IAEA assistance to the Ministry of the Environment, Japan on 'volume reduction and recycling of removed soil arising from decontamination activities after the Accident of the Fukushima Daiichi Nuclear Power Station'

SUMMARY OF THE FIRST EXPERTS MEETING

From 8 to 12 May 2023

Contents

Executive Summary 3

I – Introduction 4

I.1 – Background 4

I.2 - Objective 5

I.3 - Scope 5

I.4 - Schedule of activities and output 6

II - Mission programme 7

II.1 - Preparatory Work 7

II.2 – Content of the first IEM 7

III - Technical and courtesy visits 9

III.1 - Interim Storage Facility (ISF) 9

III.2 – Demonstration projects sites of recycling of removed soil 11

III.2.1 – Demonstration project of agricultural embankments, Nagadoro District, Iitate-Village 11

III.2.2 – Demonstration project of embankments roads 11

III.2.3 - Potted plants using removed soil 12

III.3 - Courtesy visits to Officials of the MOEJ, Okuma Town, Futaba Town, Iitate Village as well as Residents of Nagadoro District 13

III.4 - Great East Japan Earthquake & Nuclear Disaster Memorial Museum 14

IV – Technical discussions 14

IV.1 - Communication strategy 14

IV.2 - Stakeholder engagement 15

IV.3 – General approach for recycling and volume reduction 17

IV.4 - Safety Assessments and Exposure pathways 18

IV.5 - Final disposal 19

Executive Summary

In May 2023, a team of experts, comprising international experts and IAEA officials, conducted its first International Expert Meeting (IEM) with the Ministry of the Environment, Japan (MOEJ) in accordance with the terms of reference for the IAEA's assistance to the MOEJ on volume reduction and recycling of removed soil arising from decontamination activities after the Accident of the Fukushima Daiichi Nuclear Power Station.

In response to the request from the MOEJ, the objective and the scope of the review mission were tailored to provide advice and support to the MOEJ, with regard to the volume reduction and recycling of removed soil, which have been promoted based on the relevant laws and documents. The current approach to volume reduction and recycling of removed soil comprises a variety of activities, such as technology development, a couple of demonstration projects using removed soil and building public understanding. Japanese law requires the final disposal of the removed soil outside Fukushima Prefecture by March 2045. The objectives of the mission focused on discussing the current progress and challenges of the volume reduction and recycling, and providing advice and support to the MOEJ for the works both from the technical viewpoint and the social viewpoint.

To meet the objectives, the scope of the IEM covers the following four main points.

- Discussion about the current status of the volume reduction and recycling
- Discussion about the current status of the implementation of the Technology Development Strategy for Volume Reduction and Recycling and the Process Chart (Strategy and Roadmap)
- Provide the assessment, support and advice to the progress and plans, especially in terms of recycling of removed soil and final disposal outside the Fukushima Prefecture, in specific areas listed in the Strategy and Roadmap such as:
  - From the technical viewpoints for recycling (e.g.: Criterion of recycling, quality control, safety, maintenance of construction, monitoring), as well as methodologies for final disposal.
  - From the social viewpoints (e.g.: Communication with the public and promotion of public awareness)
- Visit to the sites relevant to the volume reduction and recycling of removed soil (e.g.: the Interim Storage Facilities, demonstration site for recycling of removed soil).

During the 1st IEM, the team of experts received the full cooperation of the MOEJ, as well as local authorities and other interested parties in Fukushima. Over the course of the week, a wide range of topics were discussed in Tokyo, and the team of experts had very fruitful opportunities to have hands-on experience in Fukushima, including site visits to the Interim Storage Facility (ISF) and sites for the demonstration projects, as well as courtesy visits and discussion with mayors and people who have been involved for a long time with the projects relevant to the volume reduction and recycling of the removed soil.

The team of experts noted significant progress during the IEM and, noting that discussions are not meant to be conclusive at this stage, the team of experts has identified topics that will need to be discussed in the forthcoming meetings.

This summary report was written and endorsed by the team of experts and has been published by the IAEA on its website. As next steps, the 2nd IEM and the 3rd IEM are planned to be held in the last half of 2023 and in early 2024, respectively. The work is, therefore, still in progress and the team of experts will continue its thorough review with close interaction with the MOEJ, to provide its conclusions after the forthcoming IEMs.

I – Introduction

I.1 – Background

In October 2022, the Director General of the Environmental Regeneration and Material Cycles Bureau of the Ministry of the Environment, Japan (MOEJ) requested the International Atomic Energy Agency (IAEA) to organize and perform in 2023-24 three Experts Meetings on volume reduction and recycling of removed soil arising from decontamination activities after the accident of the Fukushima Daiichi Nuclear Power Station in Japan.

Since the accident at the TEPCO's Fukushima Daiichi Nuclear Power Station (NPS) occurred in March 2011, a large number of activities involving Japanese authorities and the IAEA have been taking place. Especially, under the IAEA Action Plan on Nuclear Safety established in September 2011, a wide variety of programmes of learning and acting upon lessons following the accident have been implemented in order to strengthen nuclear safety, emergency preparedness and radiation protection of people and the environment worldwide. Lessons learned from the accident were shared and disseminated through the series of International Experts Meetings, International Peer Review Missions, and different types of technical documents. The IAEA Report on the Fukushima Daiichi Accident (IAEA Fukushima Report), which was presented at the 59th IAEA General Conference in September 2015, assessed the causes and consequences of the accident and explored a lot of lessons learned from it.

