGE ARRESTER....10
1.1.1 MEASUREMENT OF LEAKAGE CURRENT....10
1.1.2 HANDLING AND NOTICE....10

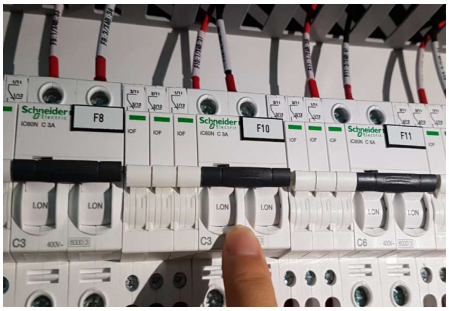
1. FAULT DIAGNOSIS

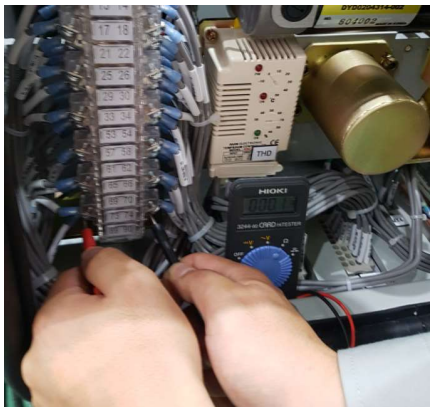
Most of the possible faults on the GIS equipment will be detected by the various detection devices and indicated on the fault indicators installed in the local control panel.

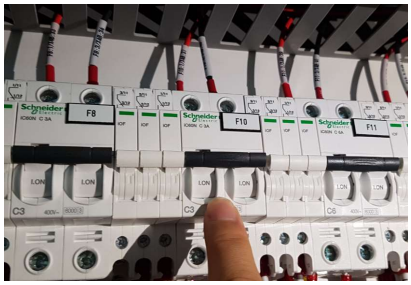
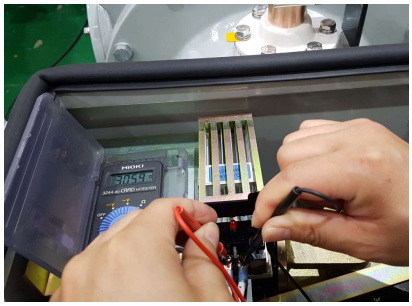
The following table, Table C2-1 will give more detailed description concerning the fault diagnosis for reference, in case of abnormal phenomena.

1.1 CIRCUIT BREAKER

Table C2-1 FAULT DIAGNOSIS FOR CB

Phenomenon	Cause	Counter measure
Spring in operating mechanism is not charged automatically	1. MCB* tripped 2. Supply voltage lacking 3. Motor defective	1. Switch the MCB* on  2. Secure the supply voltage 3. Check the motor resist and compare with others, 1) DC 125V: 3.2 Ω ± 15% at 20 ℃ 2) DC 220V: 5.1 Ω ± 15% at 20 ℃ If abnormal, replace the motor 

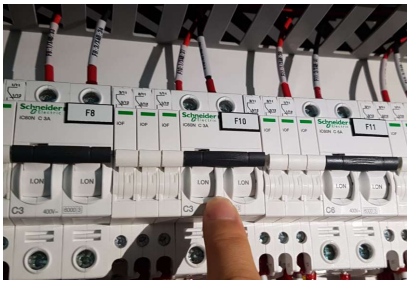
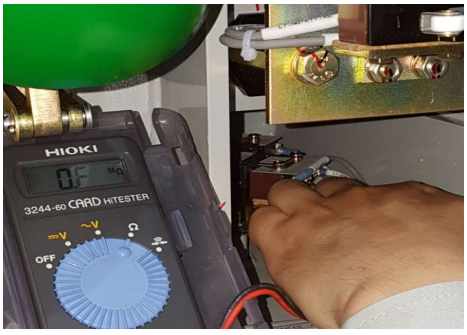
Operating mechanism does not trip or close	1. Control voltage lacking 2. Coil defective 3. Auxiliary switch does not transmit the Command	1. Secure the control voltage 2. Check the coil resist and compare with others, if abnormal, replace the coil. 1) DC 125V - TRIP COIL: 30.7 Ω ± 5% at 20 ℃ - CLOSE COIL: 36.5 Ω ± 5% at 20 ℃ 2) DC 220V - TRIP COIL: 96.4 Ω ± 5% at 20 ℃ - CLOSE COIL: 112.2 Ω ± 5% at 20 ℃  3. Check the auxiliary switch by using buzzer Test. If not, replace the auxiliary switch **Contact Rating of Aux. Switch is 4.4A @ 125Vdc** 

