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 SECOND EXPERTS MEETING

From 23 to 27 October 2023

Contents

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 managed recycling of removed soil arising from decontamination activities after the Accident of the Fukushima Daiichi Nuclear Power Station.

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 managed recycling of the removed soil. Much of the time during the 1st IEM was spared for providing the team of experts with opportunities to understand better the actual situation in Fukushima. The achievement of the 1st IEM was incorporated and published as the summary report[1].

To make further discussion (e.g. Approach for safety and standards for the recycling and final disposal of removed soil, approach for communication with stakeholders, information dissemination to the international communities), the 2nd IEM was held in October 2023 in the headquarter of the IAEA in Vienna on a face-to-face basis, with hybrid style with online participation from Japan. After the 1st IEM, the IAEA prepared for the 2nd IEM, with close coordination with the MOEJ.

The 2nd IEM provided an opportunity for the MOEJ to present the progress made after the 1st IEM in May 2023 including the current status of the institutional arrangement for the managed recycling and final disposal of removed soil, progress on the approach to communication and dissemination of information, and to share views of the MOEJ on the consistency with the IAEA Safety Standards. The team of experts presented examples of measures related to managed recycling and final disposal of removed soil and radioactive waste in various countries (e.g. United Kingdom, Belgium, Germany and USA). Furthermore, a site visit was conducted to the Nuclear Engineering Seibersdorf facility, where sorting and disposal of radioactive waste have been implemented in Austria.

The team of experts also noted significant progress during the 2nd IEM. In addition, measures for managing removed soil implemented by the MOEJ and relevant measures taken by other countries were shared, and in-depth discussion took place, with regard to assessment of the MOEJ activities on the managed recycling and final disposal of removed soil, in light of the IAEA Safety Standards.

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 3rd IEM is planned to be held in early 2024 in Japan. 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 3rd IEM.

[1] The summary report of the 1st IEM is available on the website of the IAEA: https://www.iaea.org/sites/default/files/23/08/summary-report-140823.pdf

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 managed 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 1st and 2nd IEMs were held respectively in May 2023 and in October 2023. The third IEM is planned in early 2024.

The present report is the summary of the discussions held during the 2nd IEM. A final report including the main findings and recommendation of the three IEMs will be published after the third 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.

The 1st IEM was organised from 8 to 12 May 2023 in Japan and the report was made publicly available on 1 September 2023.

The second IEM was held from 23 to 27 October 2023 in Vienna, Austria.

II.2 – Content of the 2nd IEM

The agenda of the 2nd IEM is provided in Annex 1.

The 2nd IEM was dedicated to technical discussions. It provided an opportunity for the MOEJ to present the progress made after the 1st IEM in May 2023 including the current status of the institutional arrangement for managed recycling and final disposal of removed soil, progress on the approach to communication and dissemination of information, and to share views of the MOEJ on the consistency with the IAEA Safety Standards.

Day 1 started with a first session on the overall overview of the Strategy for Volume Reduction and Recycling of Removed Soil from Interim Storage – formulated in 2016 and revised in 2019 – and the progress made by the MOEJ on activities for environmental restoration project, including volume reduction and managed recycling of removed soil arising from decontamination activities after the accident of the Fukushima Daiichi NPS after the 1st IEM. The second session was dedicated to regulations and regulatory aspects for managed recycling and final disposal of removed soil. The graded approach to regulation of exemption was discussed as well as regulations about specific clearance and screening levels.

Day 2 started with a site visit of Soil Sorting Facility at Nuclear Engineering Seibersdorf, Austria. It provided an overview of sorting activities of radioactive waste implemented in Austria. The third session focused on clearance measurements. Experiences, technologies, and procedures on clearance measurement facility measuring and sorting the soil in Belgium and in the USA were presented and discussed as well as the MOEJ progress on the demonstration projects for the managed recycling of the removed soil.