In particular, the Technical Volume 5 of the IAEA Fukushima Report extensively addressed the challenges related to the post-accident recovery including off-site remediation, on-site stabilization, and radioactive waste management. The report produced significant commentary on the strategy development and implementation of the environmental remediation in the off-site areas affected by the accident. However, the post-accident recovery including the environmental remediation work is continuing. Progress, challenges and solutions may all benefit from consideration by the IAEA, as well as sharing with the international community.

For this, it is proposed that a continuous process of consultation composed of bilateral meetings between the IAEA and the MOEJ, the Government of Japan (including other relevant authorities, as appropriate) could be established, so that progress on the environmental remediation activities would be updated and discussed in a more detailed way. The environmental remediation has resulted in the interim storage of a large volume of removed soil and waste, and volume reduction and recycling of the removed soil arising from decontamination activities in Japan is a particular topic of interest. This consultation mechanism will give the chance for both sides to have a more effective and constructive exchange of information; for the IAEA and international experts selected by IAEA to obtain better understanding of the recent progress; and consequently, for the MOEJ to receive more useful advice from the international community through the IAEA. The findings (additional experiences and lessons learned) to be collected through this consultation will be disseminated to the international community.

I.2 - Objective

As discussed above, the decontamination activities resulted in a very large volume of removed soil and waste and most of it is currently stored at the Interim Storage Facility (ISF) (the remaining is stored at Temporary Storage Sites (TSSs)). The internationally agreed waste management hierarchy supports volume reduction, reuse and recycling where possible, in order to reduce the volume of waste that needs to be disposed of. The removed soil may be an important resource and therefore options for recycling of the removed soil are being evaluated. If these options are proved to be safe and feasible then they will significantly reduce the volume of waste that will need to go for final disposal. In the remainder of this document, the term 'recycling' refers to reuse and recycling.

The IAEA assistance project marks an important step in supporting Japan towards reducing the volume of radioactive waste from the accident of the Fukushima Daiichi NPS and increasing the recycling of removed soil arising from decontamination activities after the accident. The IAEA assistance project will consist of three international expert meetings (IEMs) and will address both the technical perspective (e.g.: recycling and safety criteria), as well as the social perspective (e.g.: public and stakeholder engagement).

The objectives of the IEM are:

- To discuss the current progress and challenges of the activities associated with planning and implementation of volume reduction and recycling of removed soil, which are mainly stored in the ISF.
- To provide advice and support to Japan for the above works, especially from the technical viewpoint (e.g.: recycling and safety criteria), as well as the social viewpoint (e.g.: engagement of interested parties).

The IAEA assistance project provides an independent review against the IAEA Safety Standards. The IAEA assistance project will not result in approval or rejection of the solution provided but will review the safety of the project proposals based on the IAEA Safety Standards. Regulatory review, including approval and/or authorisation issuance to proceed with activities to manage the removed soil is the sole responsibility of the Japanese authorities.

I.3 - Scope

The scope of the IAEA assistance project covers the following items:

- Discussion about the current status of the volume reduction and recycling
- Discussion about the current status of the implementation of the Strategy and Roadmap for volume reduction and recycling
- Provide the assessment, support and advice to the progress and plans, especially in terms of recycling of removed soil and final disposal outside Fukushima Prefecture, in specific areas listed in the Strategy and Roadmap such as:
    - From the technical viewpoints for recycling (e.g.: methodology, criterion of recycling, quality control, safety, maintenance of construction, monitoring),

    - From the social viewpoint (e.g.: communication with the public and promotion of public awareness).
- Visit to the sites relevant to the volume reduction and recycling of removed soil (e.g.: the ISF, demonstration site for recycling of removed soil).
- Dialogue with associated mayors and representatives.

The IAEA is implementing the project, specifically the Waste and Environment Safety Section of the Radiation, Transport and Waste Safety Division, Department of Nuclear Safety and Security with the support of a team of 6 international experts. All selected experts have considerable experience in the areas under the scope of the IAEA assistance project and have previously worked with the IAEA on radioactive waste management, volume reduction, recycling or stakeholder engagement. The IAEA staff members and the international experts selected by IAEA are hereafter referred to as the 'team of experts'.

I.4 - Schedule of activities and output

The first IEM was held in May 2023, and 2 more IEMs are planned in the last half of 2023 and in early 2024.

The present report is the summary of the discussions held during the first IEM. A final report including the main findings and recommendation of the three IEMs will be published after the 3rd IEM.

II - Mission programme

II.1 - Preparatory Work

The IAEA and the MOEJ agreed on the terms of reference of the IAEA assistance project on 11 November 2022. A project implementation plan describing the activities to be implemented during the 3 planned IEM was developed.

By 14 December 2022, the IAEA recruited the 6 experts dedicated to the IEM. As agreed in the project implementation plan, the MOEJ provided to the team of experts reference information to provide them with an overview of the activities undertaken by Japan under the scope of the IEM as well as their legal basis. The team of experts prepared presentations based on the IAEA Safety Standards and examples based on the experience and feedback of activities implemented in their countries.

II.2 – Content of the first IEM

The agenda of the first IEM is provided in Annex 1.

The first day of the IEM as well as the fourth and fifth day were dedicated to technical discussions while the second and third days focused on technical visits, dialogue with local residents and courtesy visits.

