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Power & Industrial Systems Performance Group

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Gas Insulated Switchgear
Hyosung Power Systems has been continuously enhancing customer’s value since it started its operations in 1962. With core values focused on customer-oriented management, technological innovation and reliable quality, Hyosung Power Systems has built strong customer relationships based on trust and respect over the years. It promises to continue its quest to provide value-added products that enhances industrial productivity while conserving both energy and environment for clients all over the world.

Hyosung Power Systems strives to enhance the lives of people all over the world while conserving earth’s natural resources. With the goal to become a Leading Global Energy Solution Provider, Hyosung will pave the way towards next-generation technology and green energy solutions.
General

Hyosung designs and manufactures a wide variety of SF₆ Gas-Insulated Switchgear (GIS) systems to satisfy customers’ specific substation requirements. Hyosung believes in giving you the highest quality system at a reasonable price. Hyosung’s units are currently installed in urbanized areas and built near industrial areas, including underground power substations in large commercial buildings, switchyards of power plants and new or expanding substations. Hyosung prides itself on the ability to design and manufacture GIS that is 100% compatible with your exact specifications. Hyosung designs and constructs a wide variety of high voltage SF₆ GIS ranging from 25.8kV units to 800kV units, with short circuit ratings up to 63kA. All of Hyosung’s equipments comply with IEC, ANSI, IEEE and other international standards and it has shipped customers around the world.

Special Features

- **High Reliability**
  Features enhanced insulation properties and reduced long-term operational costs by means of sealed metal enclosure filled with SF₆ gas assuring first-rate reliability.

- **Compact Design**
  Possesses extensive experience in designing optimum phase and feeder spacing dimensions according to site conditions. This results in compact dimensions that reduce space requirements to less than 20% of conventional air-insulated substations.

- **Safety**
  Ensures personnel safety by earthed enclosure, numerous interlocks and lockout devices and provides greater stability during earthquakes with a low center of gravity.

- **Elimination of Periodic Maintenance**
  Virtually eliminates long-term maintenance costs and contamination of critical components by means of SF₆ gas-filled metal enclosures, automatic monitoring of operating mechanisms and SF₆ gas system.

- **Efficient Installation**
  Reduces installation time and costs since assembly is performed in the factory and shipped in one complete bay.

- **Environmental Compatibility**
  Minimizes operation noise to make it advantageous for urban and suburban indoor substations. Also eliminates radio interference problems.

About Quality Assurance at Hyosung

Hyosung’s commitment to quality is exemplified by its ability to deliver on-time and produce high quality products at competitive prices. The quality level of products is sustained by Hyosung’s integrated Quality Assurance program. The Quality Assurance program was created by combining Hyosung’s professional experience with abundant operating knowledge accumulated from the earliest phases of industry development. In addition, customer’s requirements are recognized from design to assembly, testing and installation and each process is carried out with the company’s manufacturing motto of “customer’s goal is Hyosung’s goal” as a foundation. This type of focus and commitment to quality has allowed Hyosung to surpass its competitors in quality and reliability.
Quality Assurance

01 Design Process
Hyosung’s Research and Development activities are dedicated to providing customers with the solutions that are demanded at the present and the future. The latest computer assisted software and systems are applied to the design analysis of each GIS for the best quality and reliability.

<table>
<thead>
<tr>
<th>Specification Design</th>
<th>Layout</th>
<th>Foundation Drawing</th>
<th>Structure Drawing</th>
<th>Block Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detail Design</td>
<td>Assembly Drawing</td>
<td>Manufacturing Drawing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawing / Document</td>
<td>Detail Drawing</td>
<td>BOM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

02 Assembly Process
All critical components of Hyosung GIS are assembled in a “clean room” as a safety measure against contaminants. These critical components are then installed in their enclosure and pressurized with SF₆ gas. All openings are sealed to prevent dust from entering during shipping.

03 Testing Process
Hyosung performs tests based on international standards and customer’s requirements. Hyosung also strives to exceed all established testing criteria by carrying out additional tests that it considers essential in advancing the current quality of its product.

