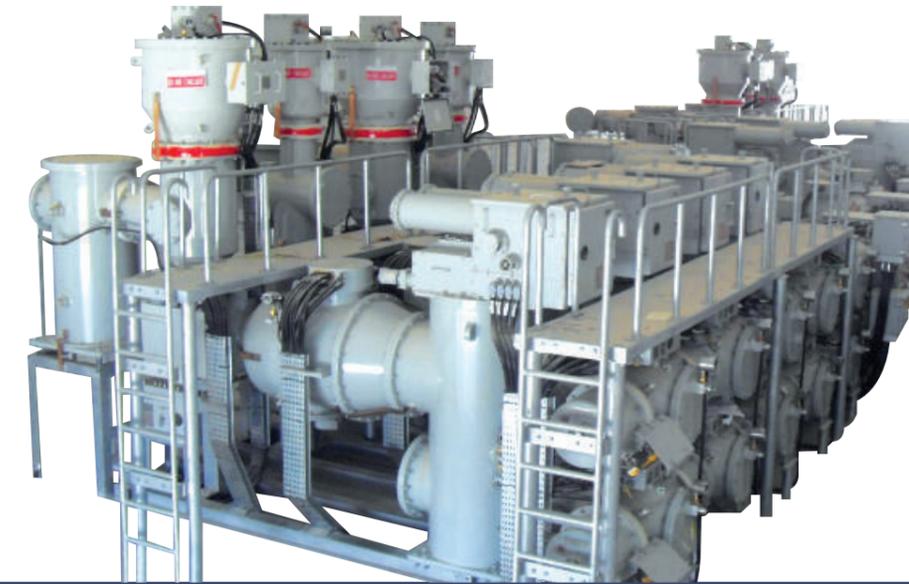


# GIS

## Gas Insulated Switchgear



[www.hyosungpni.com](http://www.hyosungpni.com)

Global Top Energy, Machinery & Plant Solution Provider

### HYOSUNG CORPORATION

Power & Industrial Systems Performance Group

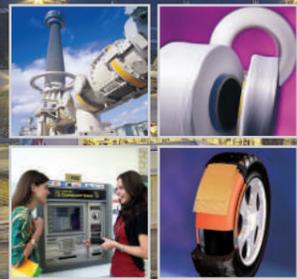
**HEAD OFFICE** 119, Mapo-daero, Mapo-gu, Seoul, Korea (04144) TEL : 82-2-707-7000

**R&D CENTER** 74, Simin-daero, Dongan-gu, Anyang-si, Gyeonggi-do, Korea (14080) TEL : 82-31-428-1000

**CHANGWON PLANT** 171, Yeondeok-ro, Seongsan-gu, Changwon-si, Gyeongsangnam-do, Korea (51529) TEL : 82-55-268-8000



# About HYOSUNG



Hyosung Power & Industrial Systems PG is a division under Hyosung which consists of seven performance groups(PGs). In addition to establishing itself as a world-class manufacturer of electrical equipments, green technology and industrial machineries, Hyosung is also the largest producer of tire cords and spandex in the global market and the second largest supplier of ATMs in the USA.



## 01 Our Business

Brief introduction of Hyosung Power & Industrial Systems

### Hyosung Power & Industrial Systems Performance Group

Hyosung Power & Industrial Systems Performance Group(PG), a comprehensive energy solution provider, boasts 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, generators, gear units, industrial machineries, industrial pumps, and wind energy business.

With globalization as one of our top priorities, we have achieved outstanding increase in sales over the past few years thanks to the enhancement in Hyosung's quality, technology, and brand recognition among overseas clients, which include North America, Europe, the Middle East, and Asia. We expect such robust performance, 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 PG is divided into four business areas or performance units(PU), depending on the types of flagship products : Power Systems PU, Industrial Machinery PU, HYOSUNG GOODSPRINGS PU, and the Wind Energy Business Division.

### Power Systems Performance Unit

Hyosung's Power Systems PU provides a full spectrum of power generation, transmission, and distribution services, from design and engineering to the maintenance of equipment. Power System PU has been building up on cutting-edge information technology resources and developing substation 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 1992, Hyosung was the first in Korea, and the sixth in the world, to develop a 765kV ultra-high voltage (UHV) transformer, and, in 1999, was the first in the world to manufacture the 2-breaker 800kV gas insulated switchgear (GIS). Those technological achievements gave Hyosung world-wide recognition as one of the global major manufacturers.

