IAEA/UNESCO Technical Meeting on Groundwater Contamination following the Fukushima Nuclear Accident

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IAEA International Missions (2013) to Japan on Fukushima-D NPP decommissioning and on off-site remediation

IAEA-NEFW
Vienna, 8-10 September 2014
TEPCO Fukushima Daiichi Accident and IAEA support

- **Initial actions**
  - IAEA Incident and Emergency Centre
  - IAEA International Seismic Safety Centre
  - Environmental Monitoring

- **Mid- and long-term actions (assorted examples)**
  - IAEA Fukushima Report
  - NPPs. Assessment of safety vulnerabilities. Regulatory body (NRA)
  - Decommissioning of F-D NPPs. Severely damaged spent fuel, waste…
  - Remediation of large off-site contaminated areas. Radiation protection, waste…
  - Fukushima Prefecture. Environmental monitoring
IAEA Missions to Fukushima on Decommissioning and Remediation

• May 2011. IAEA Fact-finding mission on Tepco-Fukushima Daiichi Accident
  ✓ Emergency response and off-site radiological consequences

• Oct 2011. IAEA international mission on remediation of large contaminated areas off-site Tepco’s-Fukushima Daiichi NPP

• **Apr 2013.** IAEA international mission on mid-and long-term roadmap towards decommissioning of Tepco’s-Fukushima Daiichi NPP. Units 1-4

• **Oct 2013.** The Follow-up IAEA mission on remediation of large contaminated areas off-site Tepco’s-Fukushima Daiichi NPP

• **Nov-Dec 2013.** IAEA international PR mission on mid-and long-term roadmap towards decommissioning of Tepco’s-Fukushima Daiichi NPP. Units 1-4
Follow-up IAEA Mission to Fukushima on Remediation

- **Period**: 14 to 21 October 2013

- **Objectives**:
  - Assistance to Japan in assessing progress on remediation of Special Decontamination Area and Intensive Contamination Survey Areas
  - Review remediation strategies, plans and works in view of advice from previous mission in 2011 (Follow-up)
  - Lessons learned to share with international community

- **Team**:
  - 13 experts
  - 3 experts WG-5 IAEA Fukushima Report
Basic Principles of Decontamination

ICRP’s recommendations

Emergency exposure situation
Planned evacuation areas
Situations in which emergency actions are required as in case of nuclear accidents

Aiming to reduce the individual annual effective dose to 20 mSv or less

Existing exposure situation
Long-term exposure after emergency

Long-term goal:
Reducing additional annual effective dose to 1 mSv

[Relatively high-dose region]
Large-scale surface decontamination is needed

[Relatively low-dose region]
Intensive decontamination of hot spots such as road ditch and gutters.

Basic emergency guidelines for decontamination
(Aug. 26, 2011: by Nuclear Disaster Taskforce)

National Government will be responsible for conducting decontamination until the residents return to their land.

• Municipalities will prepare and implement decontamination plans.
• National Government sends experts and provides financial assistance to facilitate decontamination.
Special Decontamination Area

- Area designation by the MoE
  - “Restricted areas” (20 Km)
  - Deliberate evacuation areas ($D_e > 20$ mSv/y)
- 11 Municipalities in (former) restricted zone or planned evacuation zone
- Formulation & implementation of decontamination plans by the GoJ / Minister of the Environment
Arrangement of areas for remediation

Areas to which evacuation orders have been issued

- **Area 1 (Green)**
  Annual dose $1\text{mSv} < D_{e} < 20\text{mSv}$

- **Area 2 (Yellow)**
  Annual dose $20\text{mSv} < D_{e} < 50\text{mSv}$

- **Area 3 (Red)**
  Annual dose $D_{e} > 50\text{ mSv}$ and
  Annual dose $> 20\text{mSv}$ after 5 years
Intensive Contamination Survey Area

- Area designation by the MoE
  - Additional dose: $1 \text{ mSv/y} < D_e < 20 \text{ mSv/y}$
  - Average air dose rate $> 0.23 \mu \text{Sv/hour}$

- 100 municipalities in 8 prefectures (Iwate, Miyagi, Fukushima, Ibaraki, Tochigi, Gunma, Saitama, and Chiba). (As of Aug, 2013)

