

Mitsubishi Electric Nuclear Business

**INNOVATING A SMARTER WAY
TO SUSTAINABLE ENERGY**



MITSUBISHI ELECTRIC CORPORATION

Innovating your world for over 90 years.

As Mitsubishi Electric nears its 100th anniversary, our mission is clear — apply our technologies to contribute to society and enhance the quality of life around the globe. We are working to create a brighter future through innovation and ensure a more sustainable world. We are extending our global reach and pioneering developments in fields ranging from home appliances to satellites, introducing breakthrough after breakthrough for the benefit of society, industry, and individuals. Our path to the future is built on an untarnished record of innovation and excellence, and our tradition of “changes for the better.”

JUST A FEW OF OUR ACHIEVEMENTS



Power Semiconductor Devices

Power semiconductor devices are essential for making various kinds of power electronics equipment more energy-efficient, from traction and Electric Vehicle (EV) / Hybrid Electric Vehicle (HEV) to industrial robots and air conditioning systems.



Micro-via-laser Drilling Technologies for Printed Circuit Boards

High-speed and high-accuracy, precise laser processing enables printed circuit boards to be pierced at 6,000 holes per second; an FA technology supporting the evolution of smartphones.



Mobile Mapping System (MMS)

Consisting of equipment such as GPS antenna, laser scanners and cameras mounted on a vehicle, the MMS can acquire 3D position data including buildings, road contours, and other roadside data while driving. It has diverse applications such as public survey projects and infrastructure management.



Continuous Industrial Revolution

While we are in the midst of the 4th industrial revolution Mitsubishi Electric automation products have and will continuously contribute to the advancement of manufacturing; from next generation PLCs, “the brains behind the production line”, to advanced robotics and precise servo and motion control Mitsubishi Electric is delivering manufacturing know-how that is a step ahead of the times.



Transformer Equipment Development Technologies

We verify the reliability of our transformers utilizing the largest environmental testing facilities capable of simulating severe natural environments, including extreme cold/heat, lightning earthquakes.



Autonomous Control Technologies for Spacecraft

Featuring advanced guidance, communications, data processing and power-supply technologies, our autonomous control module pilots Japan's first unmanned automated supply vehicle to the International Space Station.

*Pictures of the ISS and HTV have been provided by JAXA



SiC Train Circuit Systems

Ushering in an age of greener rail infrastructure, our silicon carbide (SiC) traction inverters, together with our regenerative braking systems and other technologies, are delivering unprecedented energy savings.



The World's Fastest Elevator

Completed in 2015, Shanghai Tower has the fastest elevator in the world. Our aerodynamic elevator cars rocket from the basement to the 119th floor in 53 seconds at more than 70 km/h in smooth, safe comfort.

1921
Establishment of Mitsubishi Electric Corporation

1928
Debut of EF52, the first large-scale electric locomotive produced in Japan

1935
Commencement of elevator and escalator production

1956
Start of electric refrigerator business

1964
Completion of radar equipment for the weather station atop Mt. Fuji

1980
Debut of Diamond Vision display at Dodger Stadium in the United States

1990
Commercial release of the world's first car navigation system incorporating GPS

2000
Adoption of MISTY™ technology as encryption standard for 3rd-generation mobile phones

2007
Completed 173-meter-tall elevator testing tower (world's tallest at the time)

2008
Launched SUPERBIRD-C2, Japan's first domestically produced commercial satellite

2011
Debut of “Hayabusa” Series E5, holder of the Japanese speed record for a train

2014
Unveiled world's largest full ultra-HD video display* in Times Square, New York City
*As of Nov. 18, 2014 (based on total area)

2017
Developed a 19.9-millimeter-thin inspection robot for turbine generators

Every step brings the world closer to a brighter future.

MITSUBISHI ELECTRIC ENERGY AND ELECTRIC SYSTEMS

Since establishing the company almost a century ago, our name has been synonymous with high-quality energy and electric systems. With a focus on power generation systems, transformers, and power transmission equipment, we have continued to develop industry-leading technologies and provide products with a global reputation for performance, reliability, and efficiency. In particular, Mitsubishi Electric power generation systems can be found around the world meeting the steadily rising demand for electrical power.