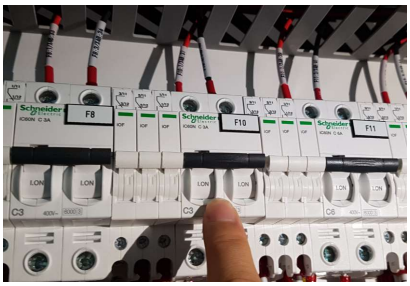
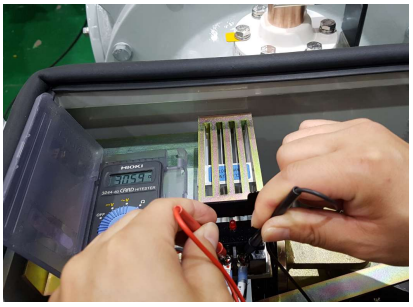
Corrosion in the operating mechanism housing	1. MCB* tripped 2. Voltage lacking 3. Heater defective 4. Moisture Impregnation	1. Switch the MCB* on  2. Secure the voltage 3. Check the heater resistance and compare with below values. If abnormal, replace the Heater. 1) AC 220V: 484 Ω ± 10% at 20 ℃ 2) AC 230V: 529 Ω ± 10% at 20 ℃ 3) AC 240V: 576 Ω ± 10% at 20 ℃  4. Check the seals of the operating mechanism

Circuit breaker is locked	1. Dry air leakage 2. GD is defective	1. Check leakage rate comparing with Gas System Diagram and if less than rate pressure, - Fill gas - Check for faulty seals and replace it if abnormal  2. Check that the dial point is normal position. If dial point is normal, the possibility of a GD defect exists. Check the GD by using a buzzer Test and if abnormal, replace the GD 

1.2 DISCONNECTOR, EARTHING SWITCH AND HIGH SPEED EARTHING SWITCH

Table C2-2 FAULT DIAGNOSIS FOR DS, ES and HES

Phenomenon	Cause	Counter measure
Operating mechanism not Running	1. MCB* tripped 2. Supply voltage lacking 3. Motor defect 4. Limit switch defect	1. Switch on MCB*  2. Secure supply voltage 3. Check the motor resistance and compare with others, if abnormal, replace the motor 1) 3PDS - DC 125V : 1.85 Ω ± 15% at 20 ℃ - DC 220V : 5.6 Ω ± 15% at 20 ℃ 2) HES - DC 125V : 9.5 Ω ± 15% at 20 ℃ - DC 220V : 34 Ω ± 15% at 20 ℃  4. Check the limit S/W by using buzzer Test. If defective, replace the limit switch 

Corrosion in the operating mechanism housing	1. MCB* tripped 2. Voltage lacking 3. Heater defective 4. Moisture Impregnation	1. Switch the MCB* on  2. Secure the voltage 3. Check the heater resistance and if the value cannot be in this range, replace the Heater 1) AC220, 230, 240V: 270 ~ 370 Ω at 20℃  4. Check the seals of the operating mechanism

1.3 VOLTAGE TRANSFORMER, SURGR ARRESTER AND OTHERS

Table C2-3 FAULT DIAGNOSIS FOR VT, SA and OTHERS

Phenomenon	Cause	Counter measure
Low dry air-pressure	1. Dry air gas leakage	1. Check flange seals by using gas leakage detector  Check leakage rate comparing with Gas System Diagram and if less than rate pressure, - Fill gas - Check for faulty seals and replace it if abnormal

※If phenomenon remains, please follow Appendix A

1.4 SURGR ARRESTER

1.4.1 Measurement of leakage current

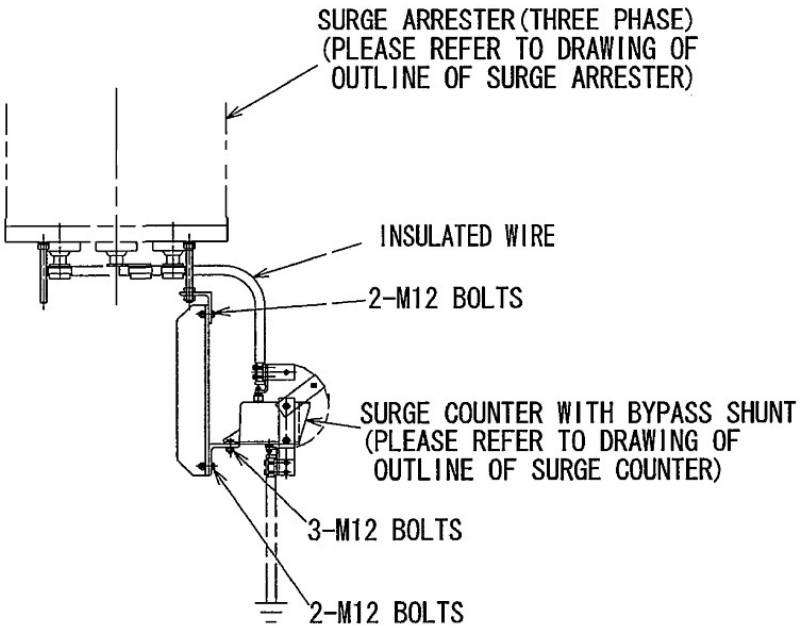
Total leakage current measurement test

The leakage current of a surge arrester can be measured while energized; being the most convenient maintenance test method.

