GIS
Gas Insulated Switchgear

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Global Top Energy, Machinery & Plant Solution Provider
Our Business

Brief introduction of Hyosung Power & Industrial Systems

Hyosung Power & Industrial Systems Performance Group

Hyosung Power & Industrial Systems Performance Group is a comprehensive energy solution provider, boasting world-leading technology in the global power industry and has secured a competitive capability on par with that of top competitors in transformers, switchgears, motors, decelerators, industrial pumps, and wind energy business.

With globalization as one of our top priorities, we have achieved outstanding increase in sales over the past five years thanks to the enhancement in Hyosung’s quality, technology, and brand recognition among overseas clients, which include North America, Europe, the Middle East, Asia. We expect such robust performances, marked by an increasing number of orders from the overseas market, to continue in the future.

At the heart of our capability to grow as a comprehensive energy solution provider is our global organization structure. Hyosung Power & Industrial Systems Performance Group is divided into four business areas or performance units, depending on the types of flagship products: Power Systems Performance Unit, Industrial Machinery Performance Unit, Hyosung-Goodbridge Performance Unit, and the Wind Energy Business Division.

Power Systems Performance Unit

Hyosung’s Power Systems Performance Unit provides a full spectrum of power generation, transmission, and distribution services, from design and engineering to the maintenance of equipment and has been building us on cutting-edge information technology resources and developing substations automation systems, such as power monitor and control systems, and early detection and prevention systems.

Such vast product assortment and technical know-how is based on our product development history. In 1962, Hyosung was the first in Korea, and the fifth in the world, to develop a 750kV Ultra-high voltage (UHV) transformer, and in 1969, was the first in the world to manufacture the 800kV gas insulated switchgear (GIS), which has put Hyosung on an equal technological ground as its top global competitors.

Having such world-class technology, we established Baoding Hyosung Tianwei Transformer Co., Ltd., a joint venture with the Baoding Tianwei Organization, to hold the largest share of the market in Baoding City, China. This venture was established in 2003, and by the end of 2004, we established a production plant producing 11,000 transformers per year. In 2006 we acquired one of the top five competitors.

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Gas Insulated Switchgear

Compact Design
The installation space that is required is about 1/10~1/20th than that of conventional air-insulated substations which makes it possible to install GIS within a building.

Safety
Enhanced insulating properties and reduced long-term operational costs by means of a sealed metal enclosure filled with SF6 gas which assures first-rate reliability, thus making it suitable for highly populated and urban areas.

Superior Reliability
Personnel safety is ensured by an earthed enclosure, numerous interlocks, and lockout devices. Greater stability is provided during earthquakes and the perfect enclosure protects from loss or damage from salt, dirt, weather, and lightning. While the SF6 gas insulation prevents deterioration, the partition of the gas prevents accidents from occurring.

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 the SF6 gas system.

Installation & Transportation
Installation time and costs are reduced since the system is shipped in a completely assembled bay or by unit.

General
Hyosung offers a wide variety of SF6 Gas Insulated Switchgear ranging with rated voltages from 72.5kV to 1,100kV and rated short-circuit breaking current up to 63kA.
Gas Insulated Switchgear (GIS) refers to the general equipment of a substation in a metal enclosure filled with high-insulation SF6 gas and connected to the ground, which includes a circuit breaker, disconnecting switches, earthing switches, and peripheral devices (e.g., current transformer, voltage transformer, and lightning arrester). It can be installed in a small space in cities or buildings. Ensuring reliable and stable operation and good maintainability, it is especially suited for polluted and/or salty seashore areas.
Our GIS ensures reliable and stable operation along with simple maintainability. We offer GIS with rated voltages ranging from 72.5kV to 1,100kV and rated short-circuit breaking current up to 63kA and have acquired international certificates from KERI (Korea Electrotechnology Research Institute), CESI (Italy), and KEMA (Netherlands). Hyosung has now become synonymous as the most trusted GIS supplier in the world.
**Breaking Performance Analysis**

- Low current breaking performance: analyze changes in SF6 gas density caused by arc heat generated between the poles of the circuit breaker by the charge current of transmission line.
- High current breaking performance: analyze changes in SF6 gas density by the high arc heat generated when the circuit breaker blocks the abnormal current. For maximizing the breaking performance, phoenics and fluent, the arc analysis tools, are used for analyzing the SF6 gas density and flow.