Americas

Turbine Generators **286 units**

Gas-insulated Switchgear **991 stations**

Europe

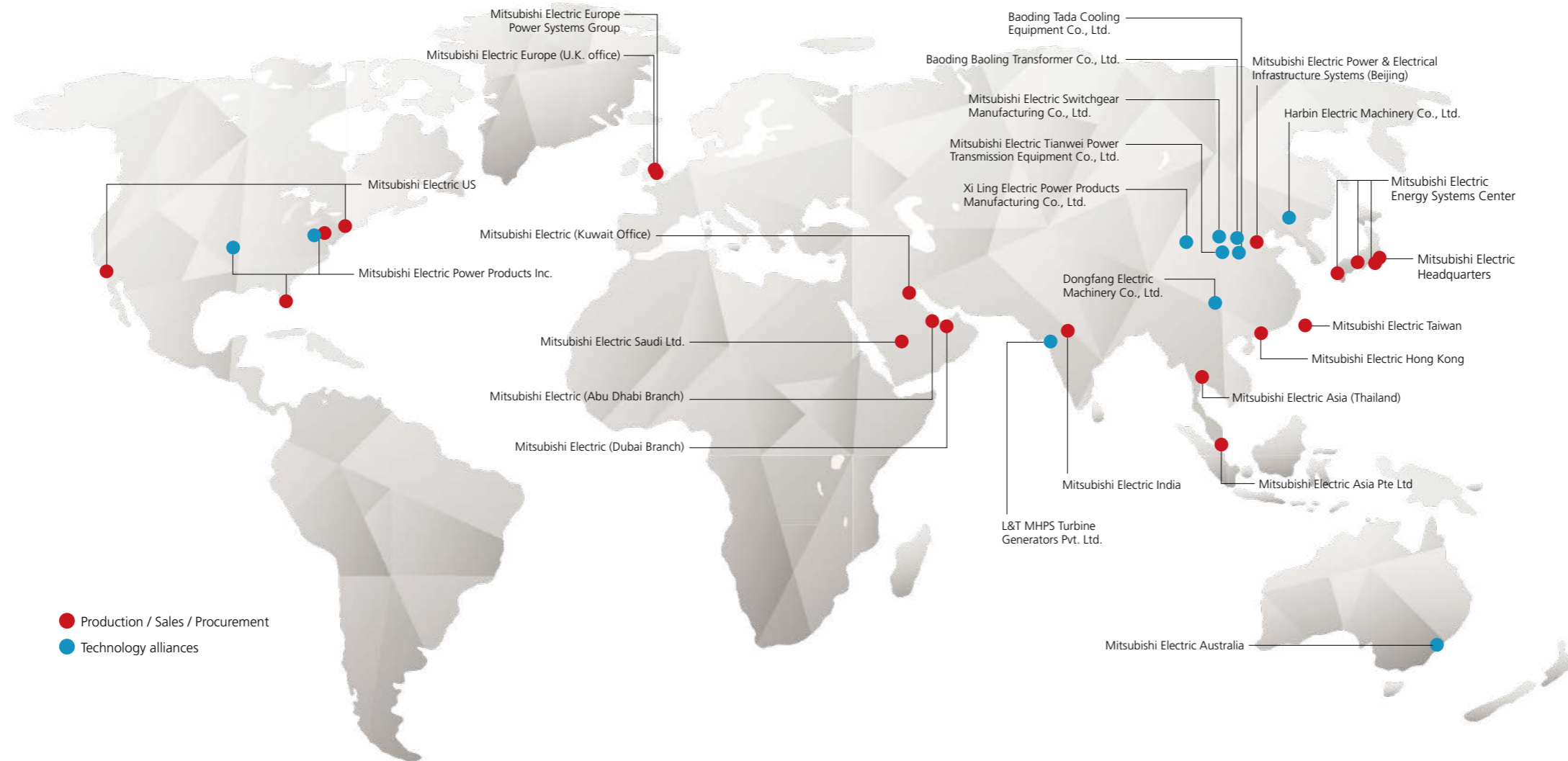
Turbine Generators **40 units**

Gas-insulated Switchgear **83 stations**

Others

Turbine Generators **47 units**

Gas-insulated Switchgear **484 stations**



World Supply Record

Turbine Generators
More than **2,000 units**

Gas-insulated Switchgear
More than **13,000 stations**

Gas Circuit Breakers
More than **48,000 units**

(As of 2015)

Asia (excluding Japan)

Turbine Generators **436 units**

Gas-insulated Switchgear **2,678 stations**

Japan

Turbine Generators **1,078 units**

Gas-insulated Switchgear **6,751 stations**

Middle East

Turbine Generators **202 units**

Gas-insulated Switchgear **2,051 stations**

Power Generation

Seeking an ideal balance of power generated from fossil fuels and renewable energy sources, Mitsubishi Electric power generation solutions contribute to creating a path to the future.

Thermal and Nuclear Power Generation

Turbine Generators

Responding to a wide range of requirements, from small power stations to large-scale nuclear power plants, Mitsubishi Electric provides an extensive lineup of turbine generators.



Digital Instrumentation & Control Systems

Improving the reliability and operability of thermal and nuclear power plants throughout Japan, these essential systems have been provided to nuclear power plants in China.



Solar Power Generation Systems

Our solar power generation systems can be found everywhere, from public facilities, office buildings and factories to schools, large-scale farms and homes, providing clean energy with superior efficiency.



Transformers & Power Transmission Equipment

In every link of the energy chain, Mitsubishi Electric is contributing to the efficient supply of high-quality power to end users.

Power Switchgear

From circuit breakers to lightning arrestors, our heavy electrical equipment is ensuring the safety and stability of electrical power lines through all nature's challenges.



Large-capacity Shell-form Transformers

Our industry-leading technologies enable the production of compact, large-capacity, high-voltage transformers that perform with optimum efficiency.

Energy Management Systems (EMS)

Equipped with leading-edge hardware, software and sophisticated design, the system plays a key role in power network control.

