The outline of Japan Atomic Energy Agency’s Okuma Analysis and Research Center (1)

- The total progress of Laboratory-1 and Laboratory-2 -

Toshihiko Inoue*1, Miho Ogawa*1, Yoshinori Sakazume*1, Hiroshi Yoshimoch*1, Soichi Sato*1, Shinichi Koyama*1, Tomozo Koyama*1, Shinichi Nakayama*2

*1 Okuma Analysis and Research Center, *2 Fukushima Research Institute
Japan Atomic Energy Agency (JAEA)
Content

1. Back Ground (Activity of JAEA in Fukushima)
2. Concept of Okuma Analysis and Research Center
   • Basic concept
   • Schedule
3. Details of Okuma Analysis and Research Center
   • Composition
   • Topics of Laboratory-1 and -2
4. Summary
1. Back Ground

◇ JAEA works on various missions for decommissioning on the 1F plant.

JAEA / Sector of Fukushima Research and Development Organization
◇ Fukushima Administrative Department (clerical work) ; (49)
◇ Fukushima Management Department (builder work) ; (17)
◇ Collaborative Laboratories for Advanced Decommissioning Science ; (134)
   (International Collaborative Research Building @ Tomioka March, 2017 - )
◇ Naraha Remote Technology Development Center ; (35) April, 2016 -
◇ Okuma Facilities Management Department ; (98)
   > Installation Design Section (20 members)
   > Safety Design Section (7 members)
◇ Fukushima Environmental Safety Center; 151 members

Source: http://cyberjapandata.gsi.go.jp/xyz/blank/{z}/{x}/{y}.png

(1st August 2017, members : involved combine post and detachment members,
https://fukushima.jaea.go.jp/english/information/organization.html)
2. Concept of Okuma Analysis and Research Center (Basic Concept)

Okuma Analysis and Research Center consists of three buildings near the 1F site.

1. Administrative building
   - Consists of Office room, Workshop for mock-up testing

2. Laboratory-1, 3. Laboratory-2: hot laboratory

<table>
<thead>
<tr>
<th>Analysis Specimens</th>
<th>Target</th>
<th>Level</th>
<th>Surface dose rate</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory-1</td>
<td>Radioactive materials</td>
<td>Low</td>
<td>Under 1 mSv/h</td>
<td>Under 300 kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
<td>Under 1 Sv/h</td>
<td>Under 2 kg</td>
</tr>
<tr>
<td>Laboratory-2 (TBD)</td>
<td></td>
<td>High</td>
<td>Over 1 Sv/h (TBD)</td>
<td>Under 200 g (TBD)</td>
</tr>
<tr>
<td>Fuel debris</td>
<td></td>
<td></td>
<td></td>
<td>Under 5 kg (TBD)</td>
</tr>
</tbody>
</table>
2. Concept of Okuma Analysis and Research Center (Construction Schedule)

Mid-and-ling-Term Roadmap for decommissioning of 1F NPS

- **Step 1:** Cold shutdown condition
- **Step 2:** Suppression of release of radioactive material to the environment

- **Phase 1:** Fuel removal from spent fuel pools
- **Phase 2:** Fuel debris removal from Units 1-3
- **Phase 3:** Decommissioning of 1F NPS

Construction schedule of Okuma Analysis and Research Center

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The Japanese Government’s &quot;Mid-and-Long-Term Roadmap for fuel-debris retrieval&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative building</td>
<td>Conceptual design</td>
<td>etc.</td>
<td>Detail design</td>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory-1</td>
<td>Conceptual design</td>
<td>etc.</td>
<td>Detail design</td>
<td>Construction</td>
<td>Operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory-2</td>
<td>Conceptual design etc.</td>
<td></td>
<td>Detail design</td>
<td>Construction</td>
<td>Operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Details of Okuma Center
(Design of main analysis items)