On day 3, session 4 dealt with communication and stakeholder involvement activities undertaken by the MOEJ for encouraging public acceptance on the managed recycling of removed soil arising from

decontamination activities after the accident of the Fukushima Daiichi NPS. Ways of building trust with stakeholders and best practices for using comparisons in explaining risk were also presented by the experts.

During session 5, the MOEJ progresses towards final disposal of removed soil and contaminated waste outside Fukushima Prefecture were discussed and a detailed presentation of IAEA safety standards on disposal of radioactive waste was provided.

On day 4 and 5, experts discussion pointed out technical and legal elements that could be useful to the MOEJ and pre-identification of the IAEA Safety Standards and other IAEA internationally recognised documents related to the main topics addressed during the 2nd IEM in order to wrap up the discussion on Day 5.

III – Technical discussions

III.1 – Regulations and regulatory aspects

Japan position

The overall process for final disposal outside Fukushima Prefecture is shown in Figure III.1.1.

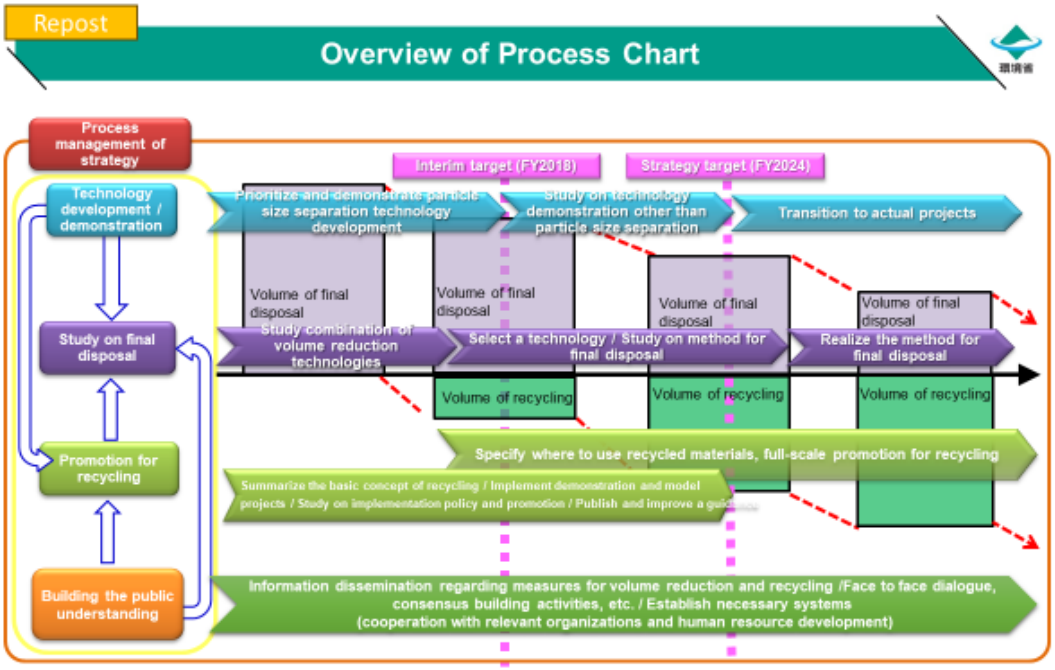

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Figure III.1.1 Overview of process chart for volume reduction and final disposal.

The end of FY2024 is the target year of the Technical Development Strategy and therefore the MOEJ is proceeding with the development of basic technology in order to present several feasible options for the required area and structure of the final disposal site.

Regarding regulatory aspects, the proposed system will apply to managed recycling of removed soil and final disposal of removed soil:

1. Managed recycling of removed soil:
   - Handling of soil: Use of removed soil as a resource (civil engineering material).
   - Objective: The removed soil is converted into recycled material through quality adjustment and other processes to match the conditions of the materials to be used. It is used under appropriate management and on limited basis as materials such as fill in public works projects.
   - Upper part: The upper part is used as roads, agricultural land, etc.
   - Concentration: Removed soil with low radioactivity concentration will be used.

- Location: Can be used inside and outside of Fukushima Prefecture.

