Strategy of the decommissioning of Fukushima Daiichi Nuclear Power Station and revitalization movement of the Hamadori

International symposium on radiological issues for Fukushima’s revitalized future

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Organizational evolution

2011

- Cold Shutdown 2011.12.16

1st Road Map 2011.12.26

2012

- Road Map Revised 2012.12.26

2013

- Road Map Revised 2013.06.27
- Contaminated Water Troubles mid-2013~

2014

- ALPS Troubles 2014.05~
- IRID 2013.08.01
- NDF 2014.08.18

Emerging entities

- Policy Government
- Emergency Response Headquarters
- Change of Administration 2012.12
- Inter-Ministerial Council for Contaminated Water and Decommissioning
- TEPCO
- TEPCO D&D Co. 2014.04.01
- Site Operation

Strategy
Latest status of Unit-1 to 4

Unit-1

Unit-2

Unit-3

Unit-4

1533/1533
December 2014

Fuel removal cover
Fuel-debris retrieval as the most challenging operation

Technical difficulties

- Decontamination of rooms of the building
- Full-remote identification of leak points of PCV
- Decontamination of the inside of reactor vessels
- Full-remote fixing of leak points of PCV
- Cutting and pull-up of fuel-debris
- Encapsulation of retrieved fuel-debris
- Removal of heavy inner structures of RPV
- Safety assurance for re-criticality, radiation, and radioactive dust formation

Access from the top with full submersion
Muon-tomography

**Unit-2** Scattering method

**Unit-1** Transmission method

Observation for 26 days

Anticipated image
Recent inspection to the inside of PCV in Unit-1

<table>
<thead>
<tr>
<th></th>
<th>(Sv/h)</th>
<th>(°C)</th>
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<tbody>
<tr>
<td>B3</td>
<td>7.4</td>
<td>17.8</td>
</tr>
<tr>
<td>B4</td>
<td>7.5</td>
<td>19.2</td>
</tr>
<tr>
<td>B5</td>
<td>8.7</td>
<td>19.4</td>
</tr>
<tr>
<td>B7</td>
<td>7.4</td>
<td>19.5</td>
</tr>
<tr>
<td>B11</td>
<td>9.7</td>
<td>19.2</td>
</tr>
<tr>
<td>B14</td>
<td>7.0</td>
<td>20.2</td>
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Root of PLR pipe

Planned route
Resultant route
Obstacles

X-100B Penetration
Retrieval of fuel debris by alternative techniques

- **Full submersion method**: Water level up to the reactor well top
- **Submersion method**: Water level over the fuel-debris location
- **Partial submersion method**: Water level lower than the upper fuel-debris location
- **Dry method**: No water and all fuel-debris is open to the air
Key of the waste management

- **Storage management**
  - Reduction of volume generated
    - Reduction of carry-in materials
    - Considerations on the secondary waste
  - Storage management
    - Plan for storage management
    - Storage management plan for the waste generated from fuel debris retrieval

- **Waste Treatment & Disposal**
  - Understanding of waste properties
    - Waste sampling plan
    - Analysis ability for understanding of waste properties
  - Treatment and disposal methods according to the characteristics of the waste at the Fukushima Daiichi NPS
    - Study on treatment and disposal methods
    - Classification management and history information management
    - Regulatory system
3. Definition of risk

(i) Risk of radioactive materials

- Risk = level of effect x probability of occurrence

(ii) Degree of effect

- If the containment function is lost, radiation effects (exposure, environmental contamination) occur.
- Degree of effect = level of activity x physical state (solid, liquid or gas)

(iii) Probability of occurrence

- Factors for the loss of the containment function include natural phenomena, failures and improper operations.
- The vulnerability of the facility to the above factors needs to be considered.
- Probability of occurrence = possibility of occurrence of the factor x vulnerability of the facility

(iv) Mapping of Risks

(v) How to reduce risk

- Move radioactive materials to a safer and more stable facility.
  - Reduce the probability of occurrence.
- Decay of radioactivity and change in the physical state
  - Reduce the degree of effect.
The future vision of 12 municipalities have been studied by a working group.