Day 1 started with a first session on the overall overview of the MOEJ activities for environmental restoration project, including volume reduction and recycling of removed soil arising from decontamination activities after the accident of the Fukushima Daiichi NPS. The MOEJ introduced its activities based on the Strategy for Volume Reduction and Recycling of Removed Soil from Interim Storage – formulated in 2016 and revised in 2019. The Strategy covers the period from FY2016 to FY2024, noting that FY2024 is the target for development of overall basic technologies for volume reduction and recycling of removed soil and waste.

The second session was dedicated to communication and stakeholder involvement activities undertaken by the MOEJ for encouraging public acceptance on volume reduction and recycling of removed soil arising from decontamination activities after the accident of the Fukushima Daiichi NPS.

Session 3 focused on the dose criteria used in assessment of additional exposure caused by recycling activities as well as volume reduction activities. The MOEJ described the approach used for setting exposure pathways by which radionuclides could give rise to exposure of members of the public and workers. The exposure pathways vary according to the option selected for recycling of soil.

Session 4 provided detailed presentation of the ISF straddling Okuma and Futaba Towns from its creation to its current situation with all different facilities implemented on site. The MOEJ highlighted the difficulties encountered with the land acquisition and the impact on the landowners in the region. The types of removed soil transported to the ISF and their radioactivity levels and their volumes were discussed as well as the design of the soil separation facilities, soil storage facilities and waste storage facilities.

On Day 4, in response to the request of the team of experts, additional topics (e.g.: definition of models and selection of parameter values for the dose assessment) were discussed, followed by the following technical presentations by the team of experts to the MOEJ

- Overview of IAEA safety standards on waste classification, storage and disposal
- IAEA DS500 (GSG 18) - The Application of the Concept of Clearance
- Examples of Radioactive Waste minimization and disposal practices in the USA
- The importance of stakeholder engagement, drawing upon experience in both UK and Australia of “volunteering” in site identification

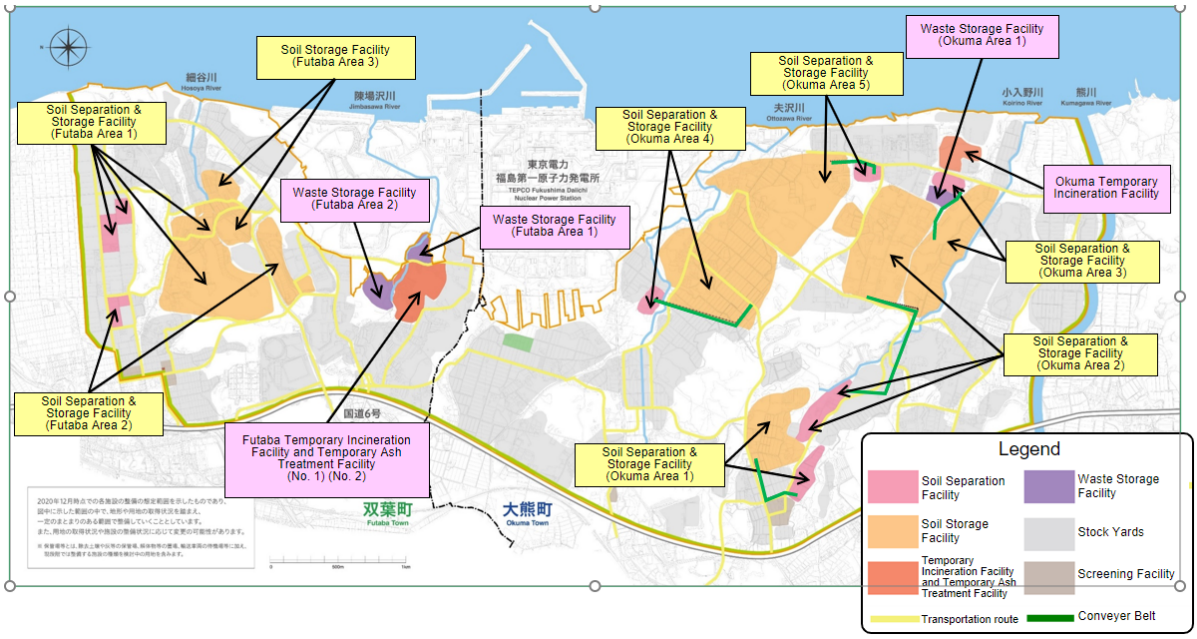
The main topics addressed during the first IEM were discussed on Day 5 to wrap up the discussion.

III - Technical and courtesy visits

III.1 - Interim Storage Facility (ISF)

The ISF, straddling Okuma and Futaba Towns, for example, contains the following facilities:

- Information centre of the ISF
- Soil Separation Facilities
- Soil Storage Facilities
- Waste Storage Facilities
- Temporary Incineration Facilities
- Recycling project of embankment roads
- Test Facility for Fly Ash Cleaning Technology



The ISF, covering an area of 16 square kilometers, falls under the responsibility of the MOEJ. It was built to provide a safe, centralized place to manage and store removed soil, waste and ash until they can be permanently disposed of. According to "*The Technology Development Strategy for Volume Reduction and Recycling of Removed Soil from Interim Storage*[1]":

- incinerated ash represents about 300,000 cubic meters
- removed soil represents about 13 million cubic meters of soil.
- removed soil is estimated to consist of about 7 million cubic meters of sandy soil (mainly from residential areas, public facilities such as schools and parks, and commercial facilities) and about 6 million cubic meters of cohesive soil (mainly from farmland, forests, etc.)