2. Final disposal of removed soil:
   - Handling of soil: Disposal of removed soil as waste.
   - Objective: Final disposal by landfill at a final disposal site (no intention to retrieve). Regulation such as to put up a notice, install fence to restrict entry into the final disposal site.
   - Upper part: Use of the upper part is not the objective.
   - Concentration: No limitation on radioactivity concentration
     - (structure of final disposal site according to concentration)
   - Location: In accordance with the law, removed soil will be transported outside Fukushima Prefecture.

With regard to the managed recycling, the MOEJ is implementing demonstration projects based on the Basic Concept for Safe Use of Removed Soil Processed into Recycled Materials compiled in 2016 (the Basic Concept) as a guideline, as well as working to encourage understanding throughout the nation.

The justification for Japan's approaches to the managed recycling of removed soil and final disposal is as follows:

- The Japanese Government has positioned the reconstruction of Fukushima as a top-priority issue.
- Decontamination has contributed to reduction of radiation risk, lifting of evacuation orders and reconstruction of the affected areas.
- Soil removed and waste arising in Fukushima Prefecture have been transported to and stored in the ISF.
- The policy of final disposal of removed soil and waste outside Fukushima Prefecture within 30 years is stipulated in the law (JESCO Law), taking into consideration the fact that the residents of Fukushima have already borne an excessive burden to environmental pollution caused by the accident.
- In order to reduce the volume for final disposal, the Japanese Government has promoted volume reduction and recycling of removed soil and waste with public understanding.
- These initiatives will reduce radiation risk, make effective use of removed soil, which is originally a valuable resource, and contribute to the reconstruction of Fukushima.

The structure of the proposed system is shown in Figure III.1.2.

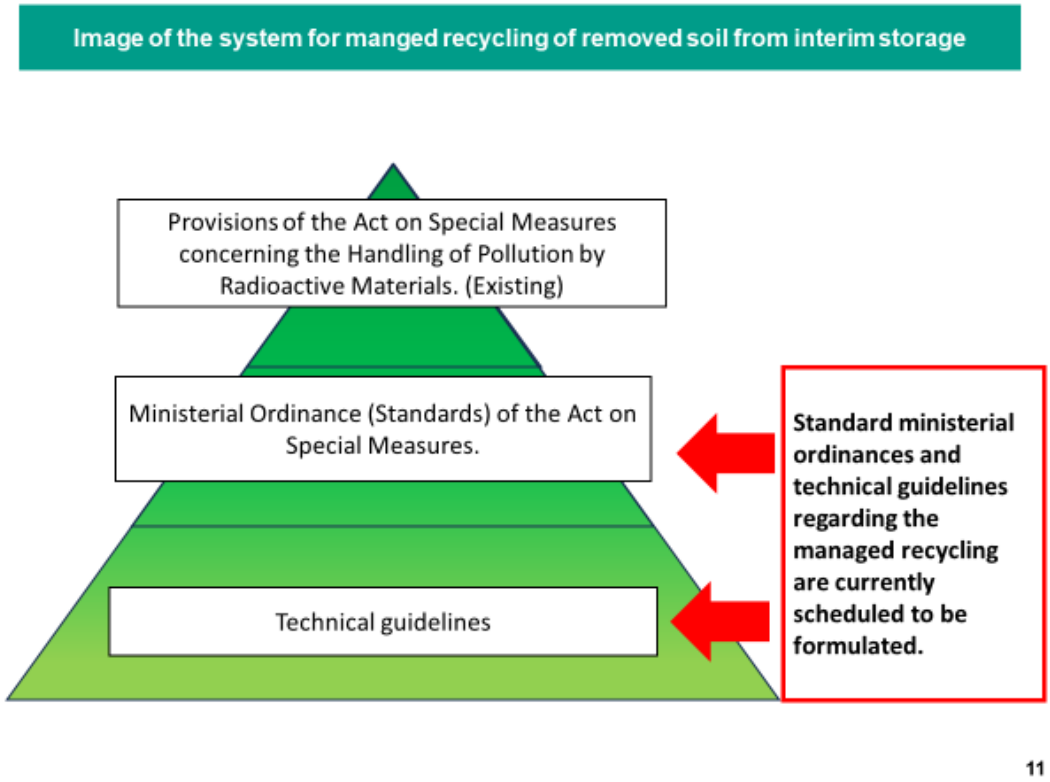


Figure III.1.2 System for regulating the managed recycling of removed soil.

