Japan AE Power Systems Corporation
Jointly owned by HITACHI,LTD., Fuji Electric Co.,Ltd. and Meidensha Corporation

8-3, Nishi-Shimbashi 3-chome, Minato-ku, Tokyo 105-0003, Japan
Tel: +81-3-5405-3401 Fax: +81-3-5405-8929
http://www.jaeps.com

Printed in Japan (H-BL) 0508

High Performance Transformers

Meeting global demands for efficient and reliable power transmission and distribution

Powering the World

HFMJÆPS

Japan AE Power Systems Corporation
Jointly owned by HITACHI,LTD., Fuji Electric Co.,Ltd. and Meidensha Corporation

Contents

Products — 2–3
Quality — 4
Research and Development — 5
Design and Manufacture — 6
Quality Assurance, Shipping, Installation, Service — 7
Cores — 8
Windings — 9
Analysis — 10–11
Cooling Systems — 12–13
Components and Accessories — 14–15
International Activities — 16–17

Created to Meet Present and Future Energy Demands

With each passing year, the worldwide demand for electric power increases significantly. Power systems must be not only efficient and reliable, but also versatile and environmentally responsible. Meeting these needs with the highest quality products and service is the mission of Japan AE Power Systems.

Created in 2001 by uniting the power transmission and distribution systems divisions of Hitachi, Fuji Electric and Meidensha, Japan AE Power Systems is ideally positioned to meet the growing global needs for power.
Combining the technological expertise and broad resources of the three companies gives us extensive capabilities in all aspects of the power systems business, from R&D to after-sales service, as well as a wide range of products from UHV transformers to distribution transformers.

Already a world leader in this vital industry, Japan AE Power Systems will continue to expand and integrate its present products, while developing new and improved products and solutions to meet future energy demands.

In our corporate name, the “A” indicates advanced, and “E” indicates energy, electricity and electronics. “Power Systems” refers to transmission and distribution equipment and facilities

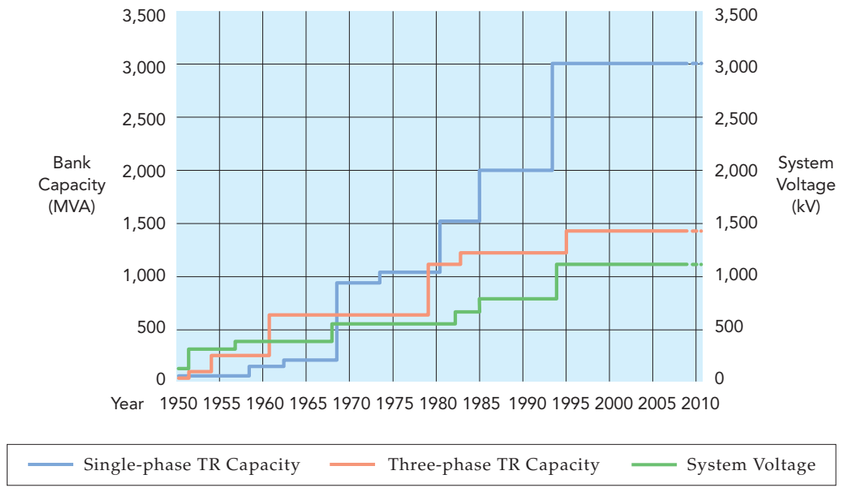
Products

In addition to a wide selection of voltages and capacities for electric power, general electric distribution, electric railways, electric furnaces and other special uses, we also offer oil immersed transformers, gas insulated transformers, cast resin transformers, and dry-type transformers for various installation locations and conditions. We also manufacture high efficiency, energy-saving types and shunt reactors for electric power grid use.

