Fuji Electric

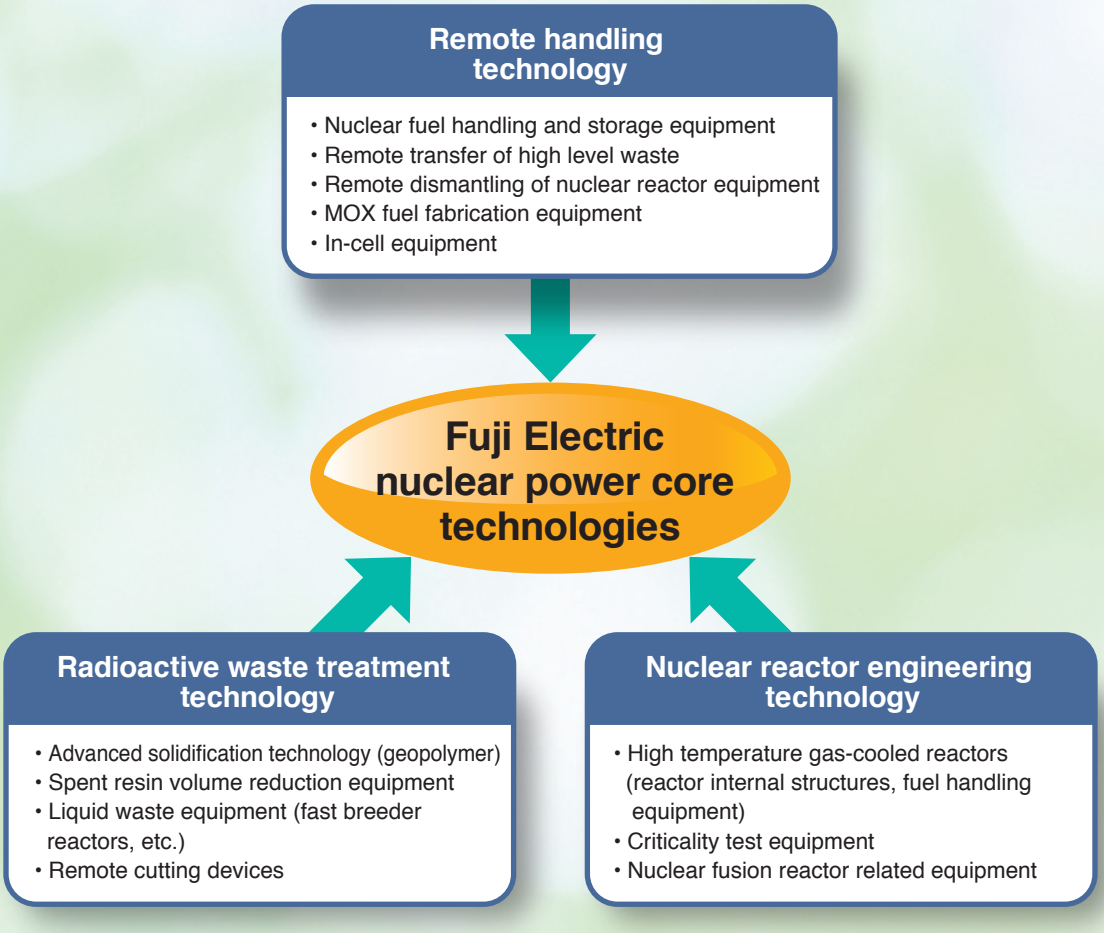
Innovating Energy Technology

Nuclear technology of Fuji Electric

01C1-E-0086b

Undertakings in the Nuclear power business

3 unique technologies -- remote handling, waste treatment, and high temperature gas-cooled reactor--have ensured energy resources for more than half a century.*



*Fuji Electric constructed Japan's first commercial nuclear power station, Tokai Power Station (a gas-cooled reactor), In 1965. It has also developed remote handling technology for radioactive materials, and superior technology for handing and processing radioactive waste, and had established unclear reactor technologies for high temperature gas-cooled reactors. Fuji Electric has played an important role in the development of the nuclear fuel cycle such as in the Fugen advanced thermal reactor, the Monju fast breeder reactor, high temperature gas-cooled reactor (HTTR), and fuel fabrication.

