

# TRANSFORMER



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# HYUNDAI HEAVY



## HYUNDAI TRANSFORMERS AT A GLANCE

Electro Electric Systems of Hyundai Heavy Industries Co., Ltd., being specialized in design and manufacturing of electrical equipment, has been pursuing the business goal of providing total solution to the customers around the world since its establishment.

We are offering the complete range of electrical equipment for power plants, transmission and distribution, and various industrial sectors such as Transformers, SF<sub>6</sub> Gas Insulated Switchgear, Medium Voltage Switchgear, Motors, Generators, Instrumentation & Control Systems, Power Electronics, etc.

Among such wide range of products, Hyundai Transformers, featuring the excellent performance and a high level of reliability proven through a lot of experiences accumulated over a long span of period, have been delivered to the customers and gained good reputation from the customers.

To best serve our clients with global capacity, we are currently operating Ulsan plant in Korea, Montgomery plant in the USA and Sofia plant in Bulgaria.

Hyundai Ulsan plant, equipped with the most advanced manufacturing and testing equipment, and having the annual capacity of 120,000MVA, is manufacturing the whole range of transformers from distribution and power transformers up to 800kV including cast resin and various kinds of special purpose transformers such as furnace transformers and gas transformers, etc.

Hyundai Power Transformer USA in Montgomery, Alabama is built based on the invaluable experience and cutting-edge technologies gained over 30 years. Hyundai Power Transformer USA strictly follows the procedures that have been tested and proven from Ulsan plant in order to guarantee the production of high-quality power transformers. The new plant is fully capable of providing client-specific power transformers to mostly, but not limited to, North America, South America, and African regions. Always striving to produce innovative and superior power transformers, Hyundai Power Transformer USA is confident in achieving worldwide customer satisfaction.

And Hyundai Sofia plant, with its long experience of more than 50 years in manufacturing transformer and tap changers, has been supplying its products to the customers for power generation, transmission and distribution areas.

Hyundai, having the competitive edges in price, delivery and quality, has become the world leading supplier of transformers over the short span of period since its establishment. We are committed to offering the best service for the customers including after-sales service.

Hyundai has kept total quality system certified by ISO 9001 and we are providing quality products and services for the customers in accordance with their requirements.

# Production Range

Being classified by its application, construction and ratings, transformers can be divided into Power Transformer, Distribution Transformer, Reactor, Cast Resin Transformer and Special Transformer.

Production range of Hyundai transformer fully covers the above transformers and services as follows ;

Transformer Plant	Scope of Production & Services
-------------------	--------------------------------

- |                             |   |
|-----------------------------|---|
| <b>Ulsan Plant in Korea</b> | <ul style="list-style-type: none"> <li>- Power Transformer up to 800kV/1500MVA</li> <li>- Distribution Transformer</li> <li>- Cast Resin Transformer</li> <li>- Dry Type Transformer</li> <li>- Reactor</li> <li>- Special Transformer</li> </ul> |
|-----------------------------|---|

- |                                |  |
|--------------------------------|--|
| <b>Montgomery plant in USA</b> | <ul style="list-style-type: none"> <li>- Power Transformer up to 500kV/600MVA</li> <li>- Distribution Transformer</li> <li>- Reactor</li> <li>- Special Transformer</li> </ul> |
|--------------------------------|--|

- |                                |   |
|--------------------------------|---|
| <b>Sofia plant in Bulgaria</b> | <ul style="list-style-type: none"> <li>- Power Transformer up to 420kV/200MVA</li> <li>- Distribution Transformer</li> <li>- Instrument Transformer up to 145kV</li> <li>- Special Transformer</li> <li>- Tap Changers such as On-Load Tap Changer, Off-circuit Tap Changer and SF<sub>6</sub> Gas Insulated Tap Changer</li> </ul> |
|--------------------------------|---|

- |  |  |
|--|--|
| <b>Services to be provided by transformer plants</b> | <ul style="list-style-type: none"> <li>- Supervision of Transformer Installation &amp; Commissioning</li> <li>- Advisory Services of Transformer Specification</li> <li>- Training of Customer Personnel</li> <li>- Inspection &amp; Trouble shooting service</li> <li>- Investigation and Assessment of problems</li> </ul> |
|--|--|