Product Range

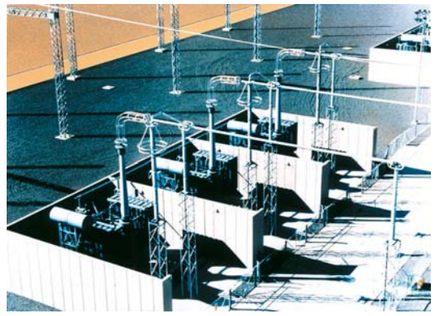
- UHV & EHV Transformers
- Mobile Transformers
- Cast Resin Transformers
- Generator Step up Transformers
- Shunt Reactors
- Traction Transformers
- Distribution Transformers
- Phase-Shifting Transformers
- SF_6 Gas Insulated Transformers
- Industrial Transformers
- HVDC (High-Voltage Direct Current) Transformer and Rectifiers
- Silicon Immersed Transformers

System Voltage and Transformer Capacities



Experimental UHV transformers
$\frac{3000}{3}/\frac{3000}{3}/\frac{1200}{3}$ MVA, $\frac{1050}{\sqrt{3}}/\frac{525}{\sqrt{3}}$/147kV

Generator step up transformer
1,450MVA, 26.325/525kV



Single-phase shunt reactor
400MVAR, 800kV

Mobile transformer
20MVA, 77/6.6kV

Cast resin transformer
13MVA, 22/6.6kV, 3phase

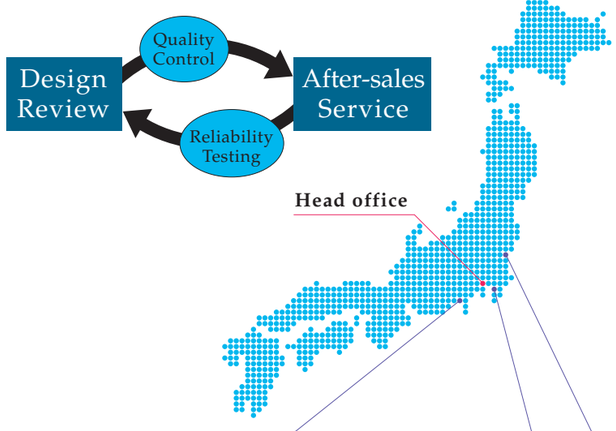
Converter transformer (HVDC)
872MVA, 500/110/110kV

SF_6 gas insulated transformer
100MVA, 154/66/10.75kV

Committed to Quality from Start to Finish

Japan AE Power Systems has a straightforward policy concerning the quality of our products: we take full responsibility for all processes from beginning to end. This commitment is embraced by every employee from every section, from research and development, design and manufacturing, testing and inspection, all the way to shipping and installation. It empowers them to carry out their duties with pride and responsibility, and results in maximum quality in every phase of our operation. Furthermore, this policy is perfectly aligned with the philosophy of the Japan Standards Organization, as shown by the fact that we are regularly awarded the coveted ISO 9001 certification. From the strong base of power transformer and electrical equipment production by the parent company, through our entire network of specialist companies, all of us at Japan AE Power Systems pursue the goal of consistently superior quality as a totally committed and integrated company.

Quality Assurance backed by Commitment



Strong R&D Program Maintains Highest Quality

Maintaining our leadership position in the production of the highest quality large-capacity transformers depends on having the most advanced technology for high voltage and large current applications. For this reason, we have established and continually upgrade extensive R&D facilities dedicated to further advancing our expertise in this field. We take particular pride in our Ultra-High Voltage Testing Laboratory, one of only a few such facilities of its kind in the world, which enables us to test and inspect equipment at voltages of 1,000kV and higher.

The Ultra-High Voltage Testing Laboratory is 57 x 60 meters and 48 meters high.

Short-circuit generator
Voltage: 11.5/13.8kV
Frequency: 50/60Hz
Capacity: 250/350MVA
Short circuit capacity: 3.0/3.6GVA

Short-circuit transformer connected to the short-circuit generator inside the laboratory.
Voltage: 14.4/12.6–12.6kV (60Hz)
12.0/10.5–10.5kV (50Hz)
Frequency: 50/60Hz
Capacity: 216MVA

The laboratory has a 2,200kV AC generator and a 6,000kV impulse generator.