Unexpected high leakage current might cause arrester thermal runaway.

It is the most useful to periodically measure the leakage current of the arrester under the normal operating voltage in order to check the soundness of the arrester.

When the leakage current value is 50~130% of the initial leakage current value measured at initial inspection after energization, the surge arrester is in good condition.



If a measurement cannot be made on the surge counter, please check the earth insulated wire is within 2.5m. in length. If there are differences on leak current values between phases, please contact to Hyosung Engineering Department.

1.4.2 Handling and Notice

The earth lead wire should be kept a distance more than 10 mm from the nearby-grounded structures to avoid flashover from the earth wire to the grounded structure.

Please install the surge counter to be within the limit of ±45 degrees to horizontal using attached bolt and nut (M12x20).

Don't disassemble the moisture-proof housing to prevent moisture from coming in the surge counter, and do not apply excess force and impact to the housing.

To cheek the operational characteristics of the counter on site, please charge up an additional condenser (2~4ùF) by means of a 1000V megger and connect it to both terminals across the surge counter. This method will confirm whether the surge counter is in good condition or not. Type "SDC-N4©" and "SDC-N4©" surge counters don't have set and reset-buttons, so keep a record of the number of operations before and after the check.

The relay box must be installed nearly horizontal. The Surge counter and relay box shall be connected. The earth terminal if the relay box (G terminal box) shall be connected to earth using wire.

The transformer tap shall be chosen according to the source voltage.

The wire connection procedure to the terminal box of the relay box is as follows.

(1) Remove the front cover by loosening the hexagon bolts (M6).

(2) Cut the rubber bushing in a cross-shape to make wire inlet hole, then lead the wires through the hole.

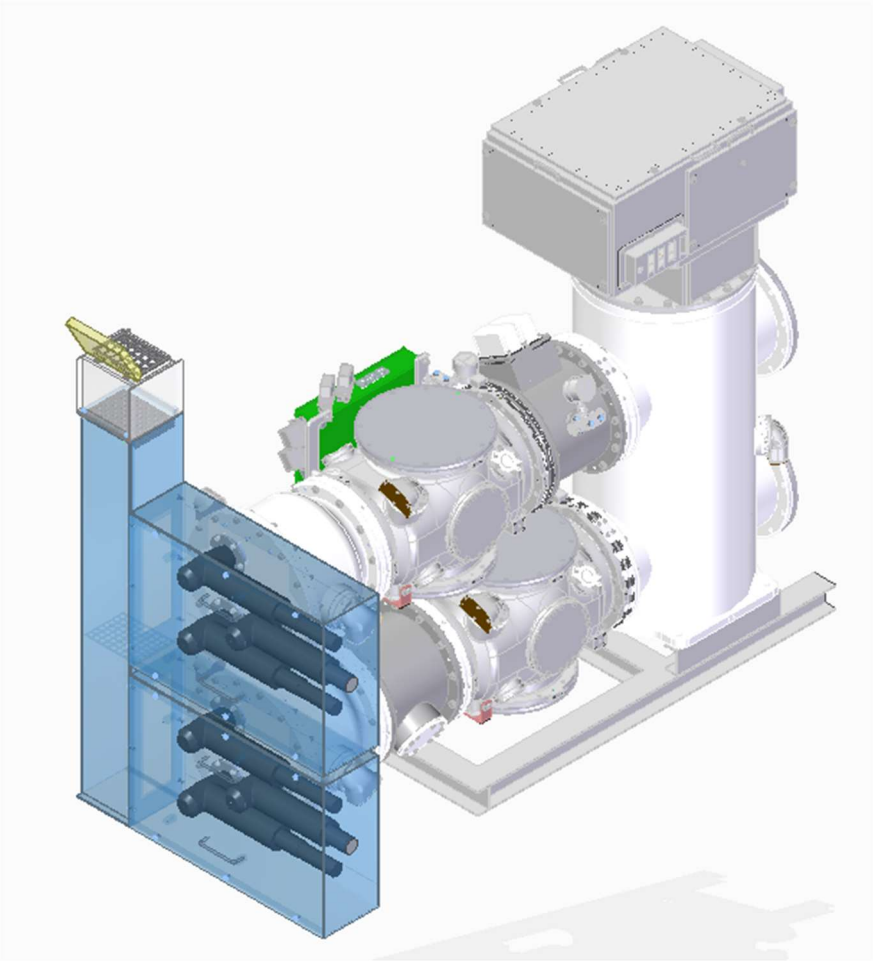
(3) Connect the wires on the terminals in accordance with the numbers

(4) Set the front cover as it was.