History of Major Achievements in the Field of Nuclear Power

Areas		1960's	1970's	1980's	1990's	2000's
Commercial Reactor	Tokai Reactor	Construction		In-vessel maintenance equipment	Confirmatory test for remote dismantling of the reactor	[Decommissioning]
Advanced Reactor	HTGR			High Temperature Engineering Test Reactor HTTR Helium Engineering Demonstration loop HENDEL [Core internals, Fuel handling system] [Fuel stuck, In core Structure test section]	HTTR spent fuel storage facility Development of demonstration reactor	
	FBR		JOYO [Fuel handling and storage]	MONJU [Fuel handling, Engineering Safety Features, and etc.]	JOYO Mk III [Automatic control system for fuel handling system] Development of demonstration reactor	
	ATR		FUGEN [Fuel handling equipment, Engineering safety protective equipment]			
Nuclear Fuel Cycle (MOX fuel fabrication Reprocessing)					MOX fuel fabrication facility [Pellet inspection facility, Pellet storage and transport facility] Reprocessing plant at Rokkasyo [Glove box equipment, In-cell equipment]	
Radioactive waste treatment plant			JOYO FUGEN	MONJU Addition of facility at FUGEN	Renewal at JOYO	IC plasma spent resin volume reduction processing equipment

Map & Supplied System

Client	Ⅰ. Remote handling technology	Ⅱ. Radioactive waste treatment technology	Ⅲ. Nuclear reactor engineering technology
The Japan Atomic Power Company(Tokai)	● (Decommissioning)		●
Japan Atomic Energy Agency(Tokai)	● (J-PARC)		
Japan Atomic Energy Agency(Oarai)	● (JOYO, HTTR)	● (JOYO)	● (HTTR)
Japan Atomic Energy Agency(Thuruga)	● (FUGEN, MONJU)	● (FUGEN, MONJU)	
Japan Nuclear Fuel Ltd,(Rokkasyo)	● (Transport systems)		

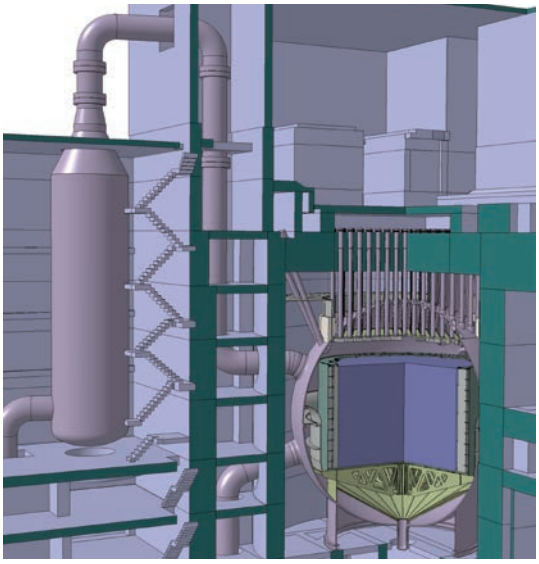
J-PARC: Japan Proton Accelerator Research Complex

Remote handling technology

Remote dismantling nuclear reactor equipment

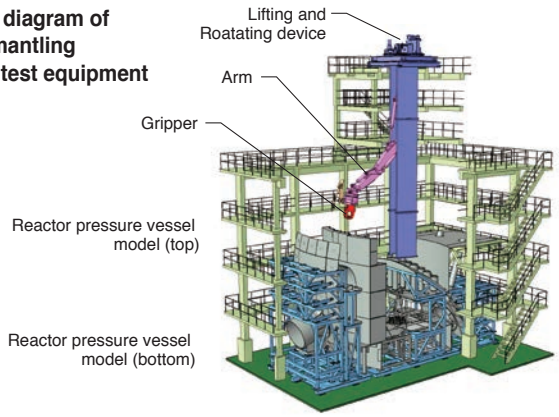
- **Customer: The Japan Atomic Power Company**
- **Output: 166 MWe**
- **Operation start: July 1966**
- **Operation end: March 1998**

Tokai Power Station

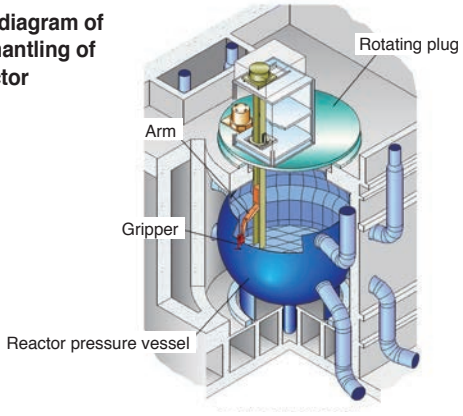

Reactor pressure vessel, internals and primary cooling system
(Drawing by 3D CAD for dismantling simulation)

The reactor dismantling test model features a faithfully simulated main reactor internal structures and reactor pressure vessel (19 m in diameter) constructed of the same material and in the same size.