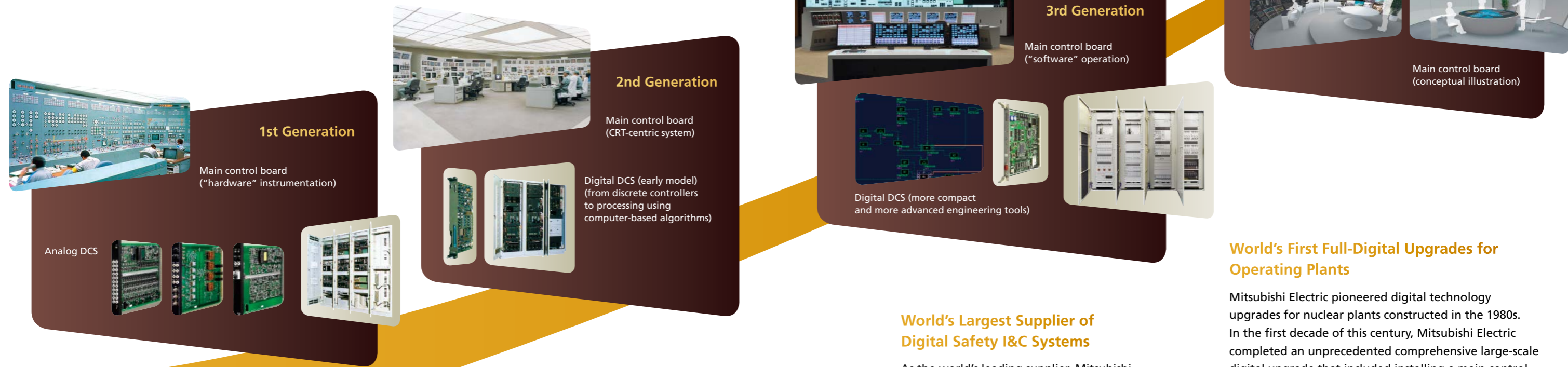


Transmission & Distribution Systems

Keeping power loss to a minimum while ensuring the stability of the power supply, these systems incorporate eco-friendly dry-air insulation technology.

NUCLEAR BUSINESS

Mitsubishi Electric has been supplying electrical systems and instrumentation-and-control (I&C) systems to nuclear power plants for decades, as well as contributing to the safe and secure operation of nuclear power plants using reliable technologies with a proven track record. Utilizing our I&C systems in particular, Mitsubishi Electric is providing both analog and digital systems made with leading-edge technologies of each generation for new plant construction and upgrading existing plants.



World's Largest Supplier of Digital Safety I&C Systems

As the world's leading supplier, Mitsubishi Electric has delivered digital safety I&C systems to many plants in Japan and overseas.

World's First Full-Digital Upgrades for Operating Plants

Mitsubishi Electric pioneered digital technology upgrades for nuclear plants constructed in the 1980s. In the first decade of this century, Mitsubishi Electric completed an unprecedented comprehensive large-scale digital upgrade that included installing a main control board. A feat only possible owing to our abundant experience with nuclear power modernization projects.

over **50** years

Experience

Abundant experience with domestic and overseas nuclear power plants.

over **80%**

Comprehensive Product Lineup

Mitsubishi Electric has the ability to supply over 80% of products itemized in "ANNEX 1:24. Electrical equipment and I&C plant equipment" of the TECHNICAL REPORTS SERIES No. 396 "Economic Evaluation of Bids for Nuclear Power Plants" issued by the International Atomic Energy Agency.



Target: **100%**
Customer Satisfaction

Customer Satisfaction

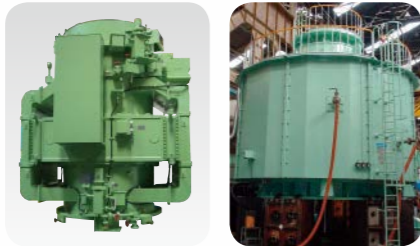
By bringing the entire manufacturing system, from design to manufacturing and testing in-house under the Mitsubishi Electric umbrella of quality control, Mitsubishi Electric supplies customers in the nuclear power industry with safe and secure products that meet and exceed expectations.

NUCLEAR POWER PLANT PRODUCT LINEUP

Vast range of products for nuclear power plants including electrical, I&C, and security systems

1 Pump Motor

Large-scale motors for safety-related and non-safety-related large-capacity pumps used for cooling the reactor, circulating water, etc. in nuclear power plants.



2 Network Camera

Our high-resolution network camera systems featured advanced functionality and performance achieved by our high image analysis technology for provide monitoring the interior of nuclear containment vessel and power generation area for security and other purposes.



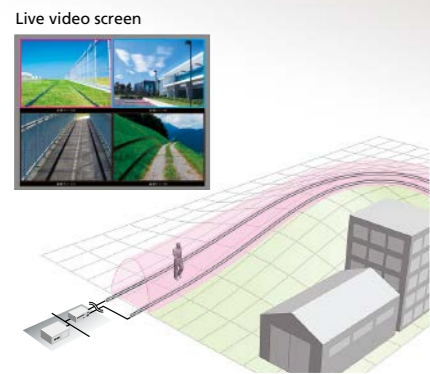
3 Electric Penetration Unit

Electric penetration units installed in the containment vessel wall maintain a high degree of airtight integrity inside and outside the vessel, and accommodate the wiring for the electrical and instrumentation systems installed within the vessel.