The wires will be connected to the surge counter after the terminal covers are removed.

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PART D-1. APPENDIX A. HOW TO ORDER



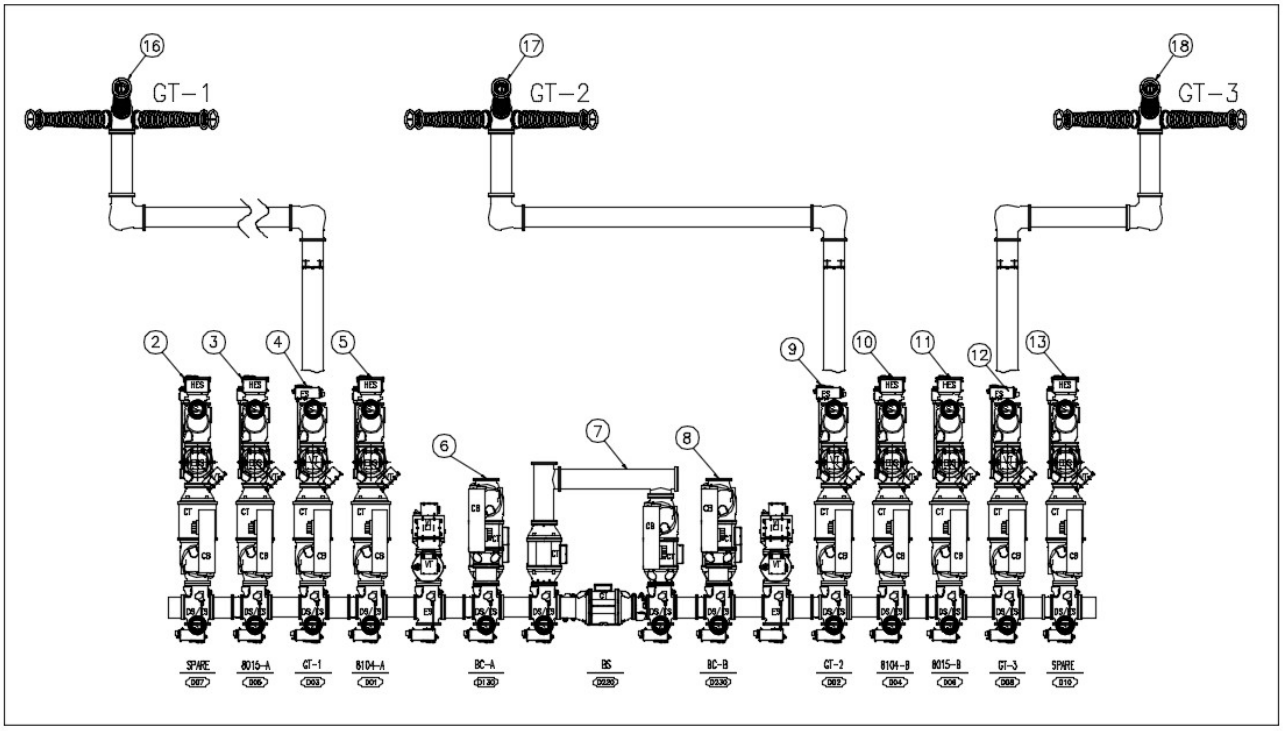
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A.1 Check of necessary equipment's location 3
A.2 Filling out Purchasing Order Form (POF) 4
A.3 Contact Hyosung 5

Appendix A. How to order

A.1 Check of necessary equipment's location

Please check necessary equipment's location through below drawing and inform us number of feeder



No.	Project No.	Item Code	Bay Description	Assembly No.
2	10079272_002	HYA01020003945	E07_TL Feeder	DYA0230041H001
3	10079272_003	HYA01020003946	E05_TL Feeder	DYA0230041H001
4	10079272_004	HYA01020003947	E03_TR Feeder	DYA0230040H001
5	10079272_005	HYA01020003948	E01_TL Feeder	DYA0230041H001
6	10079272_006	HYA01020003949	E130_Bus Coupler-A	DYA0230181H001
7	10079272_007	HYA01020003950	E220_Bus Section	DYA0230182H001
8	10079272_008	HYA01020003951	E230_Bus Coupler-B	DYA0230181H001
9	10079272_009	HYA01020003952	E02_TR Feeder	DYA0230040H001
10	10079272_010	HYA01020003953	E04_TL Feeder	DYA0230041H001
11	10079272_011	HYA01020003954	E06_TL Feeder	DYA0230041H001
12	10079272_012	HYA01020003955	E08_TR Feeder	DYA0230040H001
13	10079272_013	HYA01020003956	E10_TL Feeder	DYA0230041H001
14	10079272_014	HYA03020000924	Busbar System-1	DYA0230183H001