The Power systems PU is continuously striving to secure competitiveness in every aspect of quality, technology, sales, services, and management, in order to satisfy customer needs globally and become a top-tier company in the world by providing customers with the best quality products and services in the power systems sector.



## Gas Insulated Switchgear

### CONTENTS

02 Our Business 03 Sustainability / R&D 04 General 05 Technology 06 Design 08 Compartments  
12 Products & Details 14 Preventive and Diagnosis 16 Transportation, Installation and Maintenance 18 Total Quality Assurance  
19 Product Development History / Global Network

## 02 Sustainability

Our sustainability principles are the backbone of the way we design and manufacture products



### Quality Assurance

Hyosung strives for excellence. We believe excellence can only be achieved through absolute quality and value for customers. In order to create quality products, we believe that all of the actions of every single employee must be focused in the highest level of quality. In order to achieve such levels, we have implemented a quality assurance policy and programs that make our philosophy into a reality. Our Quality Assurance Policy was founded based on the management policy of the president and meets the demands of ISO 9001. As a globally active company, we are committed to comprehensive and quality management through three quality strategies: quality management system, customer-focused management system, and concentration on core competencies. The comprehensive quality management system ensures that we completely comply with all compliances and applicable legislation, codes, and standards in addition to implementing efficient operation of our management resources to eliminate unnecessary waste. Our customer-focused management system clarifies and simplifies our first priority which is customer satisfaction. All of our work is aimed to exceed customer needs and provide exceptional value through quality standards, flexibility, and innovation. Finally, we concentrate on our core competencies for strict quality control and continual improvement which provides quality products and cost-saving to our clients via advancement in technical capacity and technological innovation. We implement our policy via a Quality Management Team manages research laboratories, including the Measurement Standard Laboratory, the Chemical Analysis Laboratory and the Material Analysis Laboratory to maintain a strict control over quality.



### Environment Protection Policy

Hyosung understands the impact of Hyosung's activities in the environment and works to protect the environment from pollution, manages the environmental impacts of Hyosung's products and technologies, and prevents future pollution and harmful effects in the environment by investing in environmentally-friendly products and solutions. Based on this eco-philosophy of shared responsibility, Hyosung has implemented a comprehensive environmental protection program that aims to minimize our impact on the environment and conserve resources. Our environmental policy fulfils all requirements of the ISO 14001.

## 03 R&D

Inspiring innovation, creation and expertise

Hyosung 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. Hyosung pursues to be the world's best company in the field of heavy electrical machinery, industrial & electrical electronics engineering, and energy system. Ever since establishment in 1978, R&D Center had led the development of domestic technology. Along with the Anyang and Changwon labs, the group has endeavored to produce core technology and world-class products in the areas of heavy electrical machinery, energy system, electrical electronics engineering, and industrial automation system.

### Research Areas

Hyosung R&D Center engages in the activities in the field of energy system, solution & service, applied electrical and electronic technology, basic core technology, technology of improved reliability, core components, and new materials.

#### Energy System

- Renewable energy (wind system, wind turbine, wind PCS, solar system, PV PCS, fuel cell, co-generation)
- Electric Vehicle (EV charger, EV motor)

#### Solution & Service

- Power facility diagnosis algorithm and system
- Power facility lifecycle evaluation system
- Service solution for remote diagnosis for prevention

#### Applied Electrical & Electronic Technology

- Power conversion system
- Flexible AC transmission system and high voltage direct current
- Power quality solution

#### Basic Core Technology

- Fortified technology in structural dynamics, electromagnetics, heat transfer analysis, etc.
- Skills for system simulation, analysis and evaluation
- Business support technology

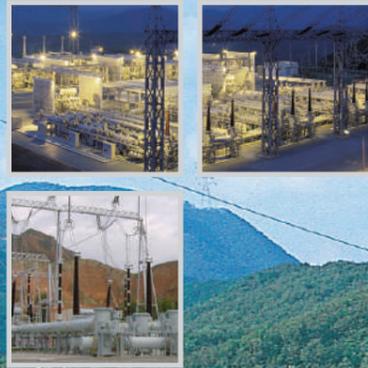
#### Technology with Improved Reliability

- Test data analysis and testing facility
- Analysis of lifecycle and cause of error
- Reliability assessment (environment-friendliness, durability, long-term degradation, and more)

#### Core Components and New Materials

- Organic and inorganic insulation materials
- Silicon forming technology
- Intelligent sensor (facility diagnosis, CT, PT, VT, LA, and more)

# Gas Insulated Switchgear



## Technology

### 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 SF<sub>6</sub> 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 SF<sub>6</sub> 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 SF<sub>6</sub> gas-filled metal enclosures, automatic monitoring of operating mechanisms, and the SF<sub>6</sub> 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 SF<sub>6</sub> 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 SF<sub>6</sub> 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.