Design and Manufacture

Every Part Designed for Optimum Quality

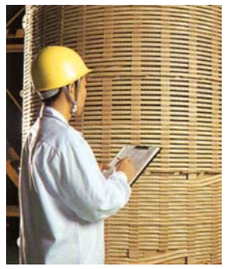
Because our clients' needs are constantly changing, we regularly conduct exhaustive Design Reviews encompassing every component of every model. Teams of experts pore over each design detail, providing feedback that lets us design improvements and eliminate potential problems. Using our state-of-the-art CAD facility, our designers can test and investigate virtual prototypes faster, in more ways and in greater depth than ever before.

Designing a transformer using the CAD system.

A Design Review meeting.

Excellence in Manufacturing from Outstanding Facilities and Workmanship

Despite its giant size, a power transformer is actually a rather delicate and sensitive piece of equipment, whose operation may be adversely affected by even a tiny particle of dust. Therefore we take the highest precautions possible to ensure that not even the tiniest foreign objects are allowed to enter. All power transformers are manufactured in special "clean rooms" separated from the regular manufacturing areas, with the air filtered and conditioned to remove particulate matter. All technicians entering the plant wear special dust-proof outerwear, and are subjected to a blast of a dust-removing "air shower" upon entering the facility. This meticulous attention to detail, combined with the exceptional workmanship of our highly trained specialists, enables us to manufacture products of the highest quality.

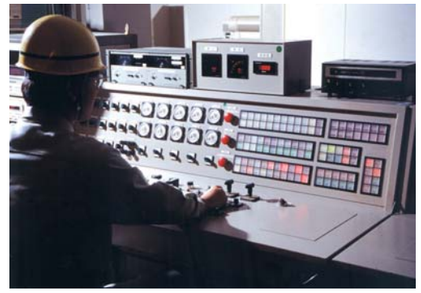


All manufacturing procedures are listed on a Process Control form, which our technicians use to record and confirm each step as it is executed.

Quality Assurance, Shipping, Installation, Service

Quality Assurance: Inspector as Representative of the Customer

Once manufacture is completed, all transformers are carefully inspected and tested by our specialists in Japan AE power systems's quality assurance section. These professionals take great pride in the fact that through their duties they are acting as the direct representative of the prospective owner, confirming that the quality and performance of each product is more than sufficient to satisfy the customer's every requirement. All personnel are thoroughly and highly trained, and take the initiative to improve their own skills at every opportunity.



Operator executing an impulse test.

All inspection and test items are recorded on Quality Control cards.

Shipping, Installation, and Follow-up Service

Manufactured with the greatest care, and having passed the rigorous testing and inspection of the quality assurance professionals, Japan AE power systems power transformers are now ready to be delivered to their new owners. Upon request, highly professional Japan AE power systems engineers will accompany the transformer to any site in the world, to take care of installation, test operation and equipment delivery, as well as maintenance and any requested follow-up service.

Transformer being loaded for shipment.

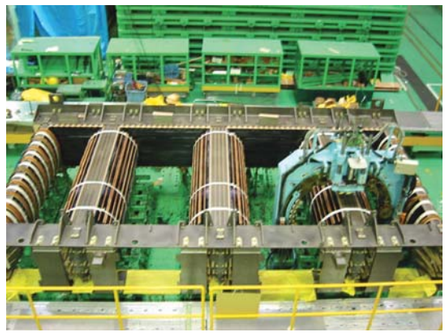
Arrival at the dock by using air castor.

On the way to the customer.