15	10079272_015	HYA03020000925	Busbar System-2	DYA0230184H001
16	10079272_016	HYA03020000926	GIB Grid_T1	DYA0230329H001
17	10079272_017	HYA03020000927	GIB Grid_T2	DYA0230330H001
18	10079272_018	HYA03020000928	GIB Grid_T3	DYA0230331H001

A.2 Filling out Purchasing Order Form (POF)

1. Site (Substation) name (If possible, please describe serial no. on name plate)	
2. Installation period (Commissioning period)	
3. Detail phenomenon regarding necessary equipment (ex. Purchasing of spare CB, Loss of manual handle, etc.)	
4. Contact point information of customer (ex. Email address, Telephone number, etc.)	

A.3 Contact Hyosung

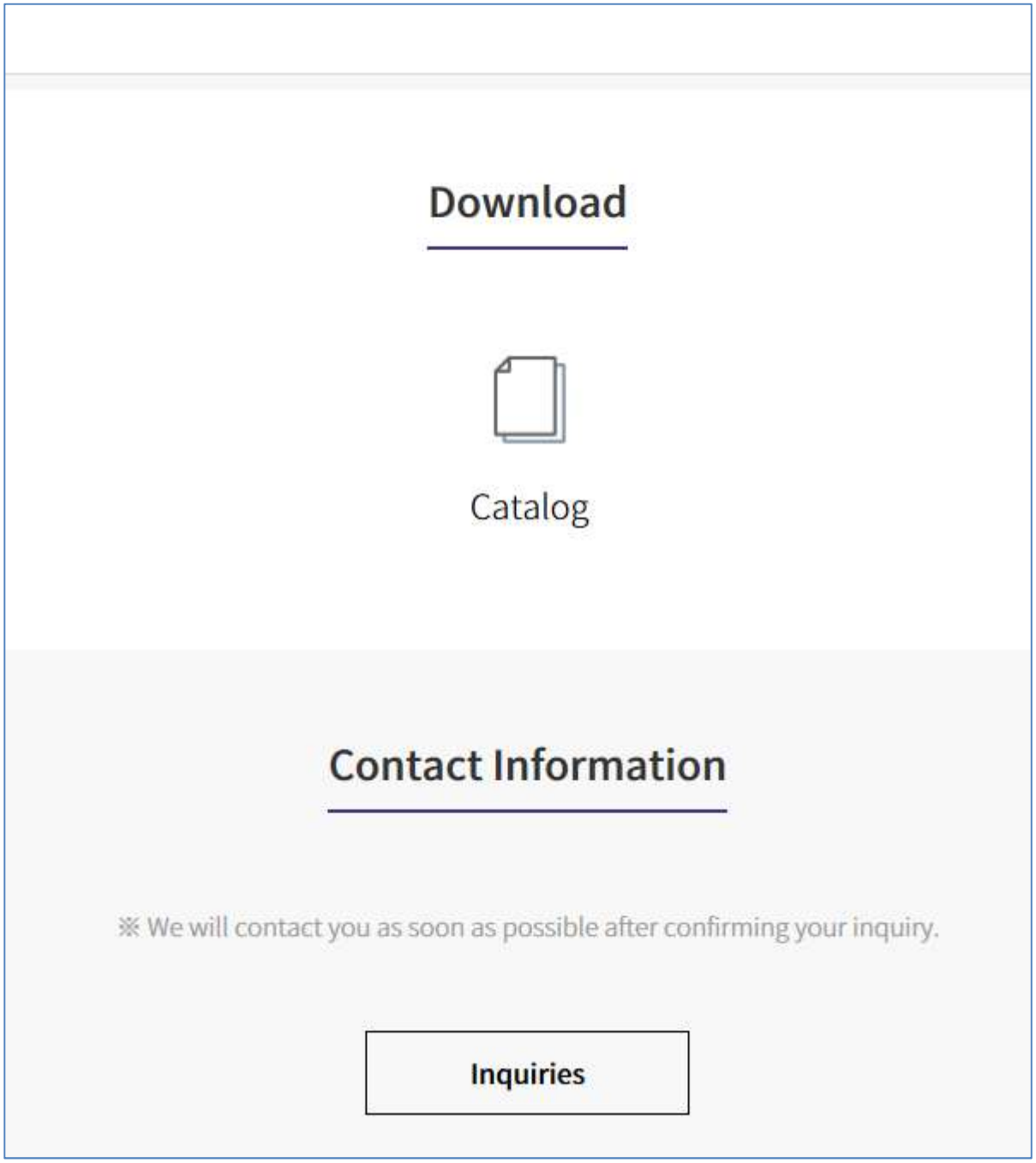
A.3.1 Please connect to Internet homepage