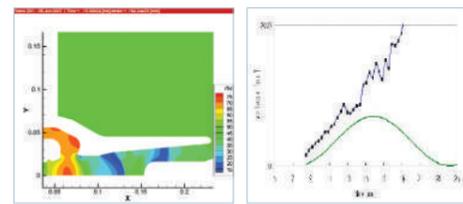


# Design

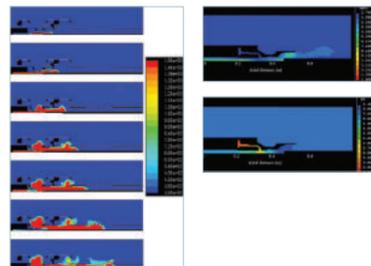


## Breaking Performance Analysis

- Low current breaking performance : analyze changes in SF<sub>6</sub> gas density cause 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 SF<sub>6</sub> gas density by the high arc heat which is 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 SF<sub>6</sub> gas density and flow



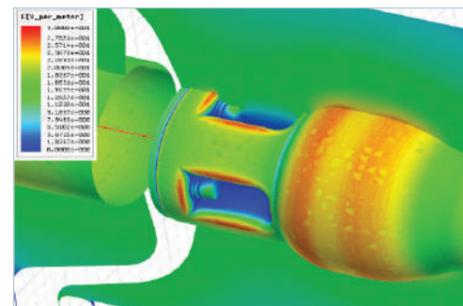
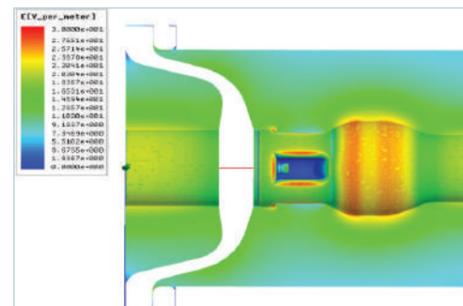
Cold Gas Analysis



Hot Gas Analysis

## Three-Dimensional Electric Field Analysis

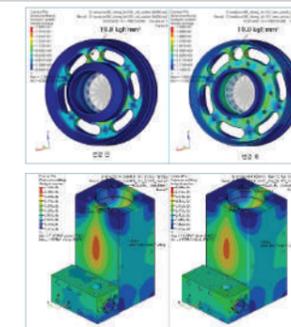
Because high voltage is applied in the SF<sub>6</sub> GIS, a very precise electric field analysis is needed. Therefore, Hyosung uses a three-dimensional analysis program to design a product that analyzes the electric field distribution of all parts of the GIS including the busbar and insulating materials