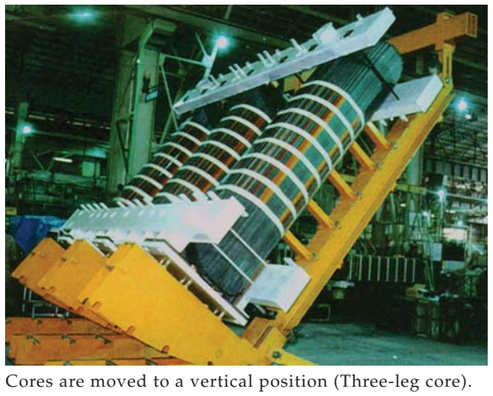
Cores Assembled with Scrupulous Care

The core is the largest single component of a transformer. Japan AE Power Systems transformer cores are composed of laminated silicon steel sheets, cut with extreme precision on a Numerical Control shearing line. To ensure that these huge cores are manufactured to the highest standards of quality, all assembly work is carried out in large “clean rooms” to guard against contamination by dust, rust or moisture. To further protect these vital components, as soon as they are completed they are stood upright and bound with protective tape.

Precision cutting on the NC shearing line

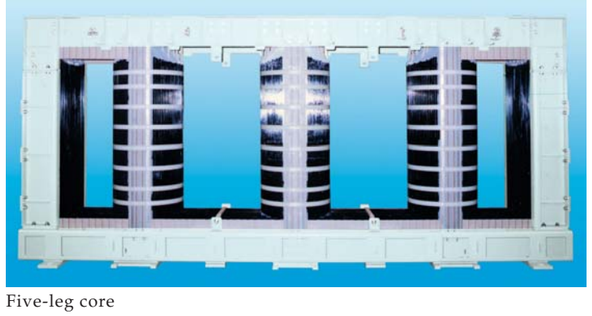


Stacking and binding



Cores are moved to a vertical position (Three-leg core).

Center core



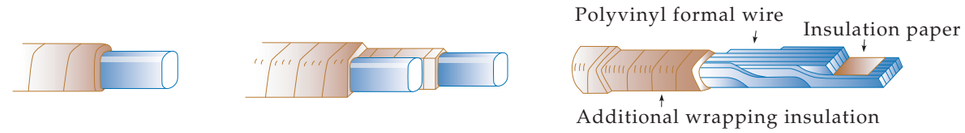
Five-leg core

Windings with Superior Strength and Integrity

The windings of a transformer must be insulated against high voltage and protected from heat, and must have sufficient mechanical strength to resist the electromagnetic forces that can be generated by current surges in the event of power system problems. Every aspect of the windings, from the composition and size of each strand of wire to the insulation paper, is decided only after extensive study.

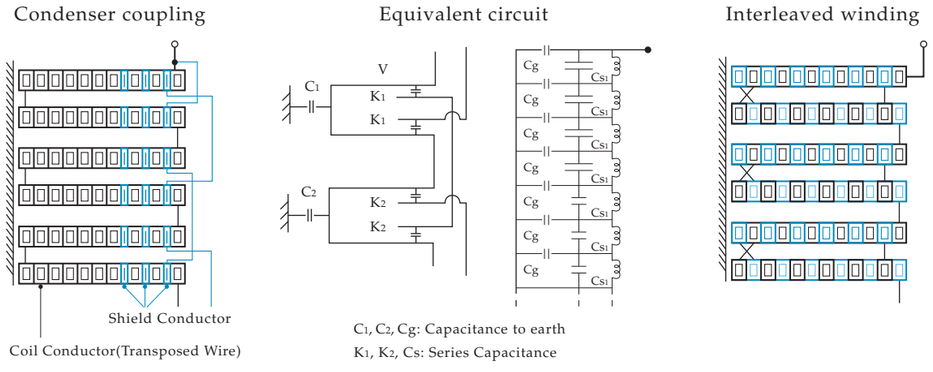
Wire Construction

We carefully select the most suitable wire composition for each individual transformer, taking into consideration such factors as current density, resistance loss and eddy current, as well as mechanical strength and space availability.