- Surveys and measurements of contamination by municipalities

- Formulation and implementation of decontamination plans by the municipalities and prefectures. Support from GoJ
# Progress in the Special Decontamination Area

## Progress Status

<table>
<thead>
<tr>
<th>Progress Status</th>
<th>Population in Decontamination Target Area (approx. figure)</th>
<th>Decontamination Target Area (ha) (approx. figure)</th>
<th>Rearrangement of the Restricted areas, etc.</th>
<th>Decontamination Plan</th>
<th>Temporary Storage Site (as of the end of Aug., ‘13)</th>
<th>Content of landowners, etc. (As of the end of Jul., ‘13)</th>
<th>Decontamination activities (As of Aug., 30, ‘13)</th>
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<tbody>
<tr>
<td>TAMURA</td>
<td>400</td>
<td>500</td>
<td>Apr 2012</td>
<td>Apr 2012</td>
<td>Secured</td>
<td>Completed</td>
<td>Completed in June 2013</td>
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<td>NARAH</td>
<td>7,700</td>
<td>2,000</td>
<td>Aug 2012</td>
<td>Apr 2012</td>
<td>Secured</td>
<td>Almost completed</td>
<td>In progress</td>
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<td>KAWAUCHI</td>
<td>400</td>
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<td>Completed</td>
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<tr>
<td>MINAMI-SOMA</td>
<td>13,300</td>
<td>6,100</td>
<td>Apr 2012</td>
<td>Apr 2012</td>
<td>Approx. 20% secured</td>
<td>Approx. 30%</td>
<td>In progress</td>
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<tr>
<td>ITATE</td>
<td>6,000</td>
<td>5,100</td>
<td>Oct 2012</td>
<td>May 2012</td>
<td>Approx. 20% secured</td>
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<td>In progress</td>
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<td>KAWAMATA</td>
<td>1,200</td>
<td>1,300</td>
<td>Aug 2013</td>
<td>Aug 2012</td>
<td>Approx. 80% secured</td>
<td>Approx. 90%</td>
<td>In progress</td>
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<td>KATSURAO</td>
<td>1,400</td>
<td>1,700</td>
<td>Mar 2013</td>
<td>Sep 2012</td>
<td>Approx. 20% secured</td>
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<td>In progress</td>
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<td>NAMIE</td>
<td>18,800</td>
<td>3,200</td>
<td>Apr 2013</td>
<td>Nov 2012</td>
<td>Approx. 10% secured</td>
<td>Approx. 10%</td>
<td>Under bidding procedure</td>
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<tr>
<td>OKUMA</td>
<td>400</td>
<td>400</td>
<td>Nov 2012</td>
<td>Dec 2012</td>
<td>Approx. 70% secured</td>
<td>Approx. 60%</td>
<td>In progress</td>
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<tr>
<td>TOMIOKA</td>
<td>11,300</td>
<td>2,800</td>
<td>Mar 2013</td>
<td>Jun 2013</td>
<td>Approx. 50% secured</td>
<td>In preparation</td>
<td>Contractor decide In preparation of work</td>
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<tr>
<td>FUTABA</td>
<td>300</td>
<td>200</td>
<td>May 2013</td>
<td>Under coordination</td>
<td>Approx. 50% secured</td>
<td>Under coordination</td>
<td>Under coordination</td>
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</table>
Progress in Intensive Contamination Survey Area

• As of the end of March 2013, the plans have been formulated in 94 municipalities.

• As the decontamination target covers large areas including public facilities, residential houses, roads, farmland and forest, municipalities shall clarify the objects and priorities, with consideration to the protection of public health.

• Decontamination work is being implemented based on decontamination plans developed by each municipality. In regard with the work schedule of the plans, 5 years is set in many municipalities mainly in Fukushima prefecture, and 2-3 years is defined in municipalities in other prefectures.
Main conclusion

Japan is allocating enormous resources to developing strategies and plans and implementing remediation.

Japan has achieved good progress in remediation activities and has well considered the advice provided by previous mission in 2011.