[1] Chapter 3, Targeted removed soil, page 4

Wastes are produced from decontamination activities as well as from other activities including demolition in Specified Reconstruction and Revitalisation Base Areas.

Other than the Restricted Areas, transport of removed soil and waste to the ISF is almost completed.

The removed soil brought in from TSSs is sorted at the **Soil Separation Facilities**. The facility plays a crucial role in the initial treatment and sorting of the soil before it is stored in the **Soil Storage Facilities**. The primary objective of the **Soil Separation Facilities** is to remove debris and combustibles to make the removed soil more suitable for the interim storage in the **Soil Storage Facilities**. The soil separation process involves several steps. Initially, the removed soil is transported to the facility and undergoes preliminary screening to remove larger debris and container bags. Subsequently, the soil is further processed to secondary screening to remove smaller debris and combustibles. These may involve techniques such as opening container bags, sieving, mechanical separation and chemical treatment to remove debris and combustibles.

The results from soil separation are then categorized into different classes based on their radioactive concentration, as stipulated in existing Japanese guidelines. These classes determine the subsequent storage and management procedures for the soil within the ISF:

- The combustible materials (e.g.: container bags, plants, roots) obtained from the separation treatment are sent to the **Temporary Incineration Facilities**. The fly ash obtained from the **Temporary Ash Treatment Facilities** is mainly stored in the **Waste Storage Facilities**, but small part of the fly ash is currently treated in the **Test Facility for Fly Ash Cleaning Technology** as a demonstration project to seek the feasibility for further volume reduction of the waste.
- The separated soil is transported to the **Soil Storage Facilities.** The **Soil Storage Facilities** are landfill facilities with double impermeable sheets and a drainage water collection system at the bottom and along the enclosing dikes. The arriving soil is levelled and compacted by bulldozer equipment. The drainage water is collected and directed to the leachate treatment facilities. Upon completion, the landfill is covered by impermeable sheets, soil and vegetation.
- Regarding the waste other than the waste arising from decontamination activities, the Specified Waste generated in Fukushima Prefecture, with an activity concentration of >100 000 Bq/kg is transported to the ISF.

Observation

According to the documents reviewed, the discussions during the mission, the facilities visited, and also recalling that this first meeting is not meant to be conclusive yet, the team of experts considers that it is reasonable for the soil and waste arising from decontamination activities to be transported to the ISF. At this point, the team of experts estimates that the removed soil treated in the ISF is properly stored (according for example to stability of the concept, impermeable sheets, cover soil…) in the Soil Storage Facility. This, as well as the other facilities and activities of the ISF, will need to be further discussed for conclusions in the forthcoming meetings. Similarly, there is no indication at this point that, for the facilities and activities observed during this first IEM (e.g.: Soil Separation Facility, Soil Storage Facility), the dose to workers is not appropriately monitored.

III.2 – Demonstration projects sites of recycling of removed soil

III.2.1 – Demonstration project of agricultural embankments, Nagadoro District, Iitate-Village

The project aims at creating embankments for farmland. After removing all debris and foreign material from removed soil with a radioactivity of 5,000 Bq or less per kilogram, they are used for the foundation of an embankment, covered with soil to block radiation, and the surface is turned into agricultural land. Tests were conducted on small areas in Nagadoro District in order to confirm safety and soil productivity. Test cultivation of flowers, vegetables and resource crops was performed. The project is carried out by the MOEJ with the close involvement of local residents and has been ongoing since 2017. It is one of several demonstration projects being conducted in Fukushima to test different methods for the volume reduction and recycling of removed soil. The results of these projects will be used to guide the creation of agricultural and road embankments and other structural infrastructure components as part of future policies and strategies for managing removed soil generated in Fukushima.

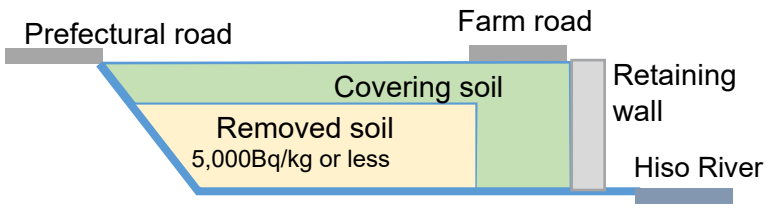


Figure. Large-scale Embankment Cross Section of Demonstration Project in Nagadoro District, Iitate Village

Observation

The team of experts notes that the soil removed from farmland during decontamination efforts is predominantly the top 5cm of the soil and is therefore meant to be good quality topsoil. The team of experts observed that the MOEJ is making efforts to support the resumption of farming by utilizing ploughed soil from other farmlands as the top 30 cm of the 50 cm of covering soil.

The activity concentration of radioactive caesium in the crops grown directly in the soil with removed soil was well below the national guidance levels. The team of experts observed that the demonstration project in Nagadoro District has been safely implemented in terms of the recycling of removed soil and expect that this project and associated monitoring will continue to provide long-term safety data.

III.2.2 – Demonstration project of embankments roads

The project aims at creating one embankment road within the ISF. After removing debris and foreign materials from removed soil with a radioactivity of 8,000 Bq or less per kilogram, they are used as recycled materials for the foundation of an embankment, covered with soil, asphalt and concrete, as

usual during the construction of roads, that also provide shielding from radiation. The demonstration road will be monitored, and the MOEJ plans to be able to see the result of the project and decide if the technique can be used at a larger scale to create embankments, or potential other kinds of constructions to be determined at a later stage such as railways, seawalls or coastal protection, as part of future policies and strategies for managing removed soil generated in Fukushima.