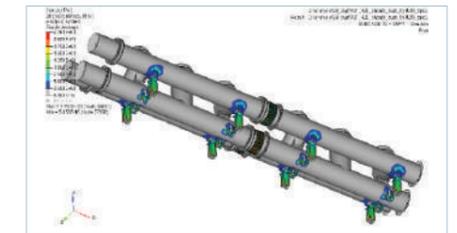
## Mechanical Performance Analysis

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



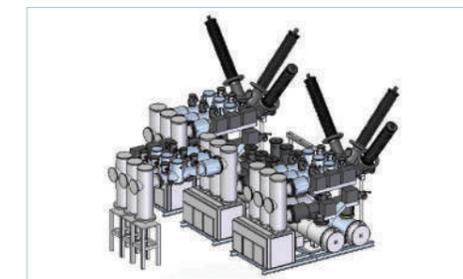
Hydraulic main valve block



Busduct support

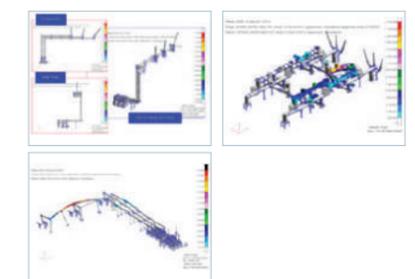
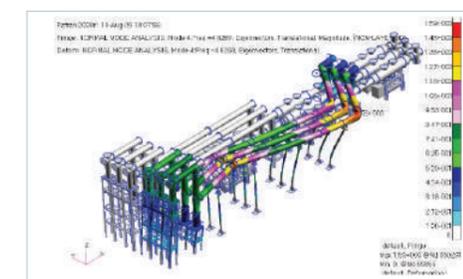
## Three-Dimensional Design & Assembly

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.

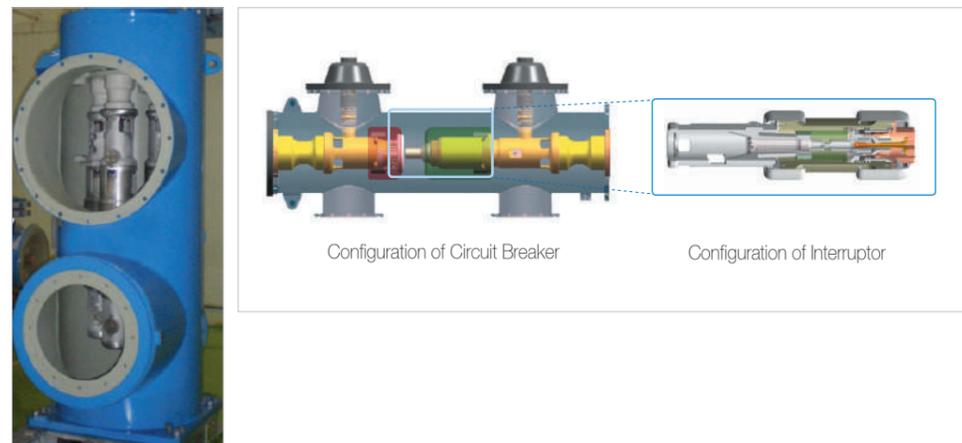


# Compartments



## Circuit Breaker

Hyosung's circuit breaker uses superior arc quenching performance and the insulation characteristics of the SF<sub>6</sub> 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.



## 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.



## Earthing Switches

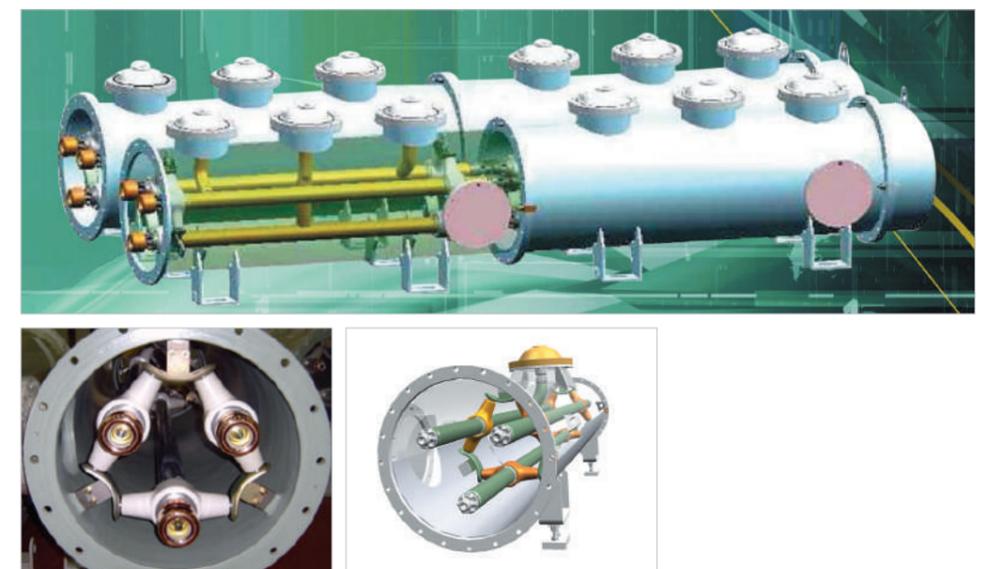
The earthing switch is classified into two types according to its role.

- 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.