04 Installation Process
All components are completely assembled into one compact unit, tested in the factory and shipped in one complete bay. Through this, Hyosung minimizes installation time and cost and passes on the savings to its customers. When the component arrives at its destination, Hyosung engineers are standing-by during installation to ensure that your new GIS is not only installed correctly but functioning to match your exact specification by performing tests through various tools and testing equipments. The final commissioning test, which consists of various essential analysis, is performed before the final acceptance of the product.
## Type and Rating

<table>
<thead>
<tr>
<th>Rated voltage (kV)</th>
<th>72.5 / 145</th>
<th>245 / 300</th>
<th>420</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase per enclosure</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rated interrupting current (kA)</td>
<td>40</td>
<td>40 &amp; 50</td>
<td>40 &amp; 50</td>
</tr>
<tr>
<td>Lightning impulse withstand voltage (kV)</td>
<td>325 / 650</td>
<td>1050</td>
<td>1425</td>
</tr>
<tr>
<td>Power frequency withstand voltage (kV)</td>
<td>140 / 275</td>
<td>460</td>
<td>650</td>
</tr>
<tr>
<td>Arrangement</td>
<td>Three-phase common type</td>
<td>Three-phase isolated type</td>
<td>Three-phase isolated type</td>
</tr>
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<th>Rated voltage (kV)</th>
<th>420 / 550</th>
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<tr>
<td>Phase per enclosure</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rated interrupting current (kA)</td>
<td>63 / 50 &amp; 63</td>
<td>50</td>
</tr>
<tr>
<td>Lightning impulse withstand voltage (kV)</td>
<td>1425 / 1550</td>
<td>2100</td>
</tr>
<tr>
<td>Power frequency withstand voltage (kV)</td>
<td>650 / 710</td>
<td>960</td>
</tr>
<tr>
<td>Arrangement</td>
<td>Three-phase isolated type</td>
<td>Three-phase isolated type</td>
</tr>
</tbody>
</table>
About Hyosung GIS Construction

A typical GIS arrangement consists of a circuit breaker, disconnecting switch, earthing switch, busbar, voltage transformer, current transformer, and lightning arrester. Gas sections are used as spacers in order to minimize problem areas, allow prompt repair, and monitor gas effectively. Manholes are available in each section to facilitate inspection and maintenance. This arrangement allows connections to the bushings, cable head, and bus duct.

01 Circuit Breakers

Double flow synchronized axial blast method significantly boosts circuit breaking performance and enables single-pole structure. Double trip coils ensure reliable circuit breaking performance combined with anti-pumping and trip-free function. Hydraulic and spring mechanism, as well as highly reliable pneumatic operating mechanism based on Hyosung’s long experience, is available upon request. An accumulator (reservoir) enables the circuit breaker to close and open twice before needing to be recharged. This structure provides simple and trouble-free maintenance.

02 Disconnecting Switches

The disconnecting switches are motor driven, motor drive-spring charged or pneumatic and features three-phase gang operation. Essentially, this design supports not only no-load switching operations, but upon customer request, facilities for capacitive charging current, transformer magnetizing current, and loop current can be added. A mechanical indicator fixed to the operating shaft inside the operating mechanism box provides a visual means of checking operating position. Visual inspection windows can be installed as well.

03 Earthing Switches

Every earthing switch has a short-time current endurance function. They are divided into two types with each one having its own particular functions. The first is the maintenance earthing switch, and it is motor driven or pneumatic. The second, the high-speed earthing switch, can be motor drive-spring charged or pneumatic. Manual operation is possible for all types. High-speed earthing switch has a short circuit making current capability. 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 draining the SF6 gas. A mechanical indicator fixed to the operating shaft inside the operating mechanism box provides a visual means of checking operating position.
Construction Details of Equipment

04 Busbars
To allow for greater compactness, Hyosung's GIS utilizes three-phase common-enclosure for voltage ratings from 25.8kV to 800kV and rated current up to 8,000A. The finger-type tulip connectors enable convenient plug-in and plug-out, while providing elasticity and tolerance. According to the rating current specified, the conductors are made of copper or aluminum and the enclosures are made of mild or stainless steel, or aluminum. The installation of bellows provides elasticity in assembly tolerance and protection against possible future foundation sinkage.

05 Current Transformers
The current transformer is the ring type used for equipment protection. To prevent moisture, the ring types have epoxy-fiber-glass applied. The ring type current transformer can be used with both three-phase common-enclosure and isolated type GIS.

06 Voltage Transformers
Hyosung uses electromagnetic transformers with highly reliable SF6 insulation. These compact models may be attached to the GIS from any position. They can be equipped as a three-phase common enclosure type or isolated type.