The MOEJ is currently developing the ministerial ordinance and technical guidelines for the managed recycling of removed soil. The ministerial ordinance will contain guidelines for the managed recycling based on the knowledge gained in the demonstration projects and the ISF project (see Figure III.1.3).

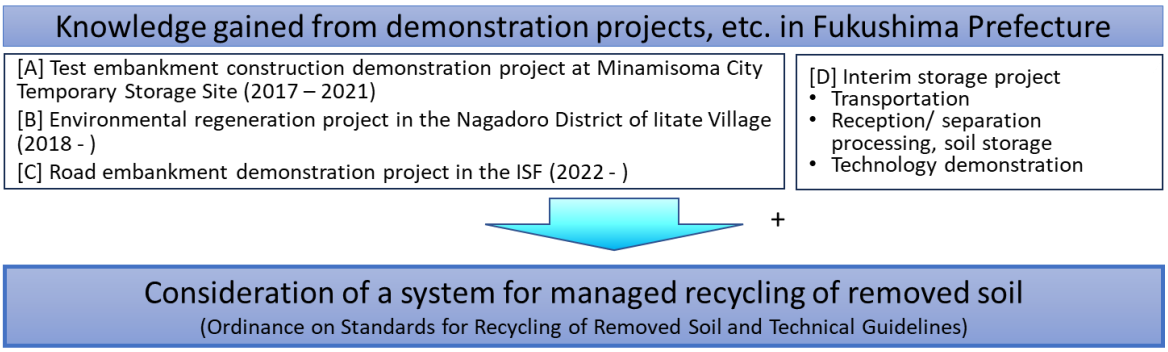


Figure III.1.3 Approach to the development of the system for the managed recycling of removed soil.

This knowledge covers the conversion to recycled material, transportation, design construction, maintenance, and methods for cooperation for appropriate construction and management. The generic safety case of each use (used in the Basic Concept) has been implemented and then based on the Basic Concept the demonstration projects have been conducted to confirm safety of the application of the screening level for the managed recycling of removed soil, so that it is not necessary to carry out a site-specific safety case. The Basic Concept used a target dose of the additional dose of 1 mSv/y to limit the activity concentration of recycled materials and then the screening level (8,000 Bq/kg or less) was derived from the sufficiently conservative generic safety case. The MOEJ also applies optimisation measures to reduce the doses to the public from the managed recycling of removed soil. In considering optimization, 10 microSv/y was studied and it was confirmed that further

reduction to 10 microSv/y was possible by installing sufficient shielding (e.g. cover soil). Based on an advice of the team of experts in the 1st IEM, it is considered to clarify in the system that the level of dose to be aimed through optimization approach will be determined in consultation with stakeholders. After the formulation of the ministerial ordinance and technical guidelines, the managed recycling will be implemented in accordance with the ministerial ordinance and technical guidelines. In addition, MOEJ's system (implementation and supervision of projects) after the establishment of the standards will be reviewed as necessary in the future. Under the Act for Special Measures, the MOEJ acts as both regulator and operator for the managed recycling and final disposal of removed soil.

The main contents of the system (ministerial ordinance and technical guidelines) for the managed recycling of removed soil from interim storage will cover:

- Basic Concept
- Radiation protection and other safety measures
- Arrangements and coordination between the facility manager and the MOEJ, measurement and recording of radiation doses
- Process (planning, recycled materialization, design, transportation, construction, and maintenance)
- Stakeholder engagement, information dissemination

The approach to radiation protection of final disposal and the managed recycling of the removed soil (optimization) is being developed by