4 Intrusion Detection Sensor

Intrusion detection sensors provide wide-area detection and precision intrusion point information, for effective site security.



5 Diesel Generator

Diesel generators are used to assure plant safety as a redundant power source if the external power source is lost.



6 Uninterruptible Power Supply (UPS)

In the event of a temporary drop in power due to a typhoon, lightning strike or other unforeseen incident, a UPS is capable of protecting the plant systems and equipment from potential damage resulting from outages and insufficient power supply.



7 Switchgear (SWGR)/ Motor Control Center (MCC)

Our SWGR and MCC provide all types of electric systems and equipment, from large-scale motors to small auxiliary equipment, with reliable power switching, control, disconnection/isolation and protection.



8 Generator Load Break Switch (GLBS)/Gas Circuit Breaker (GCB)

GLBS/GCB have been incorporated into the most recent plants to simplify power supply transfer operations in the event of a power outage.



12 Instrumentation & Control (I&C) Systems



11 Gas-insulated Switchgear

Installed in the power plant switchyard, our gas insulated switchgear plays a vital role securing and transmitting the flow of electricity between the grid and the power plant.



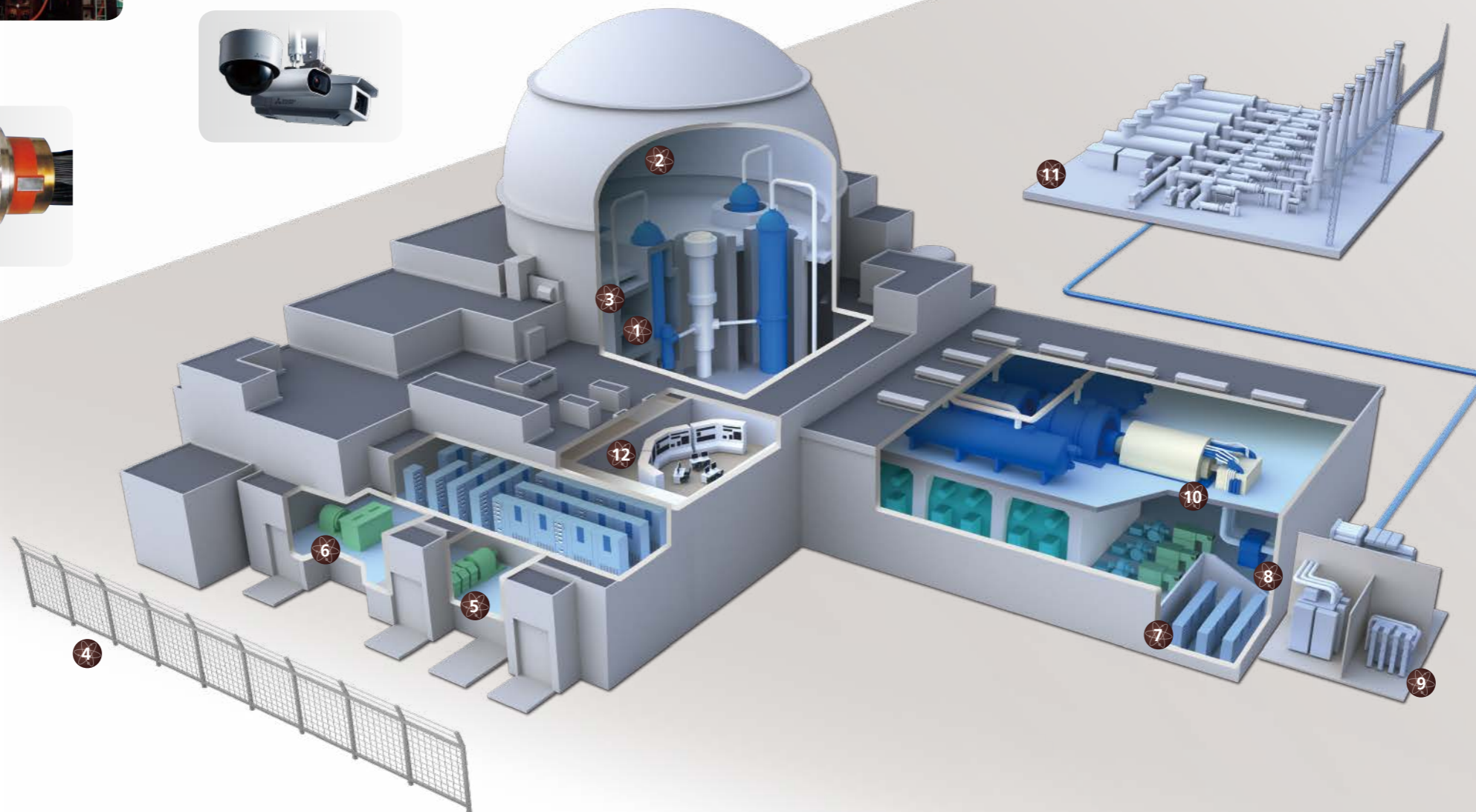
10 Turbine Generator

Turbine generators convert the rotational energy created by steam turbines into electrical energy.



9 Transformer

Nuclear power plants require large-capacity transformers for the main transformer, start-up transformer, house service transformer, reserve transformer, etc.