Good coordination of remediation with reconstruction and revitalisation efforts.
• Highlights of progress (13)

- Comprehensive institutional arrangements: National, prefectural, municipal. Enormous efforts to implement the remediation programme to reduce exposures and to support the return of people.

- Many examples of good practice in stakeholder involvement. Large amount of crucial information has been produced to help decision making processes.

- NRA team to conduct a study on safety and security measures towards evacuees returning home. Benefits to continue measurements of individual exposure doses for residents and measures other than decontamination to reduce individual exposure, health management and rebuilt daily life.

- Critical evaluation of the efficiency of the removal of contaminated material compared with the reduction in dose rate offered by different methods of decontamination.

- Good progress in the remediation of affected farmland in the Intensive Contamination Survey Area. Intensive monitoring of foodstuffs. Results suggest that top soil removal not necessarily optimal solution.
• Highlights of progress (13) – Cont.

- Comprehensive implementation of food safety measures has been effective to protect consumers, to improve consumers' confidence.

- Authorities in Japan have implemented a practical option for remediation of the forest areas (limited to 20m from residential areas).

- Comprehensive monitoring of environment and data management. Comprehensive aquatic monitoring programme on-going, as well as food monitoring of freshwater fish.

- Significant progress in the development and implementation of temporary storage facilities. Progress towards the establishment of interim storage facilities.

- Incineration used as an effective for volume reduction.
• Advice (8)
  
  ➢ More active participation of the Nuclear Regulation Authority (NRA) in the review of remediation activities. Enhance platforms to share lessons learned between Municipalities.

  ➢ Japanese institutions are encouraged to increase efforts to communicate that, in remediation situations, any level of individual radiation dose in the range of 1 to 20 mSv per year is acceptable, and that balance of all factors influencing the situation is required to obtain maximum benefit for health and safety of people.

  The Government should strengthen its efforts to explain to the public that an additional individual dose of 1 mSv/y is a long-term goal, not achievable at short time solely by decontamination work. Step by step approach to balance the allocation of resources to remediate versus to recover essential infrastructure.

  ➢ Benefits of communicating the entire remediation and reconstruction programmes and mutual interactions to reduce some uncertainties and provide greater confidence in the decisions being made.

  ➢ Further use of the individual doses to support remediation decisions and monitoring.
• Advice (8) – Cont.

- Potential to further optimization of the application of remediation measures to still produce safe foods considering the natural processes leading to reduced availability caesium to crops.

- Continuation of the optimization of the remediation of forest areas around residential areas, farmland and public spaces, focusing in areas with the greatest potential benefit in dose reduction and avoid damage to ecological functioning of forest.

- Continuation of the monitoring of freshwater and marine environments, as well as research, as the basis for site specific remediation of affected areas.

- Implementation of appropriate demonstrations of the safety (and independent evaluations) of the facilities and activities for the management of contaminated materials, in particular for long-term activities.
IAEA Peer Reviews on Fukushima Daiichi NPP Decommissioning

“Mid-and-Long-Term Roadmap for Decommissioning F-D NPP” was adopted by the Government of Japan and TEPCO Council in December 2011, revised in July 2012 and again in June 2013

Roadmap includes description of the main steps and activities to be implemented for decommissioning of TEPCO’s Fukushima Daiichi NPP

GoJ requested IAEA to organize International Peer Review of the Roadmap. Review implemented in two steps = two missions in 2013 (Apr and Nov/Dec)

Main objective: To provide an independent review of activities associated with the planning and implementation of Fukushima Daiichi NPP decommissioning. In particular, it is intended to:

• Improve the decommissioning planning and the implementation of pre-decommissioning activities
• Facilitate sharing of good practices and lessons learned with international community
IAEA First Mission on Fukushima Daiichi NPP Decommissioning

• **Period:** 15 to 22 April 2013

• **Scope:**
  - Initial review of the Roadmap and a review of several specific short-term issues and recent challenges:
    - Current conditions of reactors and PCVs
    - Management of waste, fuel and fuel debris
    - Radioactive releases and doses
    - Site decontamination and working environment
    - Structural integrity of main buildings
    - Reduction of radioactive exposure of workers

• **Team:**
  - 13 experts: 9 IAEA staff and 4 external experts (Canada, France, RF, USA)
IAEA Second Mission on Fukushima Daiichi NPP Decommissioning

