The Current Status and the Future of the Nuclear Fuel Cycle Business in JNFL

~Efforts for Safe and Stable Operation~

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Nuclear Fuel Cycle and JNFL Business

JNFL Business:
① Uranium Enrichment
② LLW Disposal
③ Vitrified Waste Storage
④ Reprocessing
⑤ MOX Fuel Fabrication

JNFL is responsible for the vital stages of the nuclear fuel cycle.
JNFL’ Role and the Significance of Nuclear Fuel Cycle

### JNFL’ Role

- Reprocessing and MOX Fuel Fabrication
  - Makes effective use of spent fuel via reprocessing/MOX
  - Reduces the volume of high-level radioactive waste
  - Makes decay period of HLW shorter

- Storage of high-level radioactive waste

- Uranium enrichment

- Disposal of low-level radioactive waste

### Significance of Nuclear Fuel Cycle

- Contributes to Japan’s energy self-sufficiency rate

- Establishes a good precedent for the peaceful use of reprocessing technology

- Provides comprehensive support for nuclear power generation

- Regional development
Low-Level Radioactive Waste Disposal Center

- Approx. 296,000 drums of LLW arising from Japanese nuclear power plants are disposed
- Site expansion to be planned

- Start of operation: December, 1992
- Ultimate capacity: 600,000 m³ (Equivalent to 3 million 200 liter drums)
- Current status:
  - Number of drums stored
    - No.1 (Solidified liquid waste) approx. 149,000
    - No.2 (Solidified miscellaneous waste) approx. 147,000
      (as of December 31, 2016)
Vitrified Waste Storage Center (Interim Storage)

- Start of operation: April 1995
- Storage capacity: 2,880 canisters
- Storage period: 30 - 50 years
Current storage status (as of December 31, 2016):

- 1,310 canisters from France (Completed on March 31, 2007)
  - 520 canisters from UK as of September 30, 2015.
- Approx. 2,200 canisters are expected to be returned in total.
- Storing returned low-level radioactive vitrified waste canisters is also planned.

346 canisters were produced at Rokkasho Reprocessing Plant in Active Test.
Reprocessing (Main Process)

- Capacity: Max. 800 tU/y
- Reprocessing technology: PUREX method
- Nuclear security measures: U-Pu Co-denitration
- Safeguards: Under continuous inspection by IAEA and Japan Safeguards Office
**Reprocessing (Main Process)**

1968 US-Japan Nuclear Cooperation Agreement

1988 US-Japan Nuclear Cooperation Agreement (Present)
1989 Licensing application
1992 Licensing approval
1993 Commencement of construction
2001 Commencement of Water Test
2002 Commencement of Chemical Test
2004 Commencement of Uranium Test
2006 Commencement of Active Test
  Tests almost completed at the main process by 2008
  Reprocessed SF in Active Test: 425 tU
  Recovered MOX product in Active Test: 6.7 tHM
2011 Great East Japan Earthquake happened
2013 Completion of vitrification tests

Completion of RRP: First half of Japanese FY 2018
New Regulatory Requirements

- New regulation on safety was enforced in December 2013, reflecting Fukushima daiichi NPP accident.
  - Design standards
  - Seismic evaluation
  - Severe accident

- JNFL submitted applications for conformance to the new safety regulations to the NRA in January 2014.

- Reviews by NRA are undergoing.
## Review of Seismic Standard

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<td>(Inland Crustal earthquake: Deto West fault,</td>
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<td>fault on the outer edge of the continental shelf)</td>
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<td>Seismic ground motions with specific hypocenters</td>
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<td>(Inter-plate earthquake and oceanic intra-plate</td>
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<td>Design-standards seismic ground motion 700 gals</td>
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MOX Fuel Fabrication Plant (under construction)
(MOX: Mixed Oxide)

- MOX powder produced from the reprocessing plant is fabricated to MOX fuel at the MOX Fuel Fabrication Plant in Rokkasho
- Application for compliance with the new safety regulations was filed in January 2014 and is currently under the review by the NRA
- Completion of the construction is scheduled to the first half of Japanese FY 2019