Power Transformer



Distribution Transformer



Cast Resin Transformer



Reactor



Traction Transformer



Tap Changer

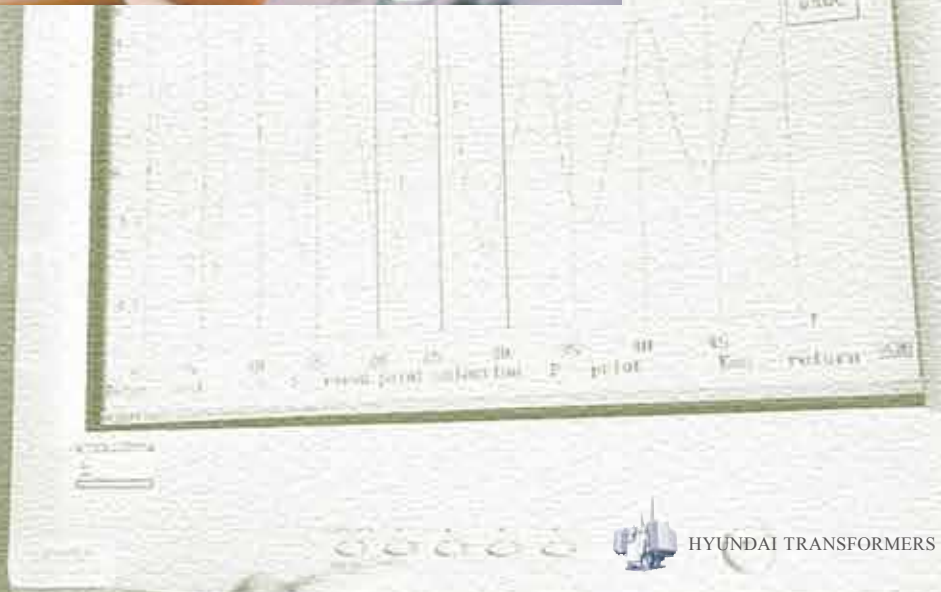
# Transformer Design

By utilizing the most modern and up-to-date design technology, Hyundai provides designs which can meet the customer's various requirements and international or national standards of IEC, ANSI, NEMA, CSA, BS, AS, etc.

And also Hyundai design has sufficient experiences and proven records which can meet the customer's various needs of power, voltage, mode of operation, low noise level, connection techniques, type of cooling, transport and installation.

Taking into account of any possible case of short-circuit fault which may be incurred in service, we utilize a computer program to calculate accurately the radial force, axial force and spacer of winding.

Particularly, Hyundai can perform seismic analysis with the computer program to ensure that the transformer has the capability to withstand the seismic condition.



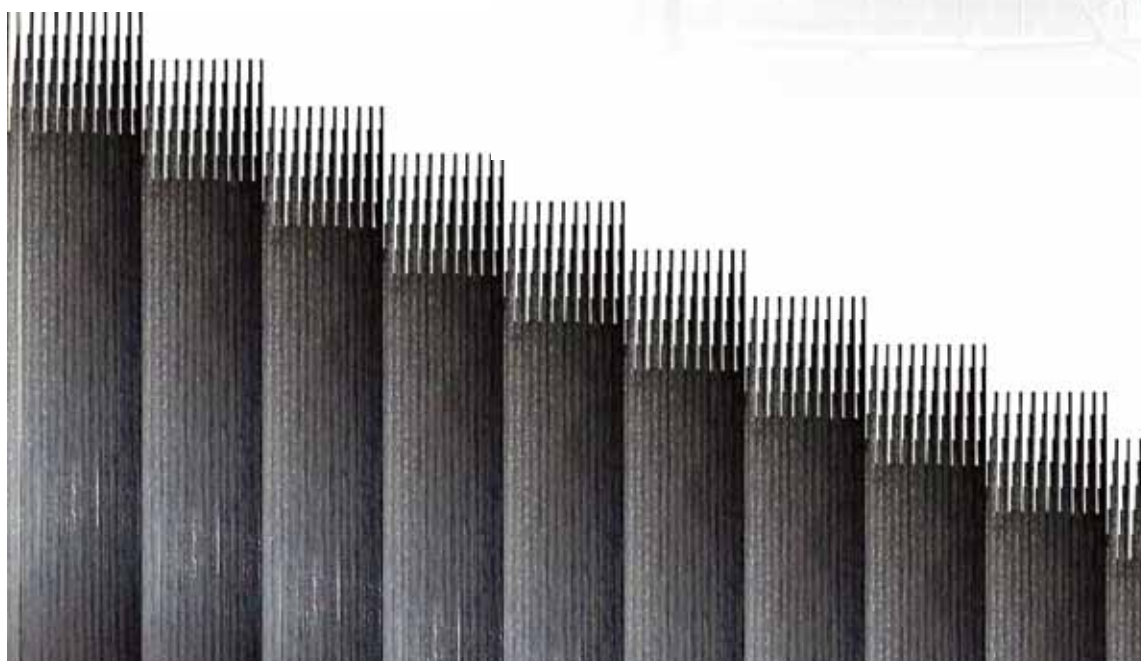
The cores for Hyundai transformers are made of high quality, cold-rolled, grain-oriented silicon steel coated with magnesium-silicate-phosphate. For low loss design as required by loss evaluation requirement of the customer, laser scribed or plasma treated silicon steel can be used.