Conceptual diagram of remote dismantling technology test equipment

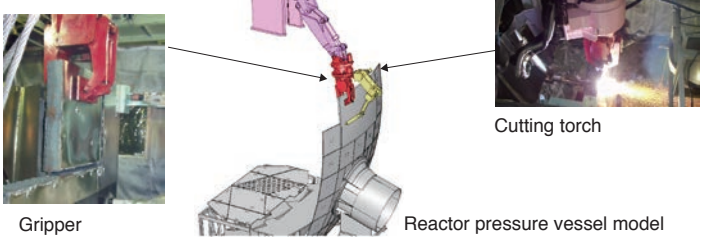


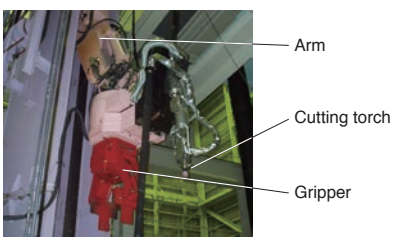
Conceptual diagram of remote dismantling of nuclear reactor



We have obtained various data useful for the remote dismantling of an actual reactor by conducting demonstration tests of the technologies to remotely dismantle nuclear reactor vessels and other equipment that cannot be brought close to humans because of the high levels of radiation after long-term operation and these technologies include cutting the reactor pressure vessel, moving pieces of the vessel using robot arms and segregating the radioactive substances.

Example of remote dismantling system demonstration test





Remoto handing technology

MOX Fuel Manufacturing Facility (MOX:Mixed Oxide)

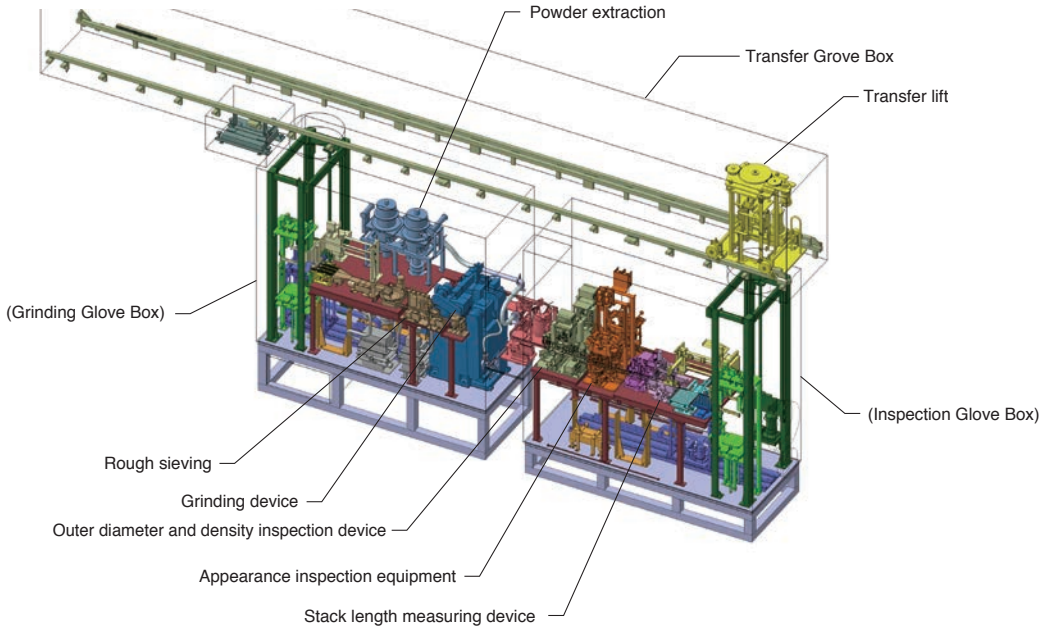
◉ Main Equipment Supplied by Fuji Electric

- Pellet Grinding and Inspection Equipment
  - Pellet size and density inspection system
  - Density measuring Device
  - Equipment to Inspect the Grinded Pellet
  - Grinding machine
  - Pellet surface inspection equipment
- Inspection Machine of Fuel Assembly
- Automatic Storage Facility of Uranium

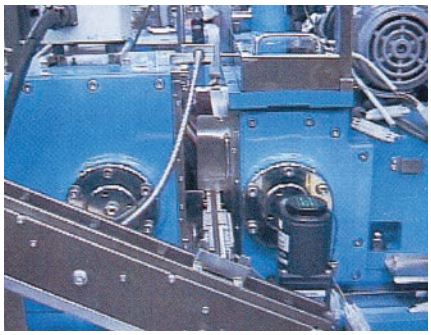
◉ Features

- Simplification of the system by the function integration
- High Speed Processing (100,000 pellets a day)
- Minimum hold up
- Improved maintainability
- Remote & Automation