- Capacity: max. 130 tHM/y
- Location: adjacent to RRP
- MOX product is automatically transferred from the reprocessing plant to MOX plant through underground tunnel.
- Construction status
  - October 2010: Construction started
    (Construction work was suspended from March 2011 to March 2012 due to the Great East Japan Earthquake.)
(Reference) New Regulatory Requirements for Reprocessing Plant

In the New Regulatory Requirements, the previous requirements are strengthened and clarified, and four new items including severe accident countermeasures are added.

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<th>Previous Requirements</th>
<th>New requirements</th>
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<td>Fire and Explosion</td>
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<td>Performance of the Other Equipment</td>
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<td>Design Standards</td>
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Newly Established

Strengthened and Clarified
Results Achieved and Future Plans

Reprocessing plant
- Pre-use inspection passed for main process
- Internal test passed for the vitrification facility

MOX fuel fabrication plant
- Building under construction
- Equipment being manufactured

Conformance to new regulatory requirements
- NRA safety review regarding basic design
- Approval by NRA regarding detailed design
- Modification, construction
- NRA pre-use inspection (Reprocessing plant first half of FY2018)
  (MOX fuel fabrication plant first half of FY2019)

Safety Agreement with Aomori Prefecture and Rokkasho Village

Operation
- Efforts for safe operation
- Continued safety operation
- Continuous activities to gain understanding of local residents and regional development
- Continued enhancement of safety
(Reference) Schedule of the Development of the Advanced Melter

- Development of the advanced melter was started at 2009

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<td>RRP</td>
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<td>Vitrification facility of RRP</td>
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<td>Pre-test, Vitrification test</td>
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<td>Design, fabrication and cold test of advanced melter</td>
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<td>Melter component development</td>
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<td>Fabrication of full-scale inactive test melter</td>
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<td>Full-scale inactive test Phase I</td>
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- Tentative
(Reference) Problems in Existing-Melter Operation in AT

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<tr>
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<th>2007</th>
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<th>2010</th>
<th>2011</th>
<th>2012</th>
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<th>2014</th>
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<td>Melter A</td>
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<td>2nd Test in AT</td>
<td>pre-confirmation test in re-AT confirmation test</td>
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<td>Melter B</td>
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<td>Full scale KMOC Melter</td>
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The advanced melter is Liquid Fed Joule-heated ceramic melter

The advanced melter was developed considering the following points

✓ Suppressing deposition of noble metals in bottom part of melter
✓ Increasing operation availability and throughput

**Existing melter**

45° slope and pyramidal form with 4 corners

**Advanced melter**

60° slope and conical form
Some thirty years have passed since “The Basic Agreement about Cooperation in the Siting of the Nuclear Fuel Cycle Plant” was concluded with Aomori prefecture and Rokkasho village.

### History of JNFL

- **Apr. 1985**: “The Basic Agreement about Cooperation in the Siting of the Nuclear Fuel Cycle Plant” was concluded
- **Oct. 1988**: Construction of the Uranium Enrichment Plant started
- **Nov. 1990**: Construction of the Low-level Radioactive Waste Disposal Center started
- **Mar. 1992**: The Uranium Enrichment Plant started operation
- **May 1992**: Construction of the High-level Radioactive Waste Storage Center started
- **Dec. 1992**: The Low-level Radioactive Waste Disposal Center started operation
- **Apr. 1993**: Construction of Reprocessing Plant started
- **Apr. 1995**: The High-level Radioactive Waste Storage Center started operation
- **Mar. 2006**: The active test was started at the Reprocessing Plant
- **Oct. 2010**: Construction of the MOX Fuel Fabrication Plant started
- **Mar. 2011**: Great East Japan Earthquake happened
- **Dec. 2013**: New Regulatory Requirements became effective
- **Jan. 2014**: NRA began screening of reprocessing facilities to check conformance to new regulatory requirements
Location: JNFL