Impulse Voltage Insulation

Japan AE Power Systems currently uses two methods of inhibiting voltage oscillation in transformer windings under impulse voltage: interleaved disk winding and condenser coupling shielding.

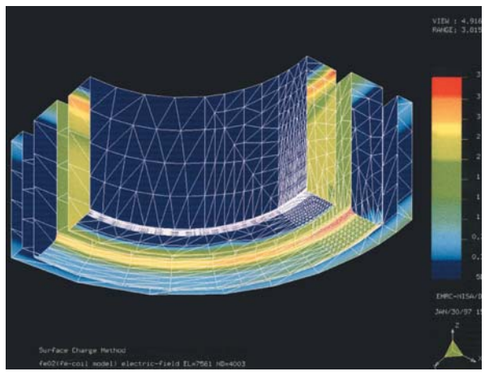


A view of the horizontal winding operation

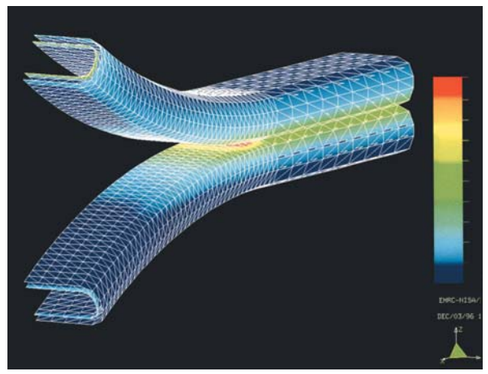
A view of the vertical winding operation

The Foundation of High Performance

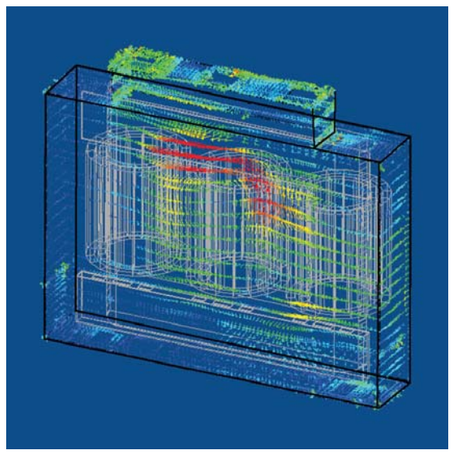
Japan AE Power Systems uses a variety of advanced analytical tools in our research and development activities, as well as in the design of everything from basic parts to transformer structures. Our analysis capabilities are the foundation for the manufacture of high performance transformers that meet diversified customer needs.



Static surface electrical field distribution



Coil model electrical field distribution



Magnetic field analysis

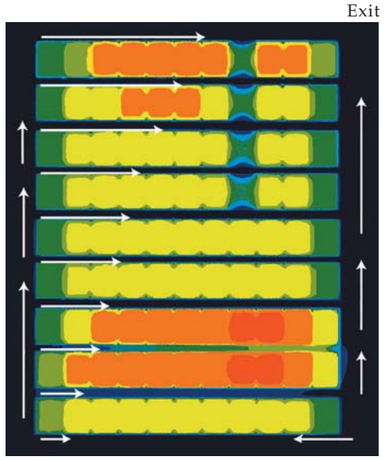
Tanks of Flawless Technique and Craftsmanship

The power transformer is encased in a welded steel plate tank. Every seam on these huge structures must be flawlessly excuted, and must be able to withstand the extreme tension of both high pressurization and partial vacuum. The basic design of the tank is determined by computer analysis and fundamental testing, ensuring that the shape, construction of noise and vibration which could be injurious or objectionable to transformer operation.

Transformer main tank

Computer analysis of stress and internal pressure

One of the most important factors determining the performance of a transformer is its cooling efficiency. Excess heat generated through unavoidable losses must be removed by an effective cooling system. Japan AE Power Systems performs detailed analysis of the interior structures of our power transformers, continually making system enhancements to improve overall cooling efficiency. Heat exchangers such as coolers and radiators, as well as pumps and fans, are carefully selected and combined in order to obtain the required performance.