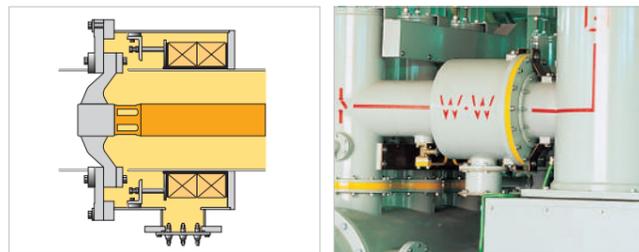


# Compartments



## 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 SF<sub>6</sub> gas.

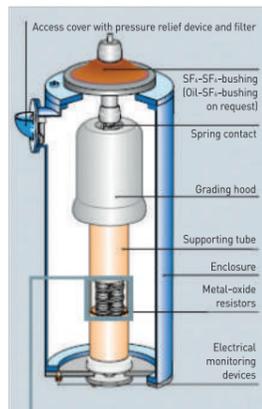


## Voltage Transformer



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 Out Fit (MOF) and general meters.

## Lightning Arrester

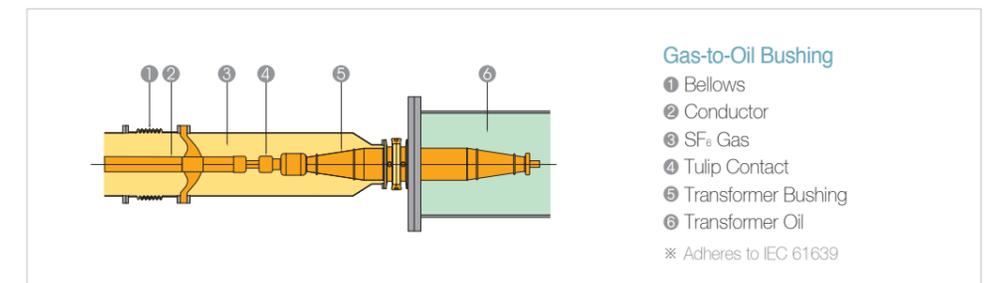
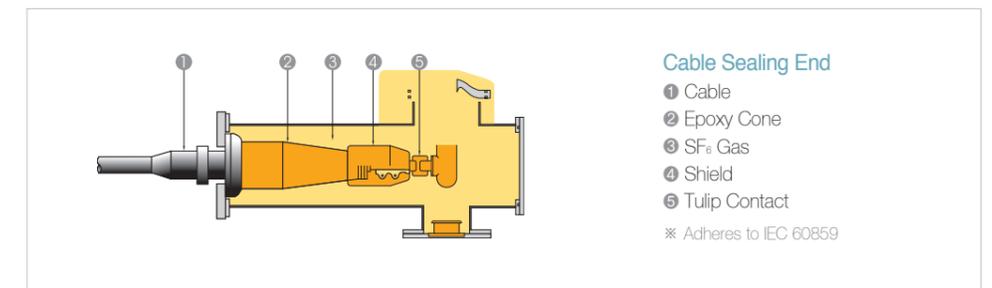


The lightning arrester protects the power utilities from overvoltage due to lightnings or surges and prevents the utilities from breakdowns and blackouts. It uses Zinc-Oxide Lightning Arrester (ZLA) which removes the series gap using Zinc Oxide element.

## Interfaces

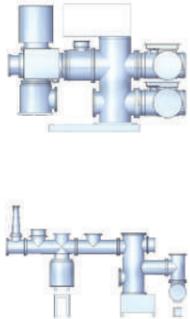
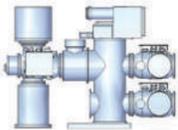
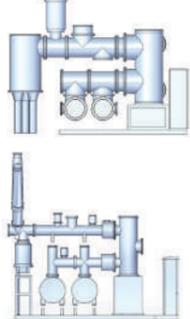
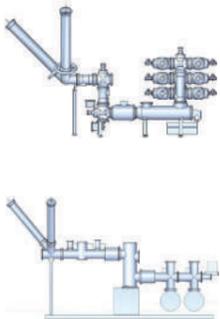
The interface is classified into three types:

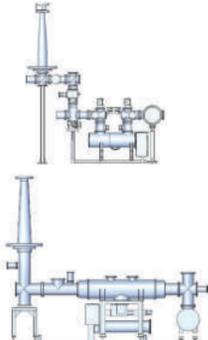
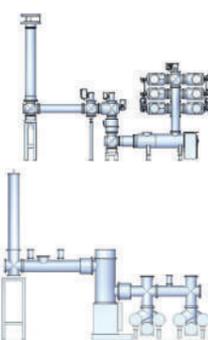
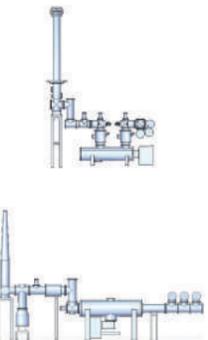
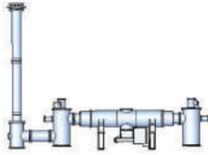
- ① Gas-to-Oil Bushing: when the interface is directly connected to the transformer, the bushing separates the gas and insulation oil. The bellows compensates the tolerance and minimizes vibration.
- ② Gas to Air Bushing: when the interface is directly connected to the feeder, the bushing filled with the SF<sub>6</sub> gas is used.
- ③ Cable Sealing End: when the interface is directly connected to power cable



# Products & Details



<b>Rated voltage (kV)</b>	72.5	145	170	245/300
<b>Category</b>	HSG 074	HSG 144	HSG 175	HSG 305
<b>Model No.</b>	HSG-074A	HSG-144A HSG-144D	HSG-144C	HSG-305A HSG-305B HSG-305C
<b>Phase per enclosure</b>	3	3	1 / 3	1
<b>Frequency (Hz)</b>	50 / 60	50 / 60	50 / 60	50 / 60
<b>Breaking current (kA)</b>	Up to 40	Up to 40	Up to 50	Up to 50
<b>Rated current (A)</b>	Up to 2500	Up to 3150	Up to 4000	Up to 4000
<b>Lighting impulse withstand voltage (kVp)</b>	325	650	750	1050
<b>Power frequency withstand voltage (kV)</b>	140	275	325	460
<b>CB Operation type</b>	Three Phase Common Operation	Three Phase Common / Isolated Operation	Three Phase Common / Isolated Operation	Three Phase Isolated Operation
<b>CB Mechanism</b>	Spring	Spring	Hydraulic / Spring	Hydraulic / Spring
<b>Arrangement (Layout)</b>				

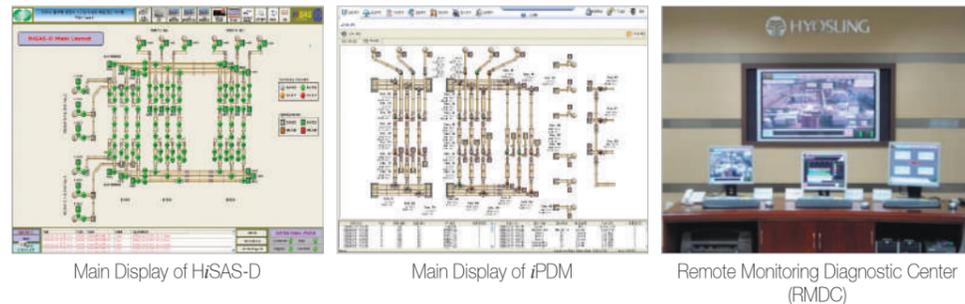
<b>Rated voltage (kV)</b>	362	420	420/550	800/1100
<b>Category</b>	HSG 362	HSG 426	HSG 556	HSG 805
<b>Model No.</b>	362H1PGS50 362HGS5 362H1PGS50	HSG-426C	550HSG	800HG550
<b>Phase per enclosure</b>	1	1	1	1
<b>Frequency (Hz)</b>	60	50 / 60	50 / 60	800kV - 50 / 60 1100kV - 50
<b>Breaking current (kA)</b>	Up to 63	Up to 50	Up to 63	50
<b>Rated current (A)</b>	Up to 8000	4000	4000	8000
<b>Lighting impulse withstand voltage (kVp)</b>	1175	1425	1425/1550	2100/2400
<b>Power frequency withstand voltage (kV)</b>	520	650	650/710	960
<b>CB Operation type</b>	Three Phase Isolated Operation			
<b>CB Mechanism</b>	Hydraulic	Hydraulic / Spring	Hydraulic / Spring	Hydraulic
<b>Arrangement (Layout)</b>				