Overview of the Reprocessing Plant
Establishment: July 1, 1992
Customers: Japanese nuclear power plant operators
Stockholders: Ten Japanese electric power utilities (approximately 90% of interests) and 74 other Japanese companies
Capital Stock: 400 billion yen + Capital reserve 200 billion yen
Net sales: 295.4 billion yen (FY 2015)
Gross assets: 2,414.5 billion yen (FY 2015)
Employees: 2,589 (as of May 1, 2016)

Approx. 62% of all employees (1,618) is from Aomori Prefecture.
# Type of Radioactive Waste in Japan

<table>
<thead>
<tr>
<th>Type of Radioactive Waste</th>
<th>Waste (Example)</th>
<th>Source</th>
<th>How to Dispose (Example)</th>
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<tr>
<td>High level radioactive waste</td>
<td>Vitrified waste</td>
<td>Reprocessing plant</td>
<td>Deeper ground (300m-)</td>
</tr>
<tr>
<td>Low level radioactive waste</td>
<td>Waste with relatively high activity (L1)</td>
<td>Control rod, components inside reactors</td>
<td>Nuclear power plant</td>
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<td></td>
<td>Waste with relatively low activity (L2)</td>
<td>Effluent, filter, consumables, etc. which are solidified</td>
<td>Deep ground (50-100m)</td>
</tr>
<tr>
<td></td>
<td>Waste with very low activity (L3)</td>
<td>Concrete, metal</td>
<td>Shallow ground</td>
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<tr>
<td>TRU</td>
<td>Fuel rod parts, effluent, filter</td>
<td>Reprocessing plant, MOX fuel fabrication plant</td>
<td>According to the level of radioactivity</td>
</tr>
<tr>
<td>Waste below clearance level</td>
<td>Most of wastes coming from dismantling of nuclear facilities</td>
<td>All plants mentioned above</td>
<td>Can be reused or disposed as general waste</td>
</tr>
</tbody>
</table>

Source: “Type and Source of Radioactive Waste“ and “Disposal Depending on the Type of Radioactive Waste”, Agency for Natural Resources and Energy
(Reference) New Regulatory Requirements for the Reprocessing Plant

- Design standards
  (To prevent damage caused by fire, internal flooding, impact from the outside, etc.)
  The basic policy was confirmed, and the review of respective measures was almost completed

[Examples of measures against tornado: Preventing damage caused by impact from outside]
(Reference) New Regulatory Requirements for the Reprocessing Plant

- Severe accident
  - Criticality accident, dryness due to loss of cooling function, explosion due to hydrogen generated by radiolysis, etc.
  - Concrete measures for events of severe accidents including the superimposition of accidents and assessments of effectiveness of measures continues to be reviewed.

- Improvement of the quality of training

Night-time cable connection training

Water supply training in winter
(Reference) Examples of Measures against Severe Accidents

- Securing hydrogen scavenging function
- Power supply truck
- Securing cooling functions
- Large-size pumping truck, Hose extension vehicle, Medium-size pumping truck, All terrain vehicle
Visiting all households
Employees visit households in the Rokkasho village to explain. They also hear opinions towards JNFL. (3,090 households in Rokkasho village [June 2015], conducted twice a year since FY1984)

Ladies’ monitor in Aomori
Request for opinions from the ladies’ perspective in Aomori. (Commenced in 1996, conducted about seven times an year, one year term of service)

Cultivating a sense of safety using an example of troubles.
Explain potential troubles and their impact.
Connect with the world as a comprehensive nuclear fuel cycle company, and aim to make Rokkasho known worldwide.

France:
- AREVA
  ⇒ International partner
- Commissariat à l’énergie atomique et aux énergies alternatives (CEA)
  ⇒ Joint research

United Kingdom:
- Nuclear Decommissioning Authority (NDA)
  ⇒ International partner

United States:
- United States Department of State
  ⇒ Provide information
- United States Department of Energy, national laboratories
  ⇒ Participation to the DOE program