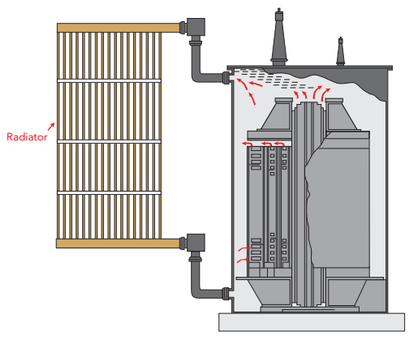


Display showing results of thermofluid analysis.
→ : Indication of flow
Length of arrow indicates oil flow velocity.

Effective Cooling Helps Ensure High Performance

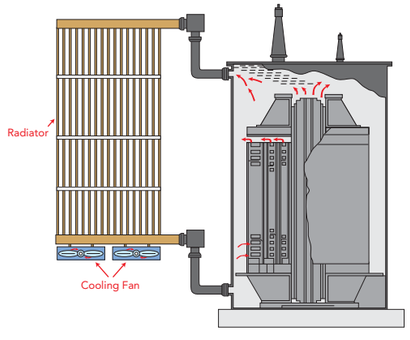
The optimum cooling system will be selected out of the following according to the customer's requirements and also taking into account the transformer capacity and circumstances at the installation site.
In a large core, the core internal temperature rise is kept under the limit by providing a cooling oil duct at right angles to the steer plate stacking direction. For the winding, an oil duct is installed in the coif as required for obtaining a high cooling effect. Especially for a forced-oil transformer having multiwindings, oil flow is measured by making a furl-sized section model so that temperature rise at each part of the winding becomes uniform.

ONAN Type



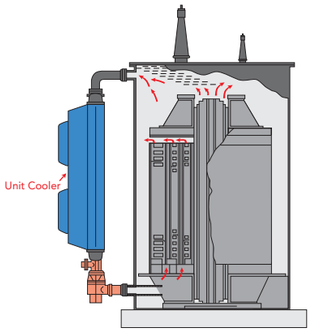
Insulating oil circulates by convection within the transformer and is cooled by air convection from a radiator. This system does not require fans or pumps.

ONAF Type



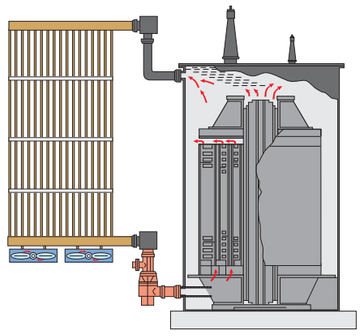
Insulating oil circulates by convection within the transformer, while forced air from fans increases the radiator's cooling capacity. With small loads, the fans may be turned off and the system operated as on ONAN type.

ODAF Type



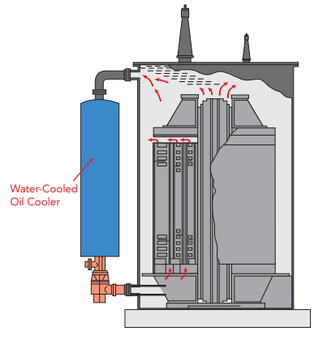
Forced air and oil flow by means of fans and pumps make this system the most effective means of dissipating loss-related transformer heat into the atmosphere.

ONAN/ONAF/ODAF Type



A combination of the three main cooling system types, this system allows selection of the appropriate level of cooling capacity for the load and oil temperature, thereby economizing the power required for the cooling equipment.