**Three-Dimensional Electric Field Analysis**

Because high voltage is applied in the SF6 GIS, a very precise electric field analysis is needed. Therefore, Hyosung uses a three-dimensional analysis program to design a product that analyzes the electric field distribution of all parts of the GIS including the busbar and insulating materials.

**Mechanical Performance Analysis**

To maximize the optimum mechanical performance of the conductor, enclosure, and controller of the GIS, values (mass, shape, stress, transformation, etc.) of all parts of the GIS are precisely analyzed using the structure analysis programs and three-dimensional design.

**Analysis with NASTRAN/PATRAN**

**Three-Dimensional Design & Assembly**

Solid Edge, the latest three-dimensional design tool, is used for basic GIS design to assembling parts in order to minimize any possible design errors. It is also used to model the final installation so that the installation site is optimized by the assembled parts.

**Seismic & Vibration**

To verify the seismic and vibration at the design stage, the latest seismic and vibration analysis tools, which consider all loads resulting from gravity (both the vertical load and the wind load), have been used for ensuring overall structural safety.
Circuit Breaker
Hyosung’s circuit breaker uses superior arc quenching performance and the insulation characteristics of the SF6 gas and adopts the puffer-type, which has a simple operation principle and structure. With the double trip coil, it guarantees reliable circuit breaking and its few parts allow for simple maintenance.

Earthing Switches
The earthing switch is classified into two types according to its role:
1. Device earthing: manually and electrically controlled for maintenance
2. Line earthing: controlled at high-speed. It has an input capacity even when the line is energized. For preventing any unforeseen accidents, it is interlocked with associated circuit breaker and disconnecting switches.

Busbars
Most busbars up to 362kV use three-phase batch tank for reducing the number of parts and installation period. The conductors are automatically connected via the tulip contactor when the housing of the busbars is assembled. The expansion or shrinkage of conductors due to temperature changes can be compensated.

Disconnecting Switch
Disconnecting switch is a device used to segment the charge current section partitioned by the circuit breaker. It is operated by an electric motor; however, it can be manually operated for maintenance tests. In addition, the user can check the switch status since the switch status display is connected to the control shaft in the control box.
Current Transformer
Current transformer protects the system by sensing any abnormal current in the line and measuring the usual conductive current. Insulation by high-voltage is not required since this is in the enclosure grounded at both ends of the circuit breaker and isolated by the first conductor and SF6 gas.

Voltage Transformer
Voltage transformer is a small-sized transformer using high-reliable gas insulated winding. It monitors the voltage of the line or the busbar. Voltage transformer is classified into two types: Metering Cut Fit (MCF) and general meters.

Lightning Arrester
The lightning arrester protects the power utilities from overvoltage due to lightnings or surges and prevents the utilities from breakdowns and blackouts. It uses Zinc-Oxide Lightning Arrester (ZLA) which removes the series gap using Zinc Oxide element.

Interfaces
The interface is classified into three types:
1. Gas-to-Oil Bushing: when the interface is directly connected to the transformer, the bushing separates the gas and insulation oil. The bellows compensates the tolerance and minimizes vibration.
2. Gas to Air Bushing: when the interface is directly connected to the feeder, the bushing filled with the SF6 gas is used.
3. Cable Sealing End: when the interface is directly connected to power cable.