Bird's eye view of grinding inspection equipment



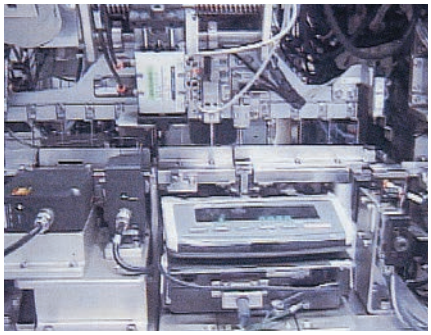
Photograph of Glove Box
(Courtesy of JAEA)



1. Grinding Machine

Major Spec.

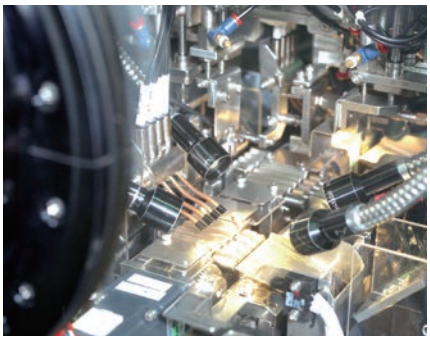
- Method: Dry type center-less grinding method
- Function: Grinding of the pellet periphery



2. Pellet size and density inspection system

Major Spec.

- Method: Size measurement by laser instrument
  Weight measurement by electromagnetic balance type
- Function: Quality check by measurement of size and weight of the pellet and computing density



Pellet surface inspection equipment

Major Spec.

- Method: 3 ITV camera imaging
- Spec.: Equipment check the surface of both end and the body of pellets

Radioactive waste treatment

Advanced solidification technology (Geopolymer) "SIAL®"

SIAL® *1 is the geopolymer, which is applied for encapsulation of radioactive waste. Geopolymer is a general term for amorphous condensation polymer formed by reaction of alkaline component and aluminosilica powder, and attracts attention in terms of the Cs encapsulation effect. It can be kneaded and solidified with a similar system to cement. SIAL® can also solidify waste, such as used radioactive ion exchange resin, sludge waste, incineration ash, oil and concentrated liquid watse etc.

Waste loading ratio	MAX 40 wt%
Compressive Strength	7-45 MPa
Density	1.4 to 1.8 g/cm^3
Viscosity	～2 Pa・s

◉ Feature

- High ability to encapsulate Cs and heavy metals
- Physically and chemically stable
- Wide range of solidification target waste
- Easy handling (high liquidity, no heating required, on site treatment with mobile facility)
- High waste loading ratio (Reduce number of waste body)

SIAL® Solidified samples

Treatment facility

◉ Solidification test of radioactive waste from NPP*2

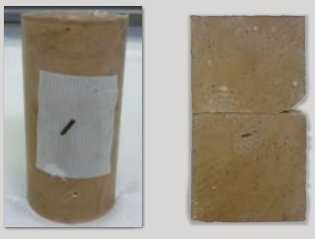
- Conducted the first demonstration test of radioactive waste solidification by geopolymer in Japan
- Basic data acquisition of the solidified body for sludge and ion exchange resin produced by the Tsuruga Nuclear Power Plants
- The impact of Isosaccharinic Acid (ISA*3) on the partition coefficient is small