◇ Okuma Analysis and Research Center consists of three buildings

<table>
<thead>
<tr>
<th></th>
<th>Administrative building</th>
<th>Laboratory-1</th>
<th>Laboratory-2 (Detail is TBD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building design</td>
<td>4 floors</td>
<td>3 floors</td>
<td>4 floors</td>
</tr>
<tr>
<td>Total floor area</td>
<td>4,786m²</td>
<td>9,671m²</td>
<td>9,200m²</td>
</tr>
<tr>
<td>Analysis materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Researcher’s Residential and Office room)</td>
<td>-</td>
<td>• Rubble and Secondary wastes (low and middle levels; under 1SV/h)</td>
<td>• Fuel debris</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>• High level radioactive rubble and secondary wastes (over 1SV/h)</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>β-γ specimen</td>
<td>α-γ specimen</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>200 samples/year</td>
<td>12 samples/year (Fuel debris)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50 samples/year (highly contaminated material)</td>
</tr>
<tr>
<td>Main equipment</td>
<td>Workshop</td>
<td>Steel cell : 4</td>
<td>Concrete cell : 14</td>
</tr>
<tr>
<td></td>
<td>Meeting room</td>
<td>Glove Box : 10</td>
<td>Steel cell : 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fume hood : 56</td>
<td>Glove Box : 25</td>
</tr>
<tr>
<td>Main Analysis items</td>
<td></td>
<td>Radioactivity : α, γ, β-ray spectrometer</td>
<td>Radioactivity : α, γ, β-ray spectrometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chemical analysis : ICP-AES, ICP-MS, Ion-chromatograph, Total-organic carbon analyzer</td>
<td>Chemical analysis : ICP-AES, ICP-MS, Ion-chromatograph, Total organic-carbon analyzer, GC-MS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface analysis : SEM/EDS, Digital microscope</td>
<td>Surface analysis : EPMA/WDS, SEM/EDS, XRD, XRF, Digital Microscope</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical analysis : Density, Thermal property, Hardness ,and so on</td>
<td>Physical analysis : Density, Thermal Property, Hardness , and so on</td>
</tr>
</tbody>
</table>

- Same equipment
3. Details of Okuma Center
(Topics of Administrative building Laboratory-1)

◇ Okuma Analysis and Research Center
(1) Administrative building  (2) Laboratory-1  (3) Laboratory-2

Administrative building
(https://fukushima.jaea.go.jp/initiatives/cat05/haishi07.html)

Progress status of administrative building.

Progress status of Laboratory-1.

Schematic layout of Laboratory-1
(second floor plan).

Schematic layout of Laboratory-1
(third floor plan).
3. Details of Okuma Center (Topics of Laboratory-1 (2/2))

◇ Okuma Analysis and Research Center

(1) Administrative building  (2) Laboratory-1  (3) Laboratory-2

Analytical flow chart in Laboratory-1
3. Details of Okuma Center (Topics of Laboratory-1 (2/2))

◇ Okuma Analysis and Research Center
(1) Administrative building (2) Laboratory-1 (3) Laboratory-2

Analytical flow chart in Laboratory-1

Schematic layout of Laboratory-1 (second floor).

Schematic layout of Laboratory-1 (third floor).
3. Details of Okuma Center
(Topics of Laboratory-2 (1/3))

◇ Okuma Analysis and Research Center
 (1) Administrative building  (2) Laboratory-1  (3) Laboratory-2

- Analysis times (TBD)
  - For the analysis of the storage management and decommissioning of the fuel debris and radioactive waste, many analysis items required by IRID/TEPCO.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic property</td>
<td></td>
</tr>
<tr>
<td>Morphorogy</td>
<td>EPMA/WDS, SEM/EDS, XRD, Digital Microscope</td>
</tr>
<tr>
<td>Diometry (diameter)</td>
<td>BET, Laser diffraction particle counter, Sieving machine</td>
</tr>
<tr>
<td>Density</td>
<td>Densimeter, X-ray CT</td>
</tr>
<tr>
<td>Porosity</td>
<td>Optical microscope, X-ray CT</td>
</tr>
<tr>
<td>Composition</td>
<td></td>
</tr>
<tr>
<td>U / Pu content</td>
<td>TIMS, α spectrometer, Titrator, ICP-MS, XRF, ICP-AES</td>
</tr>
<tr>
<td>SUS mixed ratio</td>
<td></td>
</tr>
<tr>
<td>B4C mixed ratio</td>
<td>ICP-AES</td>
</tr>
<tr>
<td>Gd mixed ratio</td>
<td>XRF, ICP-AES</td>
</tr>
<tr>
<td>U enrichment</td>
<td>α spectrometer, ICP-MS</td>
</tr>
<tr>
<td>Salt concentration</td>
<td>AAS, Ion chromatography, Total organic carbon meter</td>
</tr>
<tr>
<td>FP, CP, Actinide content</td>
<td>XRF, ICP-MS</td>
</tr>
<tr>
<td>Inventory</td>
<td>α, β, γ-ray spectrometer, γ-camera, Gas flow meter, Liquid scintillation counter</td>
</tr>
</tbody>
</table>
### 3. Details of Okuma Center
(Topics of Laboratory-2 (2/3))