Compartments
## Products & Details

### Gas Insulated Switchgear

<table>
<thead>
<tr>
<th>Rated voltage (kV)</th>
<th>Phase per enclosure</th>
<th>Frequency (Hz)</th>
<th>Breaking current (kA)</th>
<th>Rated current (A)</th>
<th>Lighting impulse withstand voltage (kVp)</th>
<th>Power frequency withstand voltage (kV)</th>
<th>CB Operation type</th>
<th>CB Mechanism</th>
<th>Arrangement (Layout)</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.5</td>
<td>3</td>
<td>50/60</td>
<td>Up to 40</td>
<td>Up to 2500</td>
<td>325</td>
<td>140</td>
<td>Three Phase Common Operation</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>145</td>
<td>3</td>
<td>50/60</td>
<td>Up to 40</td>
<td>Up to 3150</td>
<td>650</td>
<td>275</td>
<td>Three Phase Common / Isolated Operation</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>170</td>
<td>1/3</td>
<td>50/60</td>
<td>Up to 50</td>
<td>Up to 4000</td>
<td>750</td>
<td>325</td>
<td>Three Phase Common / Isolated Operation</td>
<td>Hydraulic / Spring</td>
<td></td>
</tr>
<tr>
<td>245/300</td>
<td>1</td>
<td>50/60</td>
<td>Up to 50</td>
<td>Up to 4000</td>
<td>1050</td>
<td>460</td>
<td>Three Phase Isolated Operation</td>
<td>Hydraulic / Spring</td>
<td></td>
</tr>
</tbody>
</table>

### Gas Insulated Switchgear (800kV - 50 / 60)

<table>
<thead>
<tr>
<th>Rated voltage (kV)</th>
<th>Phase per enclosure</th>
<th>Frequency (Hz)</th>
<th>Breaking current (kA)</th>
<th>Rated current (A)</th>
<th>Lighting impulse withstand voltage (kVp)</th>
<th>Power frequency withstand voltage (kV)</th>
<th>CB Operation type</th>
<th>CB Mechanism</th>
<th>Arrangement (Layout)</th>
</tr>
</thead>
<tbody>
<tr>
<td>362</td>
<td>1</td>
<td>60</td>
<td>Up to 63</td>
<td>Up to 8000</td>
<td>1175</td>
<td>520</td>
<td>Three Phase Common Operation</td>
<td>Hydraulic</td>
<td></td>
</tr>
<tr>
<td>420</td>
<td>1</td>
<td>50 / 60</td>
<td>Up to 50</td>
<td>4000</td>
<td>1425</td>
<td>650</td>
<td>Three Phase Isolated Operation</td>
<td>Hydraulic / Spring</td>
<td></td>
</tr>
<tr>
<td>420/550</td>
<td>1</td>
<td>50 / 60</td>
<td>Up to 63</td>
<td>4000</td>
<td>1425/1550</td>
<td>650/710</td>
<td>Three Phase Isolated Operation</td>
<td>Hydraulic / Spring</td>
<td></td>
</tr>
<tr>
<td>800/1100</td>
<td>1</td>
<td>800 / 50</td>
<td>50</td>
<td>8000</td>
<td>2100/2400</td>
<td>960</td>
<td>Three Phase Isolated Operation</td>
<td>Hydraulic</td>
<td></td>
</tr>
</tbody>
</table>
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.

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 lifetime.

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.

CB Operating Characteristics Monitoring
- Diagnostic contents of CB operating consist of applied current of trip/closing coil, AUX contact and stroke curve, and each sensor is installed in GIS controller and Local Control Panel (LCP).
- Signals measured from each sensor are analyzed by Hyosung algorithm and users can monitor normal or abnormal status of GIS operating by analytical results from Human Machine Interface (HMI).

GIS Supervision
Partial Discharge (PDM system : Intelligent Partial Discharge Monitoring System)
- 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.