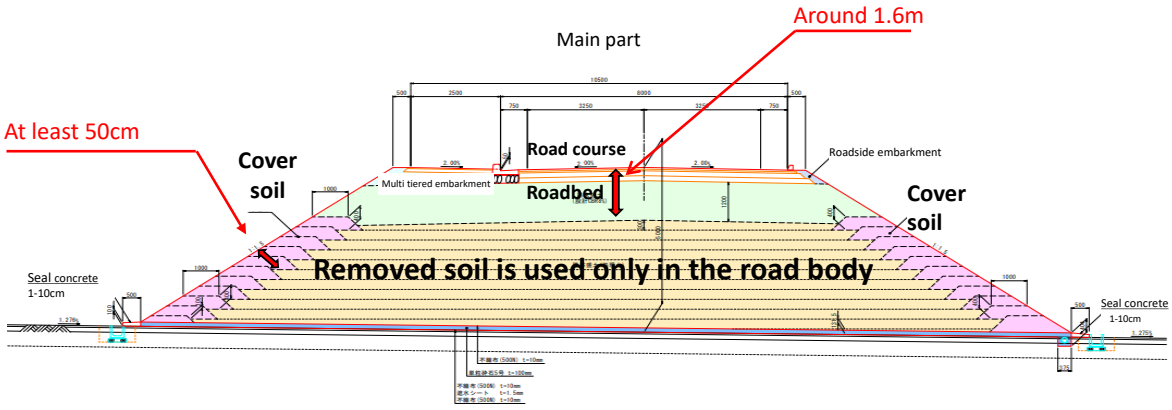


Figure. Demonstration Project on Road Embankment in the ISF

Observation

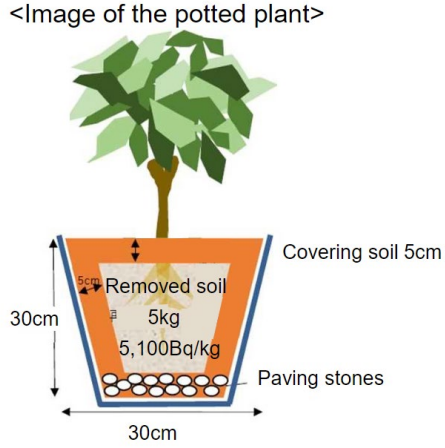
A covering of soil at least 50 cm thick may be needed to avoid removed soil from being blown and eroded by the wind, rainfall and other external impacts and to shield radiation. Japanese counterparts indicated that, regarding this demonstration project, a top layer of 160 cm is required by engineering design codes, as used in some construction projects. Therefore, radiation will be sufficiently shielded by following engineering design codes, which are usually applied in Japanese construction projects. It may be also reasonable to consider changing the thickness of the covering soil or other shielding measures according to specific applications. The team of experts expects that this project will be continued to further seek and demonstrate the feasibility for the large-scale projects to be implemented in more practical manner in the future.

III.2.3 - Potted plants using removed soil

23 potted plants using removed soil from Fukushima Prefecture are placed in 17 facilities including the MOEJ buildings, as well as the Prime Minister's office, the Reconstruction Agency, Shinjuku Gyoen National Garden, the National institute for Environmental Studies, and other locations.

The potted plants are constituted of 5 kg of removed soil surrounded by 5cm of uncontaminated soil.

<Image of the potted plant>



The dose rate in the air around at the locations of the potted plants is constantly monitored and the MOEJ observed that the air dose rate before and after installing the potted plants did not change.

Observation

Potted plants are dispatched in key locations. No additional dose was observed following installation of the potted plants. The team of experts considered that the initiative represents a good communication tool. Expanding this approach should be considered to encourage nationwide public acceptance of the recycling of removed soil. The team of experts considers that, in due time, after the use of these potted plants for encouraging public confidence, an approach for the safe and long management of soils in the pots will have to be considered.

III.3 - Courtesy visits to Officials of the MOEJ, Okuma Town, Futaba Town, Iitate Village as well as Residents of Nagadoro District

During the visits, the team of experts learned remediation measures implemented by the MOEJ, including ways in which the MOEJ is engaging interested parties. The team was able to discuss the MOEJ's understanding of stakeholder concerns and expectations.

A courtesy visit to officials of Iitate Village, and residents of Nagadoro District gave an opportunity to exchange views with some of those interested parties in person regarding the reconstruction of these areas and the difficulties raised by the decision to host the demonstration project using recycled soil for agricultural purposes.

A second courtesy visit to officials of Okuma Town and Futaba Town, prior to visiting the ISF was the occasion to better understand the point of view of the local municipalities and population regarding the ISF, including the difficult decision to accept the ISF, and the recycling projects being carried out on site.

The courtesy visits stressed the importance of securing public confidence. The team of experts highlighted the fact that risk communication differs from "education". Risk communication is also about listening to public concerns and engaging them in close communication so there is an improved joint understanding of the way forward.

III.4 - Great East Japan Earthquake & Nuclear Disaster Memorial Museum

The Great East Japan Earthquake and Nuclear Disaster Memorial Museum is located in Futaba Town. The memorial museum opened in September 2020 and has about 200 items related to The Great East Japan Earthquake, tsunami and nuclear disaster on permanent exhibition. This memorial museum shows how Fukushima has dealt with a complex and unprecedented disaster and its ongoing consequences, and communicates lessons for the future on the importance of disaster prevention and mitigation. It is an excellent resource for increasing public understanding. The team of experts was guided during the visit by Prof. Noboru Takamura, from Nagasaki University, director of the memorial museum.