• **Period:** 25 Nov to 4 Dec, 2013

• **Scope:**

  ➢ More detailed and holistic review of the Roadmap and mid-term challenges including agreed specific topics:

    • Removal of SF and fuel debris
    • Contaminated water, measures to reduce ingress of ground water to main buildings
    • Waste management
    • Public radiation exposure. Marine monitoring
    • Decommissioning programmes. Licensing. Technology development
    • Stability and reliability of structures, systems and components

• **Team:**

  ➢ 16 experts: 11 IAEA staff and 5 external experts (OECD/NEA, Canada, France, Hungary, UK)

  ➢ 3 experts involved in preparation of the IAEA Report on 1FD NPP accident (IAEA staff, USA)
Final reports submitted to GoJ on 22 May 2013 and 12 February 2014 and published on:

• **Main conclusion**

  Decommissioning F-D NPP is a challenging task that requires significant resources and innovative technologies

  Japan developed its efforts towards decommissioning the plant promptly after accident and has achieved good progress in its strategy and plans, and allocated necessary resources

  GoJ and TEPCO evolved to a more proactive attitude to address the many difficulties at the site

  Situation is still complex and there are still some challenging issues to be resolved to achieve a long-term stable condition of the plant. Japan adopted well-oriented set of measures
First Mission on Decommissioning. Conclusions

• Highlights of progress (9). Shortened examples:
  ➢ Japan addressed the 1F decommissioning in a timely manner. Early preparation of Roadmap, plans to remove fuel from pools, rational plans for removing damaged fuel
  ➢ GoJ and TEPCO have recognized importance of stakeholders involvement and public communication.
  ➢ Deployment of advanced and large-scale treatment technologies for desalinating and decontaminating highly radioactive water.
  ➢ Commitment to enhance/optimize radiation protection of workers.
Advisory points (17). Shortened examples:

- Launching efforts to define end-state of the 1F site with stakeholder involvement
- Assessment of TEPCO’s incident reporting and communication practices with authorities and public with aim to enhance stakeholders trust and respect.
- To continue efforts to improve reliability of essential systems, to assess structural integrity of site facilities, and enhance protections against external hazards.
- To prepare long-term waste management strategy and plans by estimating volumes, types and characteristics of waste streams and by identifying optimised WM scenarios.
- To review strategy for accumulated water management taking into account all constraints and associated risks of different options/measures in consultation with stakeholders. Implement adequate measures to prompt detection/mitigation of leaks.
- Management of radiation releases and public exposures from site to be improved. Assessment of overall benefit of site-boundary dose limit. Radiation levels at the site boundary due to solids and liquids stored at the site.
• Highlights of progress (19). Shortened examples:

- Revised Roadmap based on more realistic assumptions and feedback from stakeholders. International Research Institute for Nuclear Decommissioning (IRID) good example of national and international engagement.

- Acknowledgment of successful preparation and operations for removal fuel assemblies from Unit 4 pool, as a major milestone.

- Efforts to develop remote technology to identify water leakages locations in PCVs and development of techniques to repair them.

- Acknowledgment of the GoJ proactive approach to address contaminated water issue: policies and Committee on Countermeasures of Contaminated Water Treatment

- Acknowledgment of the comprehensive Sea Area Monitoring Plan
Advisory points (19). Shortened examples:

- GoJ encourages to continue on-going leading efforts towards safe decommissioning of 1F NPP. To recognise NRA important role in ensuring nuclear and radiation safety.

- Need to look for a sustainable solution to the problem of radioactive water accumulated at the site. All options have to be considered, including possible resumption of controlled discharges to the sea.

- Advise to perform assessment of radiological impact to population and environment arising from potential releases of tritium and other residual radionuclides to the sea in order to evaluate radiological significance and have good scientific basis for decisions.

- To encourage TEPCO to continue and accelerate efforts to improve and to expand capacity of Advanced Liquid Processing System (ALPS).

- Increasing quality data and public confidence on sea monitoring results: interlaboratory comparisons, independent analyses by international partners, seminars, etc.
Thank you for your attention

...atoms for peace.