I&C SYSTEMS

Mitsubishi Electric provides I&C systems for monitoring, protecting, and controlling nuclear power plants. The I&C product lineup ranges from components such as sensors to main control boards. Our I&C systems for nuclear power plants comply with the safety classification demanded by countries around the world.

1 Safety I&C System

The Safety I&C systems are the most essential components of the protective systems required to assure the safety of a nuclear reactor.



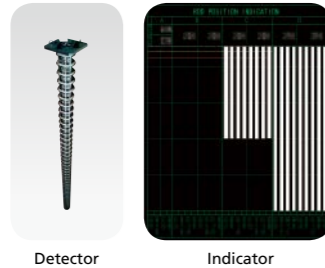
2 Control Rod Drive Mechanism Control System (CRDM-CS)

This system actuates the driving mechanism that inserts and withdraws the rod cluster within the reactor core.



3 Rod Position Indication (RPI) System

The RPI measures and monitors the position of rod assemblies, and displays the rod position. In addition Mitsubishi Electric also provides detectors.



Detector

Indicator

4 Ex-Core Nuclear Instrumentation System (NIS)

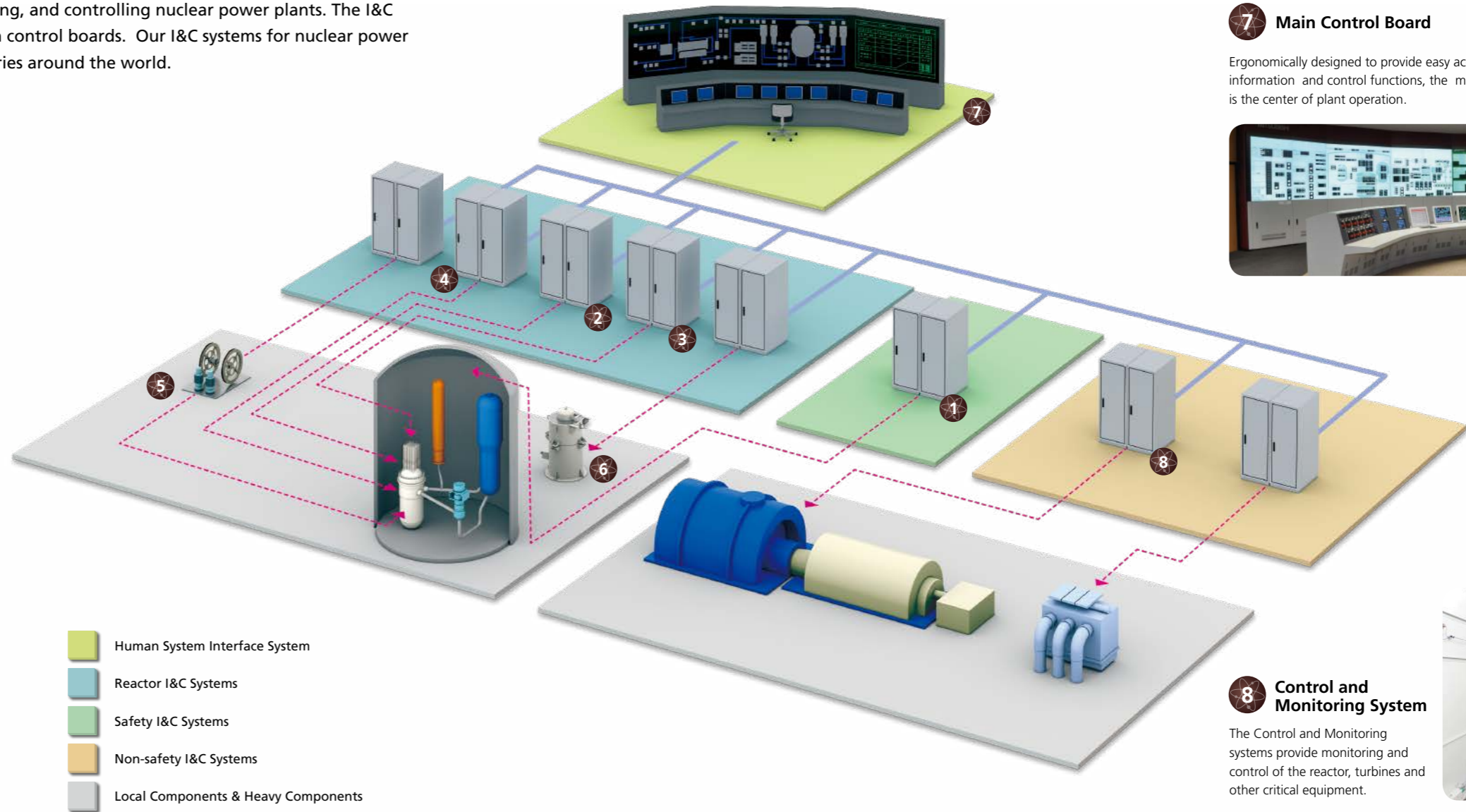
A NIS measures the nuclear reactor output level and is equipped with a neutron detector that continuously measures neutron flux.



Neutron Detector

5 In-Core Instrumentation System (ICIS)

The ICIS routes the movable in-core neutron detectors into the selected core location (thimble). Mitsubishi Electric also provides essential mechanical components such as resolvers and rotary indexes that comply with EU directives.