'http://www.hyosungheavyindustries.com/en/business/high_voltage_switch_gear.do'

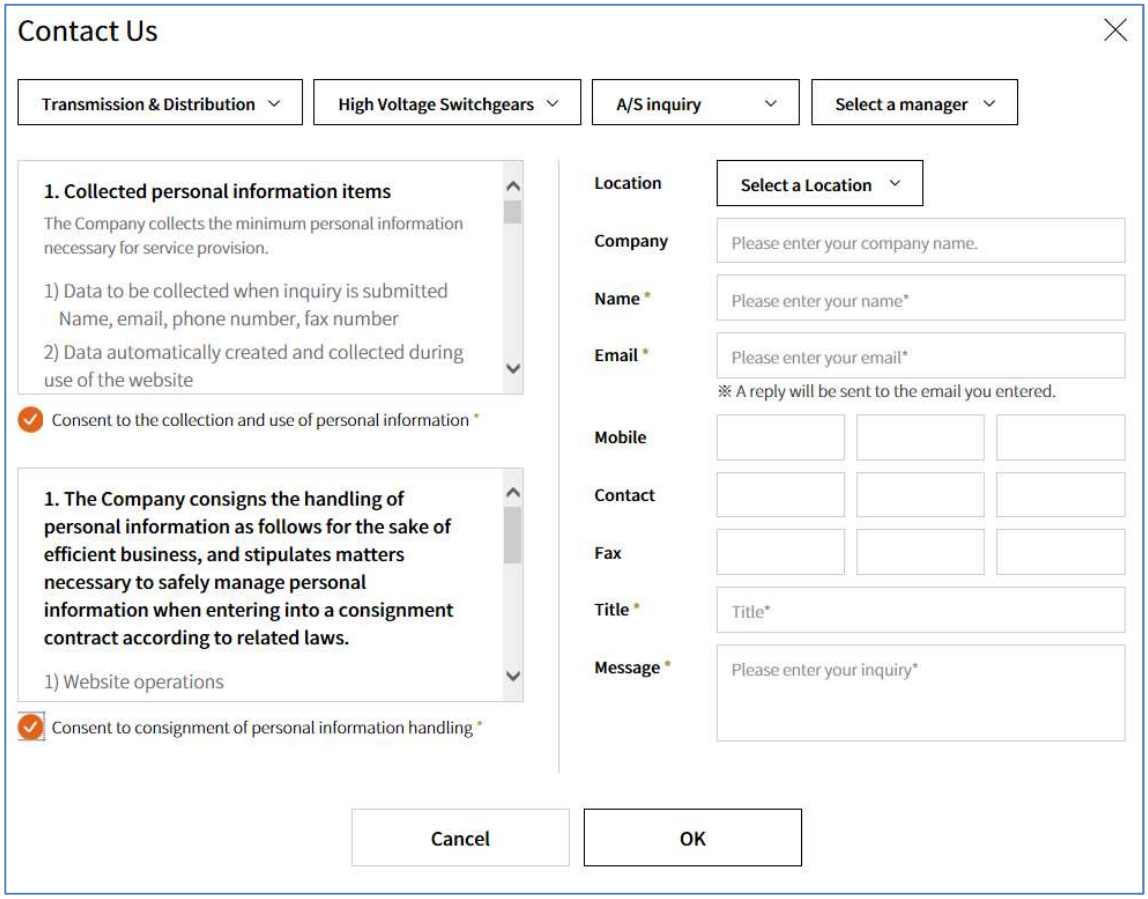
(Or call to '82-02-707-7000')



A3.2 Please find ‘Inquiries’ menu in below.



A3.3 Please fill out the form.



A3.4 Please send the contact point the written POF.