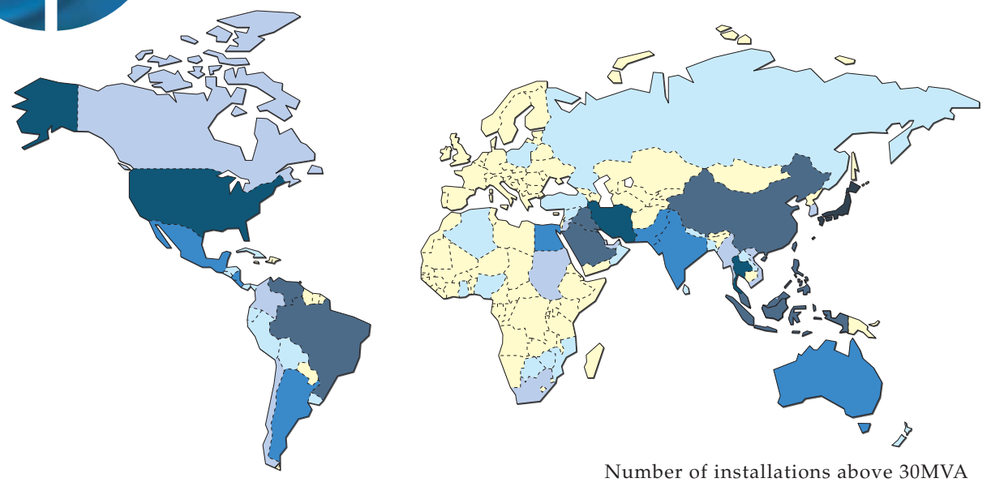
ODWF Type



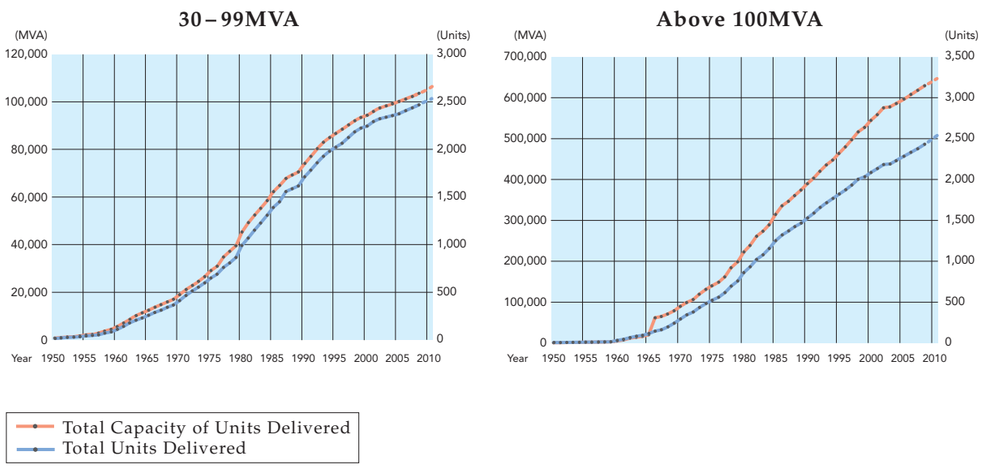
This system uses both oil and water circulation to dissipate excess heat. When a sufficient supply of cooling water is available, the weight and size of the heat exchangers can be reduced.

International Activities

Installations Around the World



Capacity and Total Units Delivered Worldwide



Canada
529MVA, 21/252/504kV

United States
315MVA, 18/225kV

Brazil
300MVA, $\frac{500}{\sqrt{3}}$ / $\frac{230.5}{\sqrt{3}}$ /13.8kV

Thailand
680MVA, 22/241.5kV

Singapore
720MVA, 22/400kV

China
900MVA, $\frac{500}{\sqrt{3}}$ / $\frac{242}{\sqrt{3}}$ /36kV

Saudi Arabia
500MVA, 400/120/(33)kV

Saudi Arabia
250MVA, 400/120/(33)kV

South Africa
2000MVA, $\frac{765}{\sqrt{3}}$ / $\frac{400}{\sqrt{3}}$ /33kV