- Human System Interface System
- Reactor I&C Systems
- Safety I&C Systems
- Non-safety I&C Systems
- Local Components & Heavy Components

7 Main Control Board

Ergonomically designed to provide easy access to all information and control functions, the main control board is the center of plant operation.



8 Control and Monitoring System

The Control and Monitoring systems provide monitoring and control of the reactor, turbines and other critical equipment.



6 Radiation Monitoring System (RMS)

The monitoring of radioactivity in the air and water is essential to ensure the safety of employees and society. Our RMS is composed of the RMS cabinet, area monitors and process monitors.



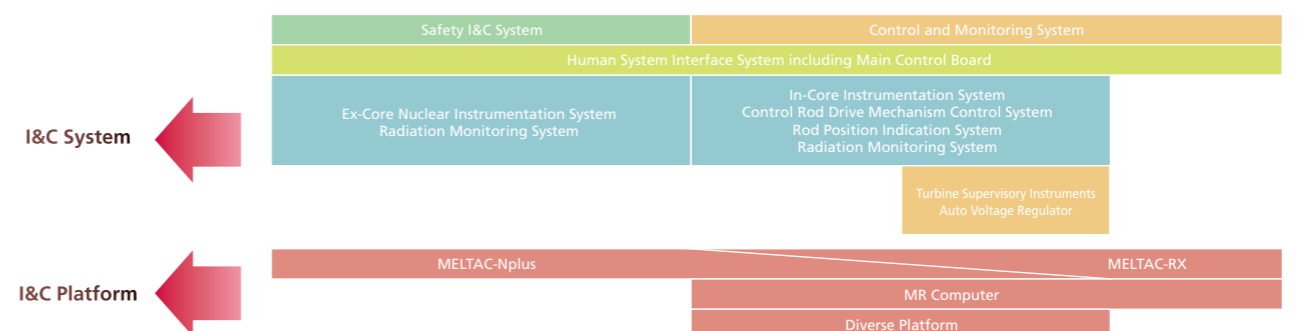
Particulate Monitor



Liquid Monitor

Safety Classifications

Organization / Country		Safety Classification of I&C Functions and Systems in Nuclear Plants			
IAEA SSG-30	Function	Safety Category 1	Safety Category 2	Safety Category 3	Systems not important to safety
	System	Safety Class 1	Safety Class 2	Safety Class 3	
IEC 61226	I&C Function	Systems important to safety			Non-classified
		Category A	Category B	Category C	
	I&C System	Class 1	Class 2	Class 3	
United States (IEEE)		Systems important to safety			Non-safety-related
		Safety-related	—		
Japan (JEAC/JEAG)		PS1/MS1	PS2/MS2	PS3/MS3	Non-nuclear safety



I&C PLATFORMS

Safety I&C Platform

If a natural disaster or accident occurs, Safety I&C Systems must perform the safe cooling and shutdown of nuclear plant operations. Mitsubishi Electric is ready with a proven platform of the highest reliability that features independence, redundancy, and diversity.

MELTAC-Nplus

MELTAC-Nplus is a digital Safety I&C platform specifically developed to respond to demands of the Safety I&C systems and to realize true "Defense in Depth" for nuclear power plants.

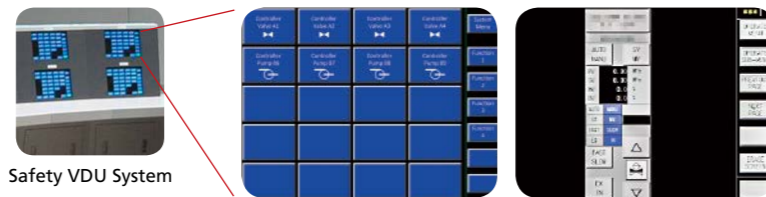
Features

- Top class digital safety I&C platform with a proven record of operating in 26 nuclear power plants.
- All hardware modules, basic software, and maintenance tools for the MELTAC platform are designed, developed, and manufactured in-house.
- Qualified hardware and software meet the strict safety regulations and standards of the U.S. and Japan.
- Easy to identify the failure part by applying originally developed software by Mitsubishi Electric.
- Possible to build Safety I&C system solution in response to specific customer requirements for each plant.
- Software operation of safety-related auxiliary equipment



Applications

- Reactor Protection System (RPS)
- Engineered Safety Features Actuation System (ESFAS)
- Safety Logic System (SLS)
- Ex-Core Nuclear Instrumentation System (NIS)
- Radiation Monitoring System (RMS)
- Safety Visual Display Unit (VDU) System



Diverse Platform

As a backup for our digital Safety I&C systems in the event of a software common cause failure (CCF), the Diverse platform features the built-in diversity of non-computerized functionality.

Features

- Analog (Non-FPGA* based).
 - Automatic actuation logic consisting of discrete components.
 - Hard-wired external cable connection to a digital I&C system.
- *Field-programmable gate array

Applications

- Diverse Actuation System (DAS), including Anticipated Transient Without Scram (ATWS) Mitigation System
- Diverse Human System Interface Panel



Control and Monitoring I&C Platform

This platform is for the control and monitoring the reactor, turbines, and other applications classified as "non-safety" in nuclear plants. Mitsubishi Electric also provides plant computer platforms that monitor the state of plant operations.