#### Okuma Analysis and Research Center
(1) Administrative building  (2) Laboratory-1  (3) Laboratory-2

#### Analysis request item list (2/2)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic property</strong></td>
<td></td>
</tr>
<tr>
<td>Chemical form, Surface analysis</td>
<td>SEM-WDS, XRD, EPMA/EDX, Optical microscope, Digital Microscope.</td>
</tr>
<tr>
<td>Moisture content</td>
<td>Karl fischer moisture titrator.</td>
</tr>
<tr>
<td>Hydrogen concentration</td>
<td>Gas chromatography.</td>
</tr>
<tr>
<td><strong>Mechanical strength</strong></td>
<td></td>
</tr>
<tr>
<td>Hardness</td>
<td>Vickers</td>
</tr>
<tr>
<td>Fracture toughness</td>
<td>Micro vickers hardness meter.</td>
</tr>
<tr>
<td>Compression</td>
<td>Micro vickers hardness meter.</td>
</tr>
<tr>
<td><strong>Thermal property</strong></td>
<td></td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>Laser flash thermal diffusivity measurement device.</td>
</tr>
<tr>
<td>Thermal behaviour</td>
<td>TG-DTA.</td>
</tr>
<tr>
<td>Thermal expansion</td>
<td>Thermal expansion meter.</td>
</tr>
<tr>
<td>Melting point</td>
<td>Melting temperature measurement device.</td>
</tr>
<tr>
<td><strong>Radiation Property</strong></td>
<td></td>
</tr>
<tr>
<td>Dose rate</td>
<td>Calculation from inventory analysis.</td>
</tr>
<tr>
<td>Calorific value</td>
<td>Calculation from inventory analysis.</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Hydrogen production, and all that</td>
<td>Gas chromatography.</td>
</tr>
</tbody>
</table>
Okuma Analysis and Research Center
(1) Administrative building (2) Laboratory-1 (3) Laboratory-2

For Analysis times (TBD)
- Many analysis items required in IRID/TEPCO. But Laboratory-2 limited in installation space. It is difficult to install all analysis equipment.

In 2016, JAEA convened the expert meeting for selected the basic analysis equipment installed in laboratory-2.
- A standard for selection
  (1) The significance of analysis items (Standard analysis items)
  (2) The timing of analysis phase (reflecting on removal method of debris)
- Main Conclusion
  (1) Selected the main analysis items (activity, element analysis, hardness, etc)
  (2) Added the SEM/EDS and XRF for the simple analysis at receiving.
  (3) Thermal equipment will be installed in medium phase.
  (4) For the future request, Keeping the backup and maintenance space.
### 3. Details of Okuma Center

**(Topics of Laboratory-2 (3/3))**

◇ Okuma Analysis and Research Center

(1) Administrative building  (2) Laboratory-1  **(3) Laboratory-2**

#### Selected analysis candidate item list

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Equipment (Laboratory-2, TBD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic property</strong></td>
<td></td>
</tr>
<tr>
<td>Morphorogy (powder/particle/mass)</td>
<td>EPMA/WDS, SEM/EDS, XRD, Digital Microscope</td>
</tr>
<tr>
<td>Diometry (diameter)</td>
<td>Digital Microscope</td>
</tr>
<tr>
<td>Density</td>
<td>Densimeter, X-ray CT</td>
</tr>
<tr>
<td>Composition (U / Pu content, SUS mixed ratio, B4C mixed ratio, Gd mixed ratio, U enrichment, Salt concentration, FP, CP, Actinide content)</td>
<td>α spectrometer, ICP-MS, XRF, ICP-AES</td>
</tr>
<tr>
<td>Inventory</td>
<td>Only installed in Lab-2</td>
</tr>
<tr>
<td>Chemical form, Surface analysis</td>
<td>SEM-EDS, XRD, EPMA/WDS, Optical microscope, Digital Microscope.</td>
</tr>
<tr>
<td>Moisture content</td>
<td>Karl fischer moisture titrator</td>
</tr>
<tr>
<td>Hydrogen concentration</td>
<td>Gas chromatography</td>
</tr>
<tr>
<td><strong>Mechanical strength</strong></td>
<td></td>
</tr>
<tr>
<td>Vickers Hardness</td>
<td>Micro Vickers hardness meter</td>
</tr>
<tr>
<td>Fracture toughness (IF method)</td>
<td></td>
</tr>
<tr>
<td><strong>Radiation Property</strong></td>
<td></td>
</tr>
<tr>
<td>Dose rate</td>
<td>Calculation from inventory analysis</td>
</tr>
<tr>
<td>Calorific value</td>
<td></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
</tr>
<tr>
<td>Hydrogen production</td>
<td>Gas chromatography.</td>
</tr>
</tbody>
</table>
3. Details of Okuma Center (Topics of Laboratory-2 (3/3))