A3.5 Hyosung's external branch

Continent	Nation	Contact number
Asia	CHINA	Hyosung Corporation Beijing Office Tel – 86-10-6512-9692 Hyosung Corporation Guangzhou Office Tel – 86-20-3765-7458 Hyosung Corporation Shangai Office Tel – 86-21-6209-0123
Asia	HONG KONG	Hyosung International(HK) Ltd. Tel - 852-2845-6778
Asia	INDIA	Hyosung Corporation India Pvt. Ltd. Tel – 91-124-4012255/3255 Hyosung T&D India Pvt. Ltd. Tel - 91-72-1900-1831
Asia	IRAN	Hyosung Tehran Office Tel – 98-21-22042489
Asia	JAPAN	Hyosung Japan Tel - 81-3-3432-1005
Asia	MALAYSIA	Hyosung Corporation Kuala Lumpur Office Tel - 60-3-2031-2416
Asia	MYANMAR	Hyosung Corporation Yangon Representative office Tel - 95-1-660927,707915
Asia	PHILIPPINES	Hyosung Corporation Manila Office Tel - 632-848-6204
Asia	QATAR	Hyosung Corporation Qatar office Tel - 974-4432-6137
Asia	SAUDI ARABIA	Hyosung Corporation Saudi Arabia office Tel - 966-11-473-5480

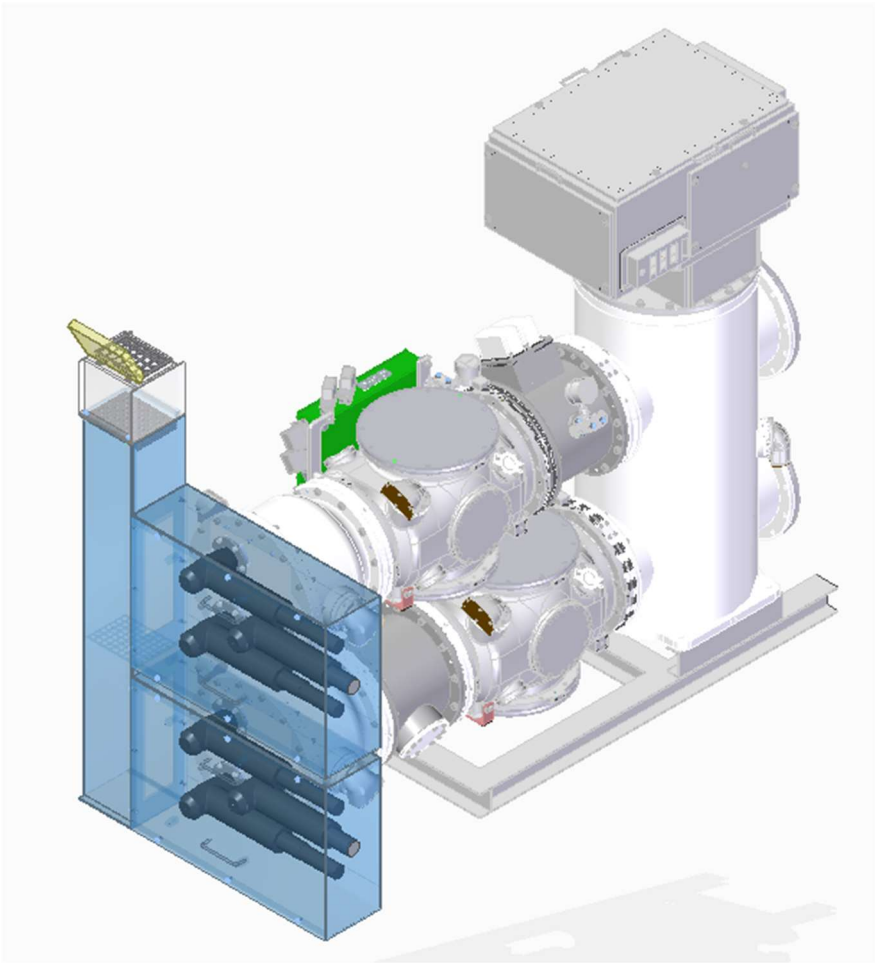
Asia	SINGAPORE	Hyosung Singapore Pte .Ltd Tel - 65-6337-2079
Asia	TAIWAN	Hyosung Corporation Tel – 886-2-2758-4636
Asia	THAILAND	Hyosung Corporation Bangkok office Tel - 66-2-653-2031~3
Asia	U.A.E	Hyosung Corporation Dubai office Tel - 971-4-221-8483
Asia	VIETNAM	Hyosung Vietnam Co., Ltd. Tel - 84-251-3566-000 Hyosung Corporation Hochiminh office Tel - 84-28-3825-1617
Europe	GERMANY	Hyosung Corporation Frankfurt Office Tel – 49-6172-85532-20
Europe	ITALY	Hyosung Europe S.R.L Tel - 39-02-9886-251
Europe	RUSSIA	Hyosung Corporation Moscow office Tel - 7-495-956-5172
Europe	SPAIN	Hyosung Corporation Barcelona Office Tel - 34-93-430-7735
Europe	UK	Hyosung Corporation Manchester Office Tel - 44-161-026-9559
Europe	TURKEY	Hyosung Corporation Istanbul Office Tel - 90-212-284-1601
Africa	SOUTH AFRICA	Hyosung South Africa Ltd. Tel – 27-(0)11-883-0896