MELTAC-RX

MELTAC-RX is a digital platform applicable in non-safety I&C systems for the control and monitoring of nuclear reactors and turbines.

Features

- Easy connectivity with other equipment (MODBUS, Profi-NET, etc.)
- Capability to interface with smart field devices (Profibus, HART, etc.)
- Compact, space-saving design achieved by high packaging efficiency.

Applications

- Reactor Control System (RCS)
- Turbine Control System (TCS)
- Feedwater Control System (FWCS)
- In-core Instrumentation System (ICIS)
- Control Rod Drive Mechanism Control System (CRDM-CS)
- Rod Position Indication (RPI) System
- Radiation Monitoring System (RMS)
- Other auxiliary systems



Mitsubishi Real-time (MR) Computer

Boasting the functionality required for controlling and monitoring nuclear power plant systems, the MR computer is an industrial computer equipped to handle a variety applications, including in a Human System Interface System (HSIS) and an alarm processing system.

Features

- Excellent stability and real-time performance achieved using software developed in-house.
- Durability and suitability for operation in plant-operating conditions verified during qualification testing.
- Easy-to-use HSI design verified by operators in domestic and overseas plants.

Applications

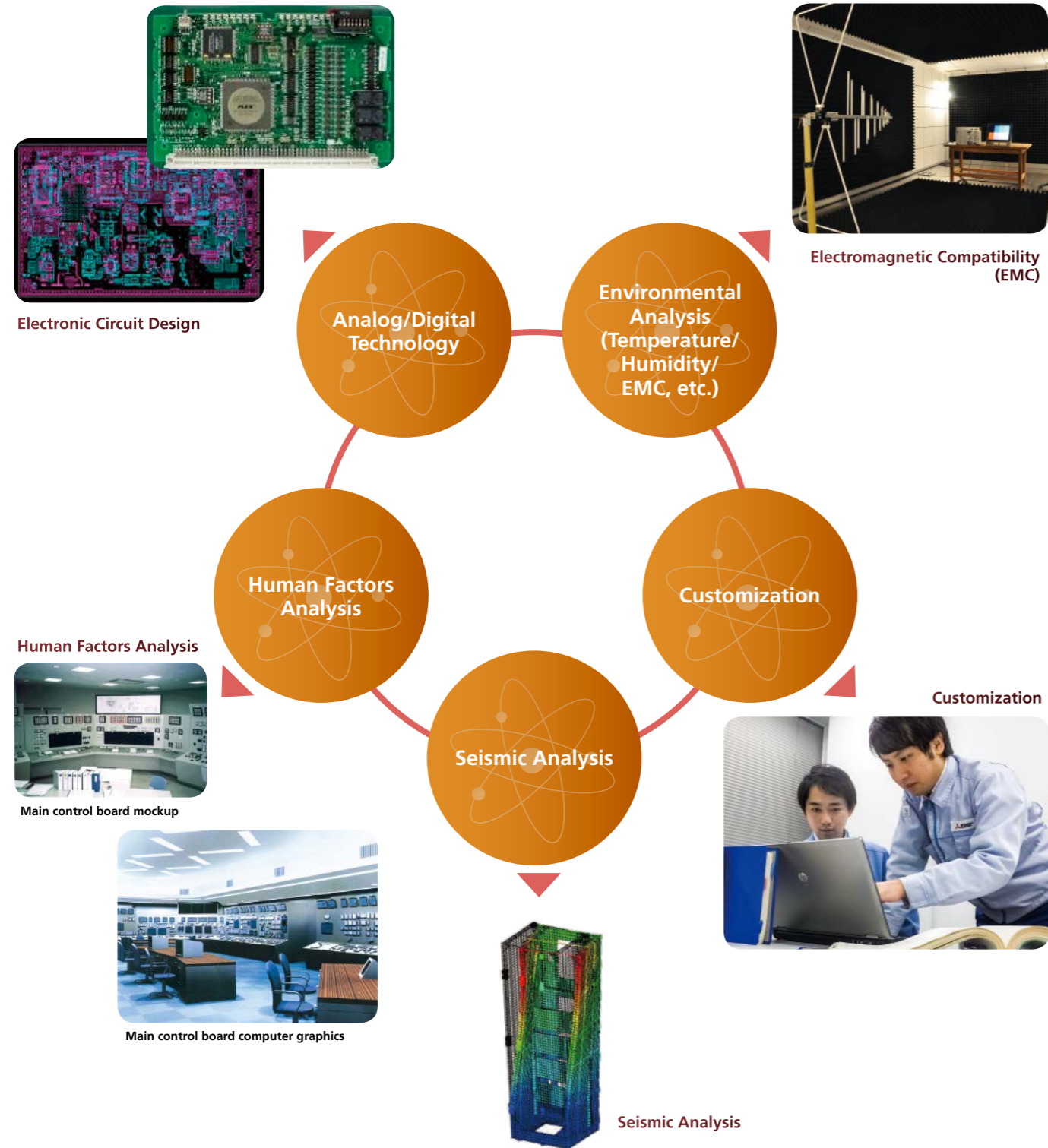
- Digital Human System Interface System (HSIS)
- Plant Control Computer System (PCCS)
- Technical Support Center (TSC)
- Safety Parameter Display System (SPDS)
- Post Accident Monitoring System (PAMS)



ENGINEERING SOLUTIONS

Design

Advanced technologies combined with our extensive experience in the nuclear power industry enable us to design and engineer the best products and solutions to maintain safe nuclear plants.