IV – Technical discussions

IV.1 - Communication strategy

Japan position

The MOEJ strategy for communication is to build nationwide public understanding of the issue of efforts to reduce the volume of removed soil, to recycle removed soil, and to dispose of the waste. As a first step, the national government's communication focuses on explaining, from a technical and safety point of view, the necessity of final disposal outside Fukushima Prefecture and recycling of removed soil. In accordance with the Technology Development Strategy for Volume Reduction and Recycling of Removed Soil from Interim Storage, the following activities through different communication media have been implemented:

- Promotion of environmental revitalization tourism and site tours of the Nagadoro Project followed by a survey
- Accompanied, free of charge visits to the ISF
- Dialogue forums in Japan to explain the importance of volume reduction and recycling of removed soil. The recordings of these are published online.
- Information leaflets
- Lectures for university students and high school students
- Creation of an internet survey to measure public understanding of the project, of the importance of volume reduction and recycling of removed soil, and comparing the differences in understanding between residents of Fukushima Prefecture with those from outside the Prefecture.

Observations

During the discussions with the MOEJ, the team of experts agreed that successful completion of final disposal outside Fukushima Prefecture by March 2045 will require public understanding of and confidence in recycling of removed soil, and noted the actions by the MOEJ including dialogues with

people all over the country, tours to the ISF and demonstration sites, dissemination of potted plants to the relevant locations.

With regard to the Web questionnaire, the team of experts observed it would be better to have more respondents to contribute further to improve the representativeness of the survey. The team of experts also noted that most people surveyed, notably living outside Fukushima prefecture, are unaware of the law stipulating that final disposal of the removed soil is to be outside of Fukushima Prefecture. The team of experts noted that the locations of projects on the recycling of removed soil is not limited outside of Fukushima Prefecture, but instead can be implemented within Fukushima Prefecture as well.

The tours of the demonstration project are free of charge and according to the discussions during the first IEM, visitors are predominantly locally based within Fukushima Prefecture. The visitors to the demonstration project were wearing safety equipment (gloves and hard hats). It was confirmed that the tour guides had explained to the visitors that this was for other safety reasons, not for radiation protection. More attention to the results of the radiation monitoring equipment could help to demonstrate how low the background levels are.

The team of experts considers that the MOEJ should further research and evaluate what perceived factors determine the different views or level of understanding of different sections of the public. This could help clarify what are the key factors affecting acceptance of the various demonstration projects. For example, are different types, uses and locations of construction better understood and accepted by different sections of the public than others? What are the views of construction firms and workers?

To conclude, the team of experts considers that the MOEJ should draw lessons from previous communication with the public and other stakeholders on the removed soil and the creation of both the Temporary Storage Sites (TSSs) within Fukushima Prefecture and the ISF. For example, it could be suggested that the creative use of illustrative materials, diagrams including "before and after" pictures to reinforce the overall communication messages of safety and environmental sustainability is implemented by the MOEJ. The following sections of this report also include suggestions regarding the communication of some of the more detailed technical aspects of the project including the regulatory aspects and safety assessments.

IV.2 - Stakeholder engagement

Japan position

The MOEJ position is that it is necessary to build public understanding nationwide of the issues and efforts to both reduce the volume and also recycle removed soil and to reduce the volume of waste to be disposed of. The MOEJ strategy is to promote public understanding of recycling technology development, of the current approach and proposed methods for recycling removed soil. Improved public understanding of radiation safety is also part of the strategy.

The MOEJ formed the Communication Promotion Team to implement activities for public understanding with the cooperation of a number of academic experts and researchers. It is understood that roughly 65 % of those surveyed in Fukushima Prefecture and 88 % outside Fukushima Prefecture have never heard about recycling use of removed soil or have only heard of it with little information and comprehension. The MOEJ is making further efforts to disseminate information about the recycling plans.

Observations

It was highlighted that risk communication differs from "education". Risk communication is also about listening to public concerns and engaging them in close communication so there is an improved joint understanding of the way forward.

While the MOEJ is focusing on the improvement of the general public's understanding of the management of soil and waste arising from decontamination activities in Japan, a clearer focus on developing effective communication with key stakeholders would be beneficial to improve the joint understanding of the issues faced.

According to the MOEJ, the anticipated date for the end of the demonstration project is yet to be determined. Efforts to capitalise on the lessons from the demonstration projects will be needed to support the next steps in recycling of the removed soil.

The MOEJ has developed a good relationship with affected local communities in Fukushima. It is, however, important that ongoing efforts still need to be continued to explain nationwide the need of recycling of removed soil and as well as the final disposal. The team of experts considers that further clarity on the plans not only for recycling but also for long-term final disposal outside Fukushima Prefecture would be beneficial to the communication strategy. This will require the identification of key stakeholders, including regulators, Prefecture representatives and officials, industry groups, universities as well as local community groups.