The standard core construction type of Hyundai transformer is 'core form type' having three leg core or five leg core of three phase and two leg core or three leg core or four leg core of single phase according to the customer's special requirement.

In the core of large power transformer, suitable insulation papers are inserted between some laminations for the purpose of reducing eddy currents and also minimizing magnetic short-circuit.

And in order to obtain effective cooling, cooling ducts are provided between the core laminations.

The leg core in which hard wooden bars are inserted, are tightened with synthetic resin impregnated glass band.



## Step Lap Core Lamination

Step lap core lamination is used to reduce no load losses and noise level.



### **Core Cut-to-length Machine**

The oriented silicon steel is cut by computerized machinery, thus minimizing air gap in the joint during assembly.



### **Core Stacking**

Five Leg Core stacking



### **Core Erection Equipment**

Special core erection equipment is used for the large core in order to prevent deflection from stress and strain during upright setting of the cores.



# Winding

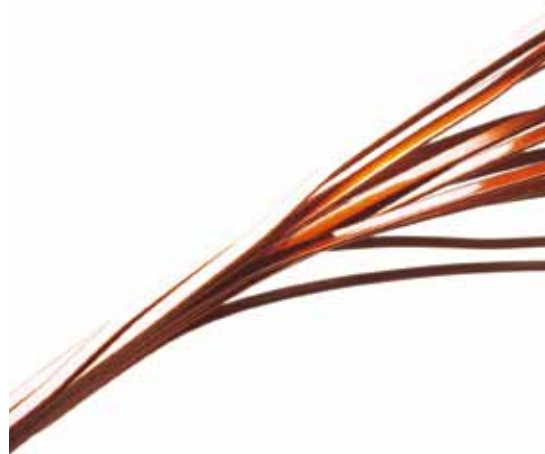
The winding is made of copper conductor covered with several layers of insulation paper or enamel coating of high dielectric strength. Rectangular conductor, multiple conductor and transposed conductor are employed in the winding. The most optimized conductor is selected after considering the voltage and capacity of the transformer.

Especially, the transposed conductor is composed of several wires individually covered with enamel and this entire wire unit is covered with several layers of insulation paper. The advantage of using transposed conductor is to decrease eddy current loss in the windings, improvement of the lamination factor and manufacturing of windings in a short span of time.

In manufacturing large power transformers, the most suitable winding method is employed according to the capacity, voltage and tap range of each transformer.

And during the manufacturing process of windings, the following factors are taken into account ;

- Short Circuit
- Ability to withstand impulses
- Eddy current loss
- Ability to distribute over-voltage



**Continuously Transposed Conductor**



**Horizontal Winding Machine**



**Vertical Winding Machine**





### Layer Winding

Applied to low voltage and large current windings



### Helical Winding

Employed according to the magnitude of current in case of low voltage winding



### Disc Winding

Applied for high voltage winding and classified into continuous and interleaved disc winding



### Interleaved Layer Winding

Applied for tap winding



# Core & Coil Assembling

For insulation, all Hyundai transformers have a concentric winding structure. One or more insulating cylinders are placed around the core legs. The number of insulating cylinder depends on the voltage stress between the leg and the winding itself.

Vertical spacers are provided to produce an oil duct for the cooling of windings. Between the low and high voltage winding a number of insulating cylinders are provided at fixed distance from each other by using vertical spacers. The high voltage winding is wound on the outer cylinder.

The bottom of the windings rest on the supporting system of the lower yoke. And a large wooden press ring called "pressing wood" is provided at the top of windings. The windings are pressed by means of the pressing wood and bolts on the upper clamp device. All leads and bus bar are tightly supported to withstand short-circuit force.

After the core and coil assembly of transformer is completed, it is dried in the vapor phase drying plants under high vacuum condition for the purpose of eliminating moisture content.



**Transformer under In-tanking Process**

On completion of the vacuum drying, the core and coil assembly is inserted in the tank.



### Winding Inserting

Low voltage winding, high voltage winding and tap winding are inserted into a leg core.



### Core and Coil Assembly

Core and coil assembly of the transformer put together from the core, windings clamping device, tap changer and lead.



### Vapor phase Drying Plant

Vacuum drying with heat in vapor phase drying plants



# Tank

Protection of the active parts in the transformer is very important, especially in case of high voltage and large current transformer.

While achieving the optimized size of transformer to suit the site condition for installation, the main role of the tank is to protect the active parts and the tank is manufactured to have sufficient strength to withstand internal and external faults that may occur during operation.

And the various ancillary devices such as lifting lug, jack pad, pulling eye and skid base are designed and provided on the tank so that the completely assembled transformer unit can be moved in any direction without damage when using rollers, plates or rails.

Hyundai strict welding procedure and leak test assure 100% leakproof seams and maximum mechanical strength.