◊ Okuma Analysis and Research Center
   (1) Administrative building  (2) Laboratory-1  (3) Laboratory-2

➢ The arrangement of Laboratory-2
3. Details of Okuma Center (Topics of Laboratory-2 (3/3))

◇ Okuma Analysis and Research Center
   (1) Administrative building  (2) Laboratory-1  (3) Laboratory-2

➢ The arrangement of alpha-concrete hot cell in Laboratory-2 (TBD)

- Decontamination
- Check the contamination
- Modifies of debris (Takeoff fuel debris)
- Sample dissolution
- Dilution
- Loading Cell for sample and waste after examination
- X-ray CT
- Neutron measurement
- Gamma-ray spectrometer
- Samples storage
- X-ray fluorescence
- Sample preparation
- Decontamination (backup/expanded space)
- Alpha tight/sealing-Cell (lining application)
- Nitrogen atmosphere
3. Details of Okuma Center (Materials Flow)

Reference of PIE facilities knowledge in glovebox and Fume hood, etc.

Apply of PIE analysis method in Tokai research and development center, etc.

Reference of PIE facility’s knowledge in hot cells

Necessity of the activity and first impression

- Neutron measurement equipment
- X-ray CT, and so on.

- Pretreatment (Modifying/ Dissolving/ Separating)
- Measurement/ Analysis

- Pretreatment (Machining/ Modifying)

- Lab site

- 1F site

- Fuel debris

Rubble and Secondary wastes (under 1Sv/h)

Rubble and Secondary wastes (over 1Sv/h)

Laboratory-1

Steel cell

Sealed room

Glove Box

Fume hood

Test room

Laboratory-2

Concrete cell

Steel cell

Glove Box

Fume hood

Test room

Rubble and Secondary wastes samples

- : low level samples (under 1mSv/h)
- : middle level samples (over 1mSv/h, under 15Sv/h)
- : highly level samples (over 1Sv/h)

Measurement/Analysis

- Fuel debris samples
- : Highly contaminated material samples (over 1Sv/h)
According to the Roadmap, JAEA push the designing and building of the Okuma Center premeditatedly.

In 2016, JAEA selected the basic analysis items for the significance and early phase in laboratory-2.
- Added the SEM/EDS and XRF for the simple analysis at receiving.
- Thermal equipment will be installed in medium phase.
- For the future request, Keeping the backup and maintenance space.

But, JAEA will promote a design for laboratories based on the existing PIE’s experience and knowledge. And the buildings will to be constructed according the plan, with safety.
Thank you for your attention.
Reference Slides
2. Background materials

Fig. 1. The Mid-and-Long-Term Roadmap for the decommissioning of 1F NPS.

Fig. 2. The Mid-and-Long-Term Roadmap for the Spent Fuels (Phase 1).

2. Background materials

Phases Defined in the Mid-and-Long-Term Roadmap and R&D Structure

**Phases in the Mid-and-Long-Term Roadmap**

- **December 2011**
  - Efforts to stabilize conditions (Step 1 and 2 completed)
  - Accomplishment of cold shutdown state
  - Significant reduction of radioactive material release
  - Period up to the commencement of fuel removal from spent fuel pool
  - Target: within 2 years after Step 2 completion

- **November 2013**
  - Phase 1 (completed)

- **December 2021~**
  - Phase 2
    - Period up to the commencement of fuel debris retrieval
    - Target: within 10 years after Step 2 completion
    - Decision on fuel debris retrieval policy for each Unit (Target: 2017)
    - Finalization of fuel debris retrieval methods for the initial Unit (in the first half of FY 2018)
    - Start of fuel debris retrieval at the initial Unit (within 2021)
  - Phase 3
    - Period up to the completion of decommissioning
    - Target: 30 to 40 years after Step 2 completion


2. Background materials

IRID is engaged in fundamental research through to practical application of technology.

Research institutions, including IRID

Ministry of Economy, Trade and Industry (METI): Project of Decommissioning and Contaminated Water Management, etc.

JAEA (Japan Atomic Energy Agency)

Universities and research institutions

Application development

- Application of new technologies
- Development of devices and equipment
- Performance demonstration
- Acquisition of safety data

Fundamental research

- Specific research facilities and equipment
- Acquisition of basic technology data

Practical application

- On-site requirements
- On-site conditions
- Regulatory requirements
- Performance guarantee

Integration of Knowledge and researchers

<Resource> The above charts were created based on the Mid-and-Long-Term Roadmap (Third revision), June 12, 2015.