Public confidence is central to the long-term success of this project and requires a clear, long-term vision of the overall solution. As earning trust and building confidence is not purely technical but is also emotional, then addressing concerns of interested parties, for example, by measuring nuclides other than radioactive caesium, could be useful. Even if there is established scientific evidence demonstrating that these are a very low proportion of the radionuclide contributions, it would make the current focus appear more rational and therefore supportable. Risk comparisons need to be sensitive to people's perceptions, but some advantage could be taken by comparing the proposals with other more familiar radiation exposures and also non-radioactive hazards. More emphasis on the benefits, not just the risks of the recycling programme would be helpful. This includes direct benefits of employment and investment in local infrastructure, as well as the wider social benefit of "doing the right thing" morally and environmentally for a sustainable future.

The team of experts considers that co-ordination with related central government and local government departments will be beneficial to support projects for recycling of removed soil, as the Nagadoro Project Operating Council indicates.

Site visits are effective means to disseminate information about the safety, practicality and benefits of the recycling projects. This is true not only for the general public and for students, but especially for key stakeholder representatives and others who are influential role models.

The team of experts was particularly impressed by the context and information provided at the Great East Japan Earthquake and Nuclear Disaster Memorial Museum which is an excellent resource for "outreach" to the wider communities and links to information about the demonstration projects could be beneficial.

Specific communications for local representatives should be developed to address their needs and

expectations:

- *The team of experts received strong messages from local representatives that they expect all removed soil to be disposed of outside Fukushima Prefecture, in accordance with the Law. However, the team of experts understood from the discussions and visits during the first IEM that, although disposal outside Fukushima Prefecture is the final disposal solution in accordance with the law, this does not preclude the recycling of removed soil in Fukushima Prefecture.*
- *There is a need to emphasize that recycling of soil is one of several potential volume reduction techniques to give communities within and outside Fukushima Prefecture the holistic picture, so that recycling is not isolated from all the many technologies that have been used.*
- *Current local communication initiatives could be used more systematically, for example, utilising trusted, independent experts like the university professor who is currently helping Futaba township more broadly in the programme. A useful source reference different initiatives is IAEA Nuclear Energy Series No. Nw-T-1.16 "Communication and Stakeholder Involvement in Radioactive Waste Disposal". (IAEA 2022)*

IV.3 – General approach for recycling and volume reduction

Japan position

From the ca. 14 million m^3 of removed soil transported to the ISF[2] , three quarters are soil with low concentration activity (under 8 000 Bq/kg) and are planned to be recycled. Thus, a volume of more than 10 million m^3, on a transportation volume basis, will be recycled within embankments roads, agricultural lands and other structural infrastructure components in Japan.

The remaining 25% of the removed soil transported to the ISF has a radioactivity concentration above 8 000 Bq/kg and, following volume reduction as much as possible, it is supposed to be transferred to a final disposal site outside Fukushima Prefecture.

Observations

The team of experts considers that recycling such large volumes of removed soil is a new topic and the issues are not straightforward to address. A clear description of the difference between recycling and final disposal with their different end points (recycling or final disposal) will clarify the general approach of the MOEJ on volume reduction and recycling.

The team of experts also suggests keeping the schedule of the development of technologies required for volume reduction and recycling, and to complete the development of basic technologies for processing of removed soil by the end of FY2024. They also stressed the importance of recycling demonstration projects to make progress in reducing volumes to be disposed of in the final disposal and in public communication to increase acceptance of recycling. The demonstration projects outside

[2] This is the volume of soil and waste transported to the ISF, arising from the areas other than the Restricted Areas. The volume will increase in the future, according to the progress of decontamination activities in the Restricted Areas.

Fukushima Prefecture have a high importance and potential to provide measurements and encourage public understanding.

Once the demonstration projects provide a conclusion on the feasibility and safety of the recycling projects, the team of experts considers that the MOEJ could develop a cost-benefit analysis (including technical, societal, environmental, safety and financial aspects) for each step of the overall approach on volume reduction and recycling. This analysis will provide the necessary elements for justifying risk-informed choices as to which options of volume reduction and recycling to achieve final disposal outside Fukushima should be pursued.

The team of experts also considers that the overall approach requires key concepts of radioactive waste management (optimisation, justification, transparency and accountability) as defined by IAEA Safety Standards to be better emphasized.

Finally, the team of experts also considers that the removed soil has value and that the recycling of removed soil is a sustainable process for the reconstruction and revitalization of areas. Therefore, there are positive reasons for the recycling of removed soil, which is originally a valuable resource, beyond volume reduction, that should be promoted.

IV.4 - Safety Assessments and Exposure pathways

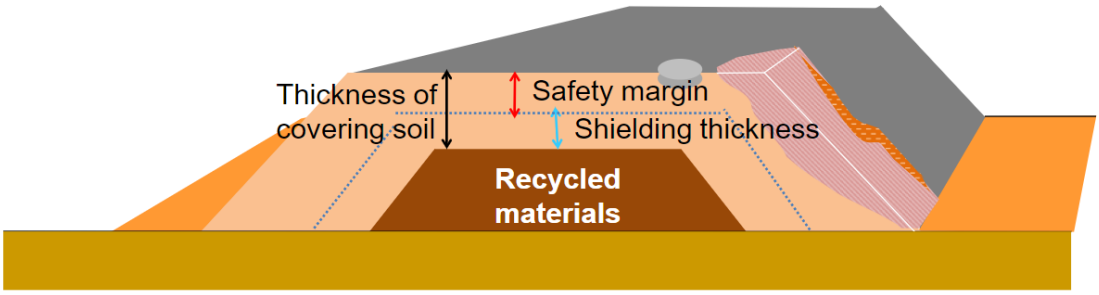
Japan position

The MOEJ explained the approach for selecting exposure scenarios and exposure pathways used in assessments to calculate the upper limit on the radioactivity concentration in the removed soil that could be recycled. Exposure pathways describe the route by which radiation or radionuclides can reach humans and cause exposure. The exposure pathways vary according to the option selected for recycling/reutilisation of soil and other materials.