After finishing the welding work, it will be shot-blasted to remove all dust and spatters before painting.

Non-Destructive Test on Transformer Tank



## Transformer Tank

The tank is made of high quality mild steel.



## Painting of Tank

The tank is painted with HHI standard painting system which is poly-urethane resin in order to prevent the tank from any possible corrosion which may appear according to the site condition.

# Cooling System

A transformer in service has losses which are transformed as heat to be dissipated and thus leading to a temperature rise in the transformer. In order not to allow the temperature to rise above the permissible level, a suitable cooling method should be considered and adopted.

Generally, the cooling method suitable for the transformer is determined by the customer after due consideration of transformer capacity and the circumstances at the installation site.



**Oil to Air Cooler**

Hyundai can design and manufacture transformer with various types of cooling systems according to the customer's requirement.

- ONAN: Natural oil cooling(ON), Natural air cooling(AN)
- ONAF: Natural oil cooling(ON), Forced air cooling(AF)
- OFAF: Forced oil cooling(OF), Forced air cooling(AF)
- ODAF: Directed oil cooling(OD), Forced air cooling(AF)
- OFWF: Forced oil cooling(OF), Forced water cooling(WF)



**Panel Type Radiator**



**Oil to Water Cooler**



# Testing

HHI, as one of leading electrical equipment manufacturers, has the state-of-the-art testing laboratory which is equipped with the most modernized testing facilities in the world.

In this ultra-high voltage testing laboratory, Hyundai transformers at the system voltage up to 1,000kV are subjected to the routine and type tests as per the customer's requirements and applicable international standards.



**Control Room of Ultra-High Voltage Test Laboratory**



**Ultra-High Voltage Test Laboratory**

Equipped with 4,400kV impulse generator and 1,200kV AC generator

# Research & Development

Research & Development is an essential requirement for improvement and advance of modern technology.

HHI's commitment to the research and development has been a motivating factor of the company's various technical achievements and will be vital in its advance into the 21st century.

HHI is operating three renowned in-house research institutes: HMRI(Hyundai Maritime Research Institute), HIRI(Hyundai Industrial Research Institute) and HEMRI (Hyundai Electro-Mechanical Institute) as well as an overseas institute(HUNELEC) in Budapest, Hungary.

In these institutes fully equipped with state-of-the-art R&D devices, HHI's top-notch brains are exploring the future of high technology.

Hyundai transformers have been supplied to most of the countries all over the world and their technology, quality and reliable performance have been widely acknowledged by the customers around the world.



# Quality Assurance

It is the policy of HHI that the products shall meet the customer's specified and implied requirements, industrial codes and national standards and shall be produced and delivered to the customers on schedule.

We have been dedicated to supplying the best quality products and services for our customers. And we have developed HHI's own quality assurance program to comply with the ISO 9001 as required by the most authoritative International Organization for Standardization (ISO) in order to assure that HHI products are designed, manufactured, inspected, tested and delivered in the most efficient manner.



**ISO 9001 Certificate of HHI Ulsan Plant**  
Quality System Certificate



HHI also considers human safety and environmental protection, the most important in performing all related works in its business, and thus acquired ISO 14001 (Environmental Management Certificate) and OHSAS 18001 Certificate (Occupational Health & Safety Management System Certificate) from DNV.



**ISO 14001 and OHSAS 18001 Certificate**  
Environmental Management Certificate



**ISO 9001 Certificate of HHI Sofia Plant**



**GOST-R Certificate**



# Worldwide Experiences

Hyundai transformers have been supplied to most of the countries all over the world and have achieved a world-wide reputation for their quality and performance to the customer's satisfaction.

## ■ Countries where Hyundai Transformers are in Service



132kV 230MVA Transformer  
Al-Qaseem Project in Saudi Arabia



220kV 125MVA Transformer  
Egyptian Electricity Transmission Company  
in Egypt



235kV 500MVA Generator Step-up Transformer  
Bowin Combined Cycle Power Plant  
in Thailand



66kV 20MVA Transformer  
Tokyo Electric Power Company in Japan



500kV 750MVA TPRS(Tank Pressure Relief System) Transformer / Hydro One in Canada



500kV 390MVA Generator Step-up Transformer Tenaska Georgia Power Plant in U.S.A.



765kV 204MVA Generator Step-up Transformer Dangjin Thermal Power Plant in Korea



235kV 205MVA Generator Step-up Transformer Sempra Energy in U.S.A.



■ Vancouver

■ Toronto

■ New York

■ Los Angeles

Canada  
Cuba  
Guatemala  
Mexico  
Nikaragua  
Panama  
Puerto Rico  
Trinidad Tobago  
U.S.A.

Argentina  
Brazil  
Chile  
Colombia  
Peru  
Venezuela

■ Sao Paulo





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