**Future vision of 12 municipalities in Hamadori**

**Essential conditions for reconstruction**

- Evacuation order ready to be lifted
- Residents are not permitted to live
- Difficult to return for long time

**Trend in the number of evacuees**

<table>
<thead>
<tr>
<th>Month</th>
<th>Out-prefecture</th>
<th>In-prefecture</th>
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<tbody>
<tr>
<td>Jun/2012</td>
<td>164,218</td>
<td>102,180</td>
</tr>
<tr>
<td>Dec/2012</td>
<td>157,136</td>
<td>98,528</td>
</tr>
<tr>
<td>Jun/2013</td>
<td>150,488</td>
<td>96,528</td>
</tr>
<tr>
<td>Dec/2013</td>
<td>138,949</td>
<td>90,005</td>
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<tr>
<td>Nov/2014</td>
<td>123,023</td>
<td>76,953</td>
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**Region**
- Compact city
- Infrastructure

**Society**
- Education and culture

**Job**
- Innovation coast vision
- Commerce
- Agriculture and fishery
- Renewable energy

**Accommodation**
- Medical care
- Welfare

**Origin**: Fukushima Prefecture
Future vision of 12 municipalities in Hamadori

- Accelerate evacuees’ return by using footholds for reconstruction, which are planned by each municipality
- Build compact cities having integrated multi-functions
- Promote mutual support and collaboration

Plan by Iitate-mura

Plan by Okuma-machi

Origin: WG for future vision of 12 municipalities
Innovation coast vision (1)

**Objective:** (1) create a new industrial base with innovation, (2) re-build new towns on a regional scale, (3) realize the new model of local regeneration

1. Establishment of an international base facility to accelerate decommissioning
   - Analytical hot-laboratory
   - Research facility for decommissioning

2. Establishment of a base facility for robot R&D
   - Mock-up test facility
   - Robot test field

3. Establishment of new industrial base
   - International research facility for industry-academia collaboration
   - Establishment of Smart Eco-park
   - Integration of energy-related industries
   - Creation of new agriculture, forestry and fishery industry
International R&D facility for industry-academia collaboration

Facility concept:

• To conduct basic and fundamental researches collaboratively through consecutive assignment of foreign and domestic researchers.

Research objectives:

• Environmental investigation of contaminated area
• Environmental restoration,
• Reconstruction of agriculture and fishery,
• Robot development,
• Medical research for residents,
• Decommissioning and decontamination.
Research Fund for decommissioning

Outline

MEXT promotes
- the R&D with gathering domestic/international researchers including scientists in the field of non-Nuclear S&T
- human resource development through the Industry-Academia-Government cooperation (“San-Gaku-Kan-RENKEI”)
  on the basis of “Acceleration Plan of Reactor Decommissioning R&D
  for Fukushima Daiichi Nuclear Power Station(F1), TEPCO”(June 2014, MEXT)

The program of human resource development for decommissioning (500 million JPY)

MEXT establishes a center/hub at research institutes such as universities for a program of human resource development in cooperation with IRID, etc.

- Needs from forefront
- Foreign experts with the experience of severe accident
- Joint research with manufacturing industry, etc.

The program of Basic & Strategic Research of Nuclear S&T (900 million JPY)

- **International cooperation program** is promoted for rebirth of Fukushima by the orchestration of NDF

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<th>TEPCO</th>
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<td>Technical Support</td>
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<td>R&amp;D Management</td>
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- **Strategic research program** is promoted through consolidating idea or knowledge beyond the field of Nuclear S&T

International cooperative research with UK, US, etc.

Fukushima Center is planned near future

Specialists

Using facilities

IRID

University (Hub)

University

Research Center, etc. (sub)
1. Technical strategic approach is essential for the successful decommissioning of Fukushima-Daiichi NPS, and the first version of the Strategic Plan has been issued by NDF.

2. Optimized risk reduction, holistic and proactive waste management, as well as the flexibility in the selection of fuel-debris retrieval method are the key elements of the new strategy. These are expected to be incorporated into the revision of the Roadmap by the Japanese government.

3. Innovation coast vision aims to reconstruct Hamadori area by creating a set of new industrial activities. Constructions of several new facilities are planned. Collaborative research facility will contribute to the radiological researches for the restoration.

4. “Future vision of 12 municipalities” tries to encompass the establishment of footholds in every town, rebuild of life-infrastructure, Innovation coast vision, and revitalization of agriculture, forestry and fishery.

5. A consolidated approach is expected to promote peoples’ return and rebuilding of life, in line with the progress of the regional decontamination and lift of the evacuation order.