Manufacturing

From materials procurement through every step of manufacturing, our products are made in Mitsubishi Electric factories under strict quality control (capable of manufacturing circuit boards compliant with RoHS). Our manufacturing and testing facilities are fully equipped to meet the challenge of both mass-produced and "made-to-order" products.

Circuit Board Manufacturing



Featuring leading-edge manufacturing equipment, such as point soldering automation and image inspection test apparatus, our factories can produce a wide variety of circuit boards that meet the highest quality standards.

Control Panel Assembly



High-quality performance of the wiring and the assembly of control panels and units are assured by highly skilled employees with national or internal technical certifications.

ENGINEERING SOLUTIONS

Test

Integrated testing of all I&C systems, including the inspection and testing of each product and verification testing in environments that simulate actual on-site conditions combined with plant simulator testing, ensures that Mitsubishi Electric ships only products of the highest quality from its factories.

Integration Test



Cabinet Test



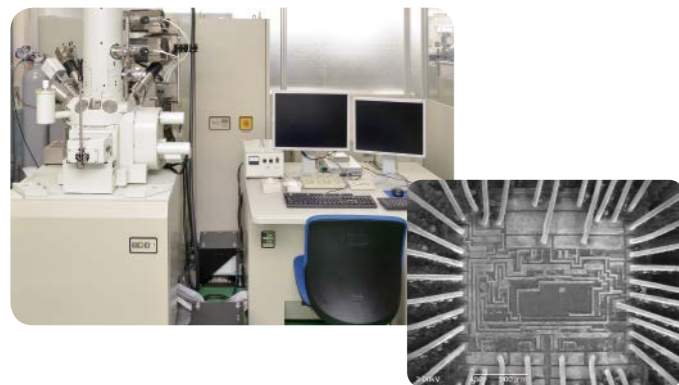
Card Test



Parts Investigation

Mitsubishi Electric performs all maintenance in-house including detailed investigation of components and devices using an array of advanced technologies such as component nanoanalysis, it contributes to our nuclear quality trusted around the world.

Scanning Electron Microscope Analysis



The extreme magnification of this analysis facilitates detection of any metallurgical defects or abnormalities on the surface of components.

Intelligent Emission Microscopy



It is possible to immediately analyze of semiconductor on print circuit board by detecting weak emission and resistance change in abnormal condition.

Qualification

Mitsubishi Electric performs qualification testing in accordance with national and international standards and regulations, which supports smooth compliance with the requirements of nuclear regulatory body in each country.

EMC



Mitsubishi Electric thoroughly tests its own products and systems to ensure that they do not propagate nor are susceptible to interference by electromagnetic fields that can result in unintended effects on operational performance.

Seismic



Products are subjected to vibration testing to verify functional and physical durability.

Environment



Testing under a variety of temperature, humidity and other plant environment conditions is performed to assure product integrity under severe conditions.

USA

HFE Design Verification and Validation

The US-APWR Design Certification Document (DCD) Chapter 18 Human Factors Engineering (HFE) was submitted by Mitsubishi Heavy Industries, Ltd. (MHI). MHI received the draft Safety Evaluation Report (SER) of the Chapter 18 by the Nuclear Regulatory Commission (NRC) as compliant with HSI design Review Guidelines NUREG-0700 and HFE program Review Model NUREG-0711. Mitsubishi Electric led the HSIS implementation, developed the full-scope simulator for the US-APWR HFE licensing activity, and resolved human factors issues addressed by NUREG-0700, NUREG-0711 and the HFE process.



Operator Verification Facility

China

Chinese Regulation: HAF604

Certified by the National Nuclear Safety Administration (NNSA) as compliant with HAF 604 regulations for equipment and products manufactured outside of China to be used in nuclear power plants in China. HAF are the Supervision and Management Regulations for Imported Civilian Nuclear Equipment.



CUSTOMER SERVICE

Optimization Design

Our abundant engineering experience, combined with reliable technologies, empower our ability to design and provide a wide variety of solutions for our customers.

Total Main Control Room Design



Training

Mitsubishi Electric can provide operator and maintenance staff training through a plant simulator located in-factory (Nuclear Simulation and Training Center (N-SAT)) and a comprehensive curriculum etc.

Classroom Training



On-the-Job Training



Installation and Commissioning

During the plant installation and commissioning phases, Mitsubishi Electric can dispatch teams of highly experienced specialists and provide technical assistance on-site.

Installation Work



Commissioning Work



Long-Term Supply and Support

Throughout the long life cycle of our customers' nuclear power plants, Mitsubishi Electric provides expert support and maintenance for our nuclear products, backed by the reliable supply of replacement components and system modernization. Before components reach their end of life and are no longer produced, customers can be confident that sufficient stock is prepared based on demand forecasts. After delivery, our "customer first" support continues with a variety of maintenance services.



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