07 Lightning Arrester
Lightning arrester protects power electric machines from over voltage that generates lightning or surge and prevents accidents or power failure. Generally, zinc oxide-type lightning arrester(ZLA) that eliminates series gap by zinc oxide is used.

08 Interfaces
Hyosung provides customer with connector, chamber, bushing and accessories that are necessary to connect any cable end. This facilitates maintenance by allowing independent tests to be performed in key areas of GIS without causing system degradation. Hyosung engineers are experts in designing and installing bushings used in gas-to-air, gas-to-oil, or standard cable connections. In addition, Hyosung provides its clients with the necessary connecting chamber, contacts, and bellows that are required to compensate for alignment errors and to absorb excess vibration.
Hyosung’s Monitoring & Diagnosis System

Hyosung’s monitoring system strengthens reliability to fit the customer’s needs. By monitoring and diagnosing equipment operation status, the system creates an accurate database. This database extends power apparatus lifetime by minimizing periodic inspections and preventing unexpected fault.

GIS Supervision

- Partial Discharge
  - By analyzing the installed equipment in the field, Hyosung provides clients with operation information by detecting the UHF signal that is generated when partial discharge occurs inside GIS. After analyzing the amount of discharge, causes and position of partial discharge is provided along with trends and risks.
  - It is possible to forecast inspection and lifetime of the equipment. When it reaches the allowable setting value, a warning message appears and provides instructions about maintenance.

- LA Degradation Supervision
  - Hyosung’s customers may view the trends at the same time by monitoring total leakage and the 3 harmonic leakage currents of LA.
  - Warning messages occur when it reaches the allowable setting value and provides information about inspection and reminding life time.

- SF6 Gas Density
  - SF6 gas density is monitored by densimeter to check the condition of injected SF6 gas for isolation media of GIS. A sensor for each gas section is attached to monitor air tightness leakage.
  - If ground fault occurs inside of the GIS, it is possible to resolve the problem promptly by detecting the rising pressure.

Development Process of Monitoring & Diagnosis System

- Management Requirements
  - Reduced Maintenance Costs
  - Extended Asset Life

- Time Based Maintenance (TBM)
- Condition Based Maintenance (CBM)
- Reliability Centered Maintenance (RCM)

- Equipment condition greatly depends on service conditions
- Past
- Current
- Future
Following factory assembly and testing, the GIS is disassembled for packing and shipment. The equipment is designed to minimize the number of disassembled parts, while considering performance, maintenance, ease of installation and transportation. The disassembled parts are packed as a complete unit whenever possible to reduce the construction cost at the site.

**01 Transportation**

The interior of GIS equipment is designed to eliminate almost all inspection and maintenance. To maintain the highest criteria of operating reliability, a routine inspection and maintenance schedule may be recommended.

**02 Commissioning Test**

The commissioning tests are performed in the presence of a Hyosung commissioning engineer to ensure faultless operation of the GIS.

**03 Maintenance**

The interior of GIS equipment is designed to eliminate almost all inspection and maintenance. To maintain the highest criteria of operating reliability, a routine inspection and maintenance schedule may be recommended.

### Routine Inspection and Maintenance Schedule

<table>
<thead>
<tr>
<th></th>
<th>Number of switching CB operations (*1)</th>
<th>Service schedule</th>
<th>Inspection</th>
</tr>
</thead>
</table>
| **Ordinary Inspection** | Every 500 times                        | Every 2 months   | 1. Gas pressure and operating pressure check  
|                      |                                        |                  | 2. Recording number of operations of CB and lightning arrester |
| **Regular Inspection**  | Every 2,000 times                      | Every 3 years    | 1. Gas leakage test  
|                      |                                        |                  | 2. Operating device inspection and lubrication |
| **Detailed Inspection (**2**)| Every 5,000 times                      | Every 6 years    | 1. Detailed inspection of operating device  
|                      |                                        |                  | 2. Internal check of CBs |

(*1) Number of switching operations at rated current of circuit breaker  
(*2) Only CB portion is inspected. Busbar and disconnecting switch portions do not require inspection except for the operating device
R&D Center identifies innovation, creation and expertise as core value, and concentrates on world-class R&D activities in the 21st century with a philosophy aspiring after customer satisfaction, quality priority and performance orientation.

**Global Network**

Aggressive Expansion of Global Customer Support Structure

**Service Network**

Hyosung’s Worldwide Service Network for Timely Service