The dose criterion is 1mSv/y as the additional maximum dose to be received by residents in the surrounding area due to volume reduction, transportation, storage, etc. This dose is used in the calculations that determine the maximum activity concentration that is 'allowed' to be recycled. Then a further step is to add shielding by clean soil so that the dose rate to the public around and using the completed structure after the soil is recycled is reduced, leading to doses below 10 microSv/y.

Specifically, the MOEJ assessment experts highlighted that a variety of measures will be introduced, including adding covering soil, to reduce the additional dose to a value below 1 mSv/y for the public and workers, and to ensure the 10 microSv/y dose for the public during normal operations. The assessment approach is to use conservative parameter values to overestimate the dose received from a particular activity concentration. This leads to a lower "allowed" activity concentration and therefore provides a safety margin. In addition, an upper limit of 8,000 Bq/kg is imposed for recycling of removed soil, to be consistent with the documents related to the Act on Special Measures. Uncertainties are covered by the conservative parameter values. Many of the parameter values were the same as those used to derive the 8,000 Bq/kg activity concentration level specified in the documents related to the Act on Special Measures.

The assessment approach is generic because no site has yet been specified.



Observations

The team of experts considers that the target dose of the additional dose of 1 mSv/y is a proper target for the recycling of removed soil and it is appropriate to use the recycled soil under proper management to meet the 1 mSv/y. Safety assessments are conducted in a very conservative way, and thereby the target dose can be sufficiently achieved by using the recycled soil of 8,000 Bq/kg or less under proper management including preventing scattering and leakage of removed soil.

The team of experts considers that demonstrating compliance with 1 mSv/y by implementing an additional dose of 10 microSv/y is very conservative: a factor of 10 is used in many countries as a 'safety factor' or 'investigation level' rather than a factor of 100. The team of experts also considers that the 10 microSv/y is a worthy value to be pursued.

The team of experts considers that realistic safety assessments will also be useful before implementation of specific applications to take into account site specific information. It would support optimization as required by the IAEA Safety Fundamentals.

The calculations show the dose to the public for different thicknesses of soil cover. The team of experts noted that the calculations are very conservative so the thickness of soil needed to shield the recycled soil should be sufficient to reduce additional dose. From the viewpoint of the principle of optimisation in radiation protection, realistic assessments would be beneficial to avoid misallocation of resources in specific applications. Safety assessments can also be used to address specific concerns of stakeholders.

The team of experts considers that the measurement of radiological influence by elements other than radioactive caesium, such as Sr-90, Pu, etc, will be useful from the viewpoint of reassurance of people. The team of experts will spend further time reviewing the detailed safety assessments to confirm that safety has been demonstrated in accordance with the approach set out in the IAEA Safety Standards.

IV.5 - Final disposal

Japan position

The Strategy envisages the complete final disposal of removed soil generated by decontamination measures outside Fukushima Prefecture within 30 years after the start of interim storage in accordance with the law. Currently the MOEJ has been addressing four steps of the eight steps towards the final disposal.

Observations

The team of experts noted that, there are a lot of safety, socio-economic and technical challenges to be addressed to realize the final disposal outside Fukushima Prefecture, which is clearly stipulated in the law. The team of experts suggests that a holistic strategy and timeline for the final disposal of removed soil outside Fukushima Prefecture, including siting, design and safety assessment should be defined by the MOEJ. They emphasized that the whole process is time consuming and requires a positive interaction with all stakeholders, including the public.

Annex 1 – Agenda of the 1st IEM

Day 1: May 8th (Mon.)

- Session 1: Current status of the Fukushima environmental restoration project
- Session 2: Stakeholder involvement & communication on volume reduction and recycling of removed soil
- Session 3: Rationale for radioactivity concentration of 8,000Bq/kg for recycling of removed soil
- Session 4: Strategy for volume reduction and recycling of removed soil
  - Outline of the Interim Storage Facility
  - Technology Development Strategy for Volume Reduction and Recycling of Removed Soil from Interim Storage

Note: Day 2 (May 9th) and Day 3 (May 10th): Site visits in Fukushima Prefecture (See the below reference)

Day 4: May 11th (Thu.)

- Session 5: Q&A Session
  Discussion about additional questions raised during the meetings (e.g.: models and parameters used for dose assessment)
- Session 6: Environmental restoration projects and initiatives of other countries related to the recycling of removed soil, and explanation of IAEA Safety Standards

Day 5: May 12th (Fri.)

Session 7: Summary of the 1st Experts' Meeting, etc.

(Reference)

Day 2: May 9th (Tue.)

- Courtesy visit to the Regional Environmental Office in Fukushima, the MOEJ
- Visit to the demonstration project site of recycling of removed soil in Nagadoro District, Iitate-Village
- Courtesy visit to the Mayor and Vice Mayor of Iitate Village
- Exchange opinions with Iitate Village officers and residents of Nagadoro District

Day 3: May 10th (Wed.)

- Courtesy visit to the Mayor of Futaba Town
- Courtesy visit to the Mayor of Okuma Town
- Site visit to the Interim Storage Facility
- Visit to the Great East Japan Earthquake and Nuclear Disaster Memorial Museum