SF6 Gas Density Transducer CB Operating Current Transformer

Development Process of Monitoring & Diagnosis System
Past
- Reduced Maintenance Costs
- Extended Asset Life

Current
- Equipment condition greatly depends on service conditions

Future
- Reliability Centered Maintenance (RCM)
Transportation, Installation and Maintenance

Transportation
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.

Installation
The installation works are performed in the presence of a Hyosung supervisor to ensure faultless operation of the GIS.

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>Inspection Type</th>
<th>Service Schedule</th>
<th>Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary</td>
<td>Every 2 months</td>
<td>1. Gas pressure and operating pressure check</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Recording number of operations of CB and lightning arrester</td>
</tr>
<tr>
<td>Regular</td>
<td>Every 500 times</td>
<td>1. Gas leakage test</td>
</tr>
<tr>
<td></td>
<td>Every 3 years</td>
<td>2. Operating device inspection and lubrication</td>
</tr>
<tr>
<td>Detailed</td>
<td>Every 2,000 times</td>
<td>1. Detailed inspection of operating device</td>
</tr>
<tr>
<td></td>
<td>Every 6 years</td>
<td></td>
</tr>
</tbody>
</table>

* Number of switching operations at rated current of circuit breaker
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.

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.

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 equipment. The final commissioning test, which consists of various essential analysis, is performed before the final acceptance of the product.

Certificates

<table>
<thead>
<tr>
<th>Year</th>
<th>Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>800kV 63kA GCB</td>
</tr>
<tr>
<td>2009</td>
<td>420kV 63kA 50kA GCB</td>
</tr>
<tr>
<td>2008</td>
<td>170kV GIS bay controller (IEC61860)</td>
</tr>
<tr>
<td>2006</td>
<td>Partial discharge monitoring system for GIS</td>
</tr>
<tr>
<td>2005</td>
<td>24kV 25kA GIS (New IEC standard)</td>
</tr>
<tr>
<td>2004</td>
<td>24kV 40kA GIS</td>
</tr>
<tr>
<td>2003</td>
<td>36kV 31.5kA 1 Pole GIS</td>
</tr>
<tr>
<td>2001</td>
<td>170kV 50kA Condensation free 3Phase common tank GIS</td>
</tr>
</tbody>
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<tr>
<th>Year</th>
<th>Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>170kV 31.5kA 3Phase common tank GIS</td>
</tr>
<tr>
<td>1998</td>
<td>The world’s first 800kV/50kA 8000A GIS</td>
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<tr>
<td>1997</td>
<td>36kV/40kA 3Phase common tank GIS</td>
</tr>
<tr>
<td>1996</td>
<td>145kV 31.5kA 3Phase common tank GIS</td>
</tr>
<tr>
<td>1995</td>
<td>145kV 40kA GCB</td>
</tr>
<tr>
<td>1994</td>
<td>145kV 40kA GCB</td>
</tr>
<tr>
<td>1993</td>
<td>36kV/40kA 2Pole GIS</td>
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<tr>
<td>1992</td>
<td>170kV 31.5kA 3Phase common tank GIS</td>
</tr>
<tr>
<td>1991</td>
<td>145kV 40kA GCB</td>
</tr>
<tr>
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<td>170kV 31.5kA GIS</td>
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<td>1989</td>
<td>145kV 40kA GCB</td>
</tr>
<tr>
<td>1988</td>
<td>145kV 40kA GCB</td>
</tr>
<tr>
<td>1987</td>
<td>145kV 40kA 2Pole GIS</td>
</tr>
<tr>
<td>1986</td>
<td>145kV 40kA GCB</td>
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<td>1985</td>
<td>36kV/40kA 2Pole GIS</td>
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<td>1984</td>
<td>145kV 40kA GCB</td>
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<td>36kV/40kA 2Pole GIS</td>
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<tr>
<td>1982</td>
<td>170kV GCB</td>
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<tr>
<td>1981</td>
<td>170kV GCB</td>
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Global Network