Solidification and Characterization

Solidified body

Sludge

Compressive strength 14 MPa



Appearance　　Cross-sectional photograph

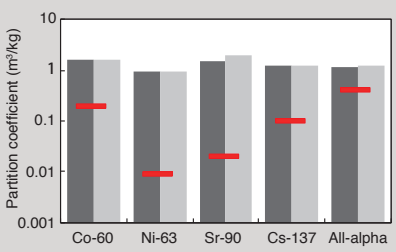
Ion exchange resin

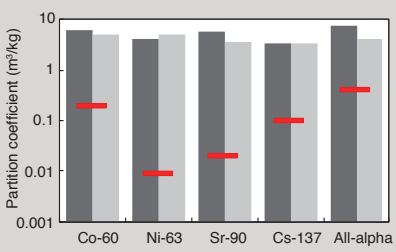
Compressive strength 7.7 MPa

Appearance　　Cross-sectional photograph

Loading Ratio of radioactive waste: 40 wt%
Dimensions: ϕ50×100 mm

Partition coefficient





The configuration values *4

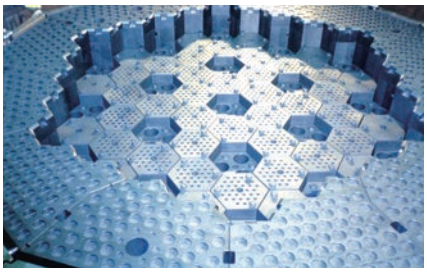
Without ISA
With ISA

*1 SIAL is a licensed technology of Jacobs
*2 A part of the results of the contracted research program with Japan Atomic Power Company.
*3 Isosaccharinic acid, decomposition product of cellulose, is concerned about the decline of Partition coefficient.
*4 No. 3 Waste Disposal Facility at Rokkasho Low-Level Radioactive Waste Disposal Center

Nuclear reactor engineering

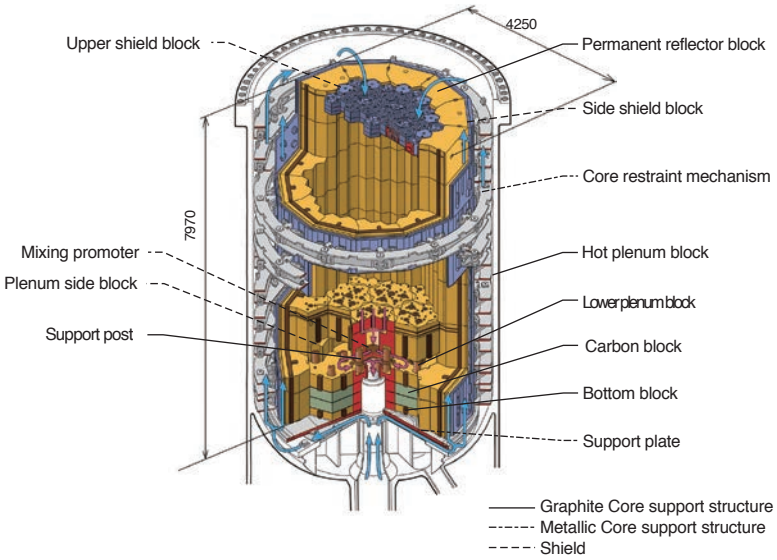
High temperature engineering test reactor (HTTR)

- **Customer: Japan Atomic Energy Agency (JAEA)**
- **Output Power: 30 MWth**
- **Outlet coolant temperature: 850°C/950°C**
- **Main products: Reactor internal structures、Fuel handling & storage system**
- **Core design, Safety analysis: in cooperation with JAEA**



Reactor internals (top view, outer dimension 4.25 m)

Core Internals



'HTTR' Fuel Handling Machine

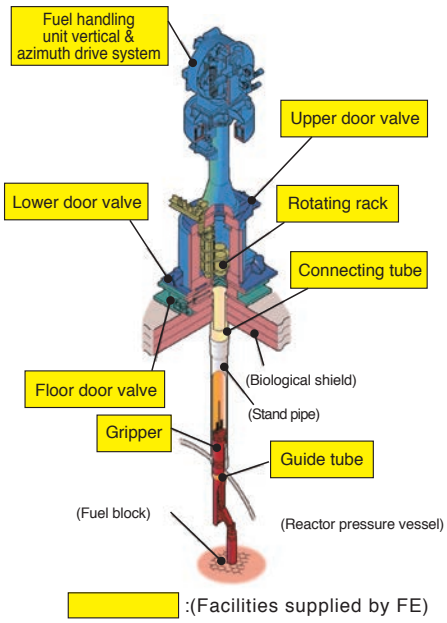
Feature

- Fuel handling machine is used for charging/discharging of fuel blocks into/out of nuclear reactor and is used for transfer of fuel blocks between spent fuel storage facilities and fresh fuel storage facilities
- Fuel remote and automatic operations perform a series of refueling, and position fuel assembly blocks to any predetermined places inside reactors.

Design pressure	98 kPa
Design temperature	200°C
Dimensions	11 m
Weight	150 t
Atmosphere (external / internal)	Air / helium gas
Handling load capacity	Fuel assembly block, etc. 200 kg

Fuel Handling Machine

Fuel Handling Machine (Gripper)



Fuji Electric Co., Ltd.
Gate City Ohsaki, East Tower, 11-2, Osaki 1-chome, Shinagawa-ku, Tokyo 141-0032, Japan
Phone : (03)5435-7111

Internet address : www.fujielectric.co.jp

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