North America	USA	Hyosung USA, Inc.(Headquarter) Tel - 1-704-790-6100 Hyosung USA, Inc. (Decatur Plant) Tel - 1-26-340-2215 Hyosung USA, Inc. (L.A. Office) Tel - 1-714-989-8900 HICO America Sales and Technology. Inc. Tel - 1-412-787-1170
Latin America	BRAZIL	Hyosung Do Brasil Ltda. Tel-55-11-3284-6466 Hyosung Brasil Industria E Comercio De Fibras Ltda Tel-55-47-3025-9610
Latin America	MEXICO	Hyosung Corporation Oficina de Mexico Tel-52-55-5250-2790
Latin America	PANAMA	Hyosung Corporation Panama Office Tel – 507-214-8968

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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PART D-2. INSTRUCTION – GIS DISPOSAL AFTER LIFE CYCLE



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1.2 Warning Signs....3
1.3 General Safety....4
1.4 Specific Safety....4
2.1 Disposal process – gas and lubricant....5
2.2 Disposal process – internal part of GIS....5

1.1 Introduction

These instructions to inform how Hyosung GIS to be disposed after its own life cycle.

Note: These instructions do not subject to cover all details work procedure for disposal of GIS. In case technical support is required from Hyosung, users to contact to Hyosung HV GIS engineering.

1.2 Warning Signs

Throughout this Instruction, warning signs are used to emphasize instructions and information that should be very carefully observed.



Danger

Danger indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.



Warning

Warning indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.



Caution

Caution indicates a hazardous situation that, if not avoided, may result in minor or moderate injury.

Notice

Notice indicates hazards that may result in property damage only.

Important

Important indicates an operational tip or maintenance suggestion.

1.3 General Safety



Danger

All personnel associated with the disposal of the GIS should be thoroughly instructed and supervised on de-energizing and de-gassing.

Safety programs should also take into account the local environment and GIS application, including such variables as ambient temperatures, actual continuous current, number of operations, type of interrupting duty, and any unusual local condition, such as a corrosive atmosphere or major insect problems.

Important

The network function can be used when the Network Interface option is installed.

1.4 Specific Safety



Danger

Do not work on an energized GIS. If work must be performed on the GIS, take it out of service, open the disconnect switches at each side of the GIS, then close the GIS and ground each phase.

Do not work on any part of the de-energized GIS until all control power has been disconnected.

Do not disassemble any portion of the gas system of any GIS until system pressure has been reduced to zero psig (0 psig) by opening the appropriate drain valves. When the gas pressure has been reduced to zero, cautiously remove covers, tubes, fittings, and other parts.

Important

This GIS is spring open and spring closed. Always ensure that *both* springs are discharged before working on the GIS.

2.1 Disposal process – gas and lubricant

After GIS is de-energized, degassing and removing lubricant on external GIS to proceed. Disassembly, removing lubricant internal GIS and absorbent filter is next step to do.

Material	Spot to work	Approx. Weight
Lubricant - external	On flange of GIS connection, Each mechanism gear part	7kg / 1 bay of GIS
Lubricant - internal	On surface of each oring groove	5kg / 1 bay of GIS
Absorbent filter	Each Gas section of GIS	15kg / 1 bay of GIS

Notice

Weight of each kind of material is variable up to configuration of each GIS bay

All the materials to be disposed separated as far as possible.

2.2 Disposal process – internal part of GIS

After GIS step 2.1 above, internal GIS part to be disassembled and separated. Removing internal lubricant and absorbent filter may proceed with this work.

Material	Spot to work	Approx. Weight
Rubber – Industrial waste	Each sealing groove and selected moving part	12kg / 1 bay of GIS
Aluminum - recycling	GIS enclosure, conductor	2550kg / 1 bay of GIS
Iron steel - recycling	GIS cover on enclosure	120kg / 1 bay of GIS
Copper - recycling	On surface of each oring groove	60kg / 1 bay of GIS
Epoxy - Industrial waste	Each GIS compartment	200kg / 1 bay of GIS
Electric device (Motor, Contactor, Terminal block, wire etc.) - Industrial waste or recycling	Each GIS mechanism, CT/VT terminal box and LCC.	140kg / 1 bay of GIS

Notice

Weight of each kind of material is variable up to configuration of each GIS bay

All the materials to be disposed separated as far as possible.

When disposal of GIS is required at site, the instruction may need to be revised or support from GIS manufacturer may be needed. Local service office of Hyosung will provide technical support if required.

End of Instruction