# Preventive and Diagnosis

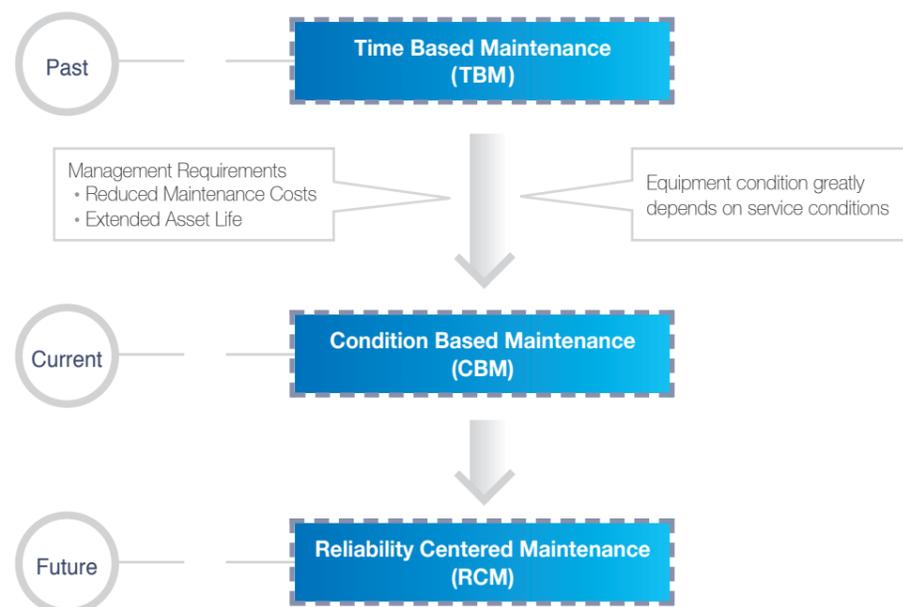


## Hyosung's Monitoring & Diagnosis System

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.



## Development Process of Monitoring & Diagnosis System



## GIS Supervision

### Partial Discharge(iPDM 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.



### 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.

### SF<sub>6</sub> Gas Density

- SF<sub>6</sub> gas density is monitored by densimeter to check the condition of injected SF<sub>6</sub> 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).



# 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.



Bay unit Transportation



Shock and Vibration Control

## Installation

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



Temporary Clean Room adapted for Outdoor Type Installation



Bus Connection Work in the Wrap of Plastic Vinyl Sheet



## 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

	Number of switching CB operations*	Service schedule	Inspection
Ordinary Inspection		Every 2 months	1. Gas pressure and operating pressure check 2. Recording number of operations of CB and lightning arrester
Regular Inspection	Every 500 times	Every 3 years	1. Gas leakage test 2. Operating device inspection and lubrication
Detailed Inspection	Every 2,000 times	Every 6 years	1. Detailed inspection of operating device

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



Dielectric Test



UHF External Sensor



UHF Internal Sensor

# Total Quality Assurance

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 SF<sub>6</sub> 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.

## Certificates



# Product Development History

Year	Milestones
2010	800kV 63kA GCB
2009	420/550kV 63kA GIS
2008	170kV GIS bay controller (IEC61850) 25kV C-GIS bay controller (IEC61850) 25.8kV 25kA dry air insulated switchgear 245kV 40kA motor direct drive mechanism GIS 1100kV 50kA CB
2006	Partial discharge monitoring system for GIS
2005	36kV 31.5kA GIS
2004	245kV 50kA GIS 25.8kV 25kA GIS (New IEC standard) 24kV 40kA 3000A GIS
2003	362kV 50kA GIS 420kV 50kA 1Pole GIS
2001	170kV 50kA Condensorless 3Phase common tank GIS 550kV 50kA GIS

Year	Milestones
1999	800kV 50kA GIS 362kV 63kA 8000A GIS
1998	The world's first 800kV 50kA 8000A 2Pole GIS 362kV 63kA 4000A GIS
1997	300kV 40kA 1600/3150A GIS
1993	145kV 25kA 3Phase common tank GIS
1992	72.5kV 20kA 800/2000A GIS 170kV 31.5kA 3Phase common tank GIS
1987	170kV 31.5kA 1200A GIS
1989	145kV 40kA GCB
1983	362kV 40kA 2Pole GIS
1980	170kV 31.5kA GIS
1979	362kV GCB
1978	170kV GCB

# Global Network

