We contribute to the realization of a safe, serene, sustainable society.
**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.*

---

**Remote handling technology**
- Nuclear fuel handling and storage equipment
- Remote transfer of high level waste
- Remote dismantling of nuclear reactor equipment
- MOX fuel fabrication equipment
- In-cell equipment

**Radioactive waste treatment technology**
- Advanced solidification technology (geopolymer)
- Spent resin volume reduction equipment
- Liquid waste equipment (fast breeder reactors, etc.)
- Remote cutting devices

---

**Nuclear reactor engineering technology**
- High temperature gas-cooled reactors (reactor internal structures, fuel handling equipment)
- Criticality test equipment
- Nuclear fusion reactor related equipment

---

*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 handling 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

<table>
<thead>
<tr>
<th>Areas</th>
<th>1960’s</th>
<th>1970’s</th>
<th>1980’s</th>
<th>1990’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Reactor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear Fuel Cycle (MOX fuel fabrication Reprocessing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radioactive waste treatment plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remote handling technology**
- HTGR (Fuel handling and storage)
- JOYO (Fuel handling and storage)
- MONJU (Fuel handling and storage)
- FUGEN (Fuel handling and storage)

**Nuclear reactor engineering technology**
- JOYO (Fuel handling and storage)
- FUGEN (Fuel handling and storage)
- MONJU (Fuel handling and storage)

**Radioactive waste treatment technology**
- JOYO (Fuel handling and storage)
- MONJU (Fuel handling and storage)
- FUGEN (Fuel handling and storage)

**Map & Supplied System**

![Map of Japan showing locations of nuclear power plants and organizations.](image)

- **Japan Atomic Energy Agency (Tsuruga)**
- **Japan Nuclear Fuel Ltd., (Rokkasho)**
- **The Japan Atomic Power Company (Tokai)**
- **Japan Atomic Energy Agency (Oarai)**
- **Japan Atomic Energy Agency (Fugen, Monju)**
- **Japan Nuclear Fuel Ltd., (Rokkasho)**

### Client

<table>
<thead>
<tr>
<th>Client</th>
<th>I. Remote handling technology</th>
<th>II. Radioactive waste treatment technology</th>
<th>III. Nuclear reactor engineering technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Japan Atomic Power Company (Tokai)</td>
<td>☑ (Decommissioning)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan Atomic Energy Agency (Tokai)</td>
<td>☑ (J-PARC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan Atomic Energy Agency (Oarai)</td>
<td>☑ (JOYO, HTTR)</td>
<td>☑ (JOYO)</td>
<td>☑ (HTTR)</td>
</tr>
<tr>
<td>Japan Atomic Energy Agency (Thuruga)</td>
<td>☑ (FUGEN, MONJU)</td>
<td>☑ (FUGEN, MONJU)</td>
<td></td>
</tr>
<tr>
<td>Japan Nuclear Fuel Ltd., (Rokkasho)</td>
<td>☑ (Transport systems)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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.*

- **Advanced solidification technology (geopolymer)**
- **Spent resin volume reduction equipment**
- **Liquid waste equipment (fast breeder reactors, etc.)**
- **Remote cutting devices**
- **High temperature gas-cooled reactors (reactor internal structures, fuel handling equipment)**
- **Criticality test equipment**
- **Nuclear fusion reactor related equipment**

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

Customer: The Japan Atomic Power Company
Operation start: July 1966
Operation end: March 1998

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

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
Remote 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

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

Remote dismantling nuclear reactor equipment

MOX Fuel Manufacturing Facility

Conceptual diagram of remote dismantling technology test equipment

Example of remote dismantling system demonstration test

Photograph of Glove Box
(Pellet Inspection Equipment)
Presented by JAEA

Major Spec.
- Method: 3 ITV camera imaging
- Spec.: Equipment check the surface of both end and the body of pellets
Advanced solidification technology (Geopolymer) "SIAL® II"

SIAL is the geopolymer, which is only applied and industrialized in the world (practically operated in Slovakia, Czech Republic) for encapsulation of radioactive waste.

It can be kneaded and solidified with a similar system to cement.

SIAL can also solidify waste, which is difficult to be solidified with cement such as used radioactive ion exchange resin, sludge waste, incineration ash, oil and concentrated liquid waste etc.

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.

(SIAL is the technology owned by wood Plc.)

Feature

- High retention capacity of Cs and heavy metals (10 times more than Cement)
- Physically and chemically stable (Surpass each characteristics of Cement)
- Wide range of solidification target
- Easy handling (No need of heat treatment + liquidity, on site treatment at mobile facility)
- High Waste loading ratio (Reduce number of waste body)

<table>
<thead>
<tr>
<th>Waste loading ratio</th>
<th>MAX 40wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength</td>
<td>20-45 MPa</td>
</tr>
<tr>
<td>Leachability index</td>
<td>Li: Cs-137: 8 — 14</td>
</tr>
<tr>
<td></td>
<td>Sr-90 : 12 — 14</td>
</tr>
<tr>
<td></td>
<td>Am, Pu: 12 — 18</td>
</tr>
<tr>
<td>Radiation stability</td>
<td>~1 MGy (Co-60)</td>
</tr>
<tr>
<td>Viscosity</td>
<td>~2 Pa • s (8h after kneading)</td>
</tr>
</tbody>
</table>

Performance record

- **Slovakia: Jaslovské-Bohunice Al (shut down by accident-under decommissioning)**
  - On-site solidification of strontium-90, cesium-137 and TRU contaminated sludge
  - On-site solidification of more than 700 m³ of sludge, spent IX resin and crystalline borates

- **Czech Republic: Dukovany NPP and Temelin NPP (both in operation)**
  - On-site solidification of sludge - more than 200 m³
  - On-site solidification of spent ion exchange resin – more than 200 m³
  * Czech Power Company, CEZ decided to expand SIAL® application in 2017 for solidification of concentrated liquid borates or crystalline borates.
High temperature engineering test reactor (HTTR)

- **Customer**: Japan Atomic Energy Agency (JAEA)
- **Output Power**: 30MWth
- **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 4.25m)]()

### ‘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.
- A series of refueling operations and positioning to the fuel block is performed remotely and automatically.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design pressure</td>
<td>98kPa</td>
</tr>
<tr>
<td>Design temperature</td>
<td>100°C</td>
</tr>
<tr>
<td>Dimensions</td>
<td>111m</td>
</tr>
<tr>
<td>Weight</td>
<td>150t</td>
</tr>
<tr>
<td>Atmosphere (external / internal)</td>
<td>Air / helium gas</td>
</tr>
<tr>
<td>Handling load capacity</td>
<td>Up to approx. 200 kg</td>
</tr>
</tbody>
</table>

---

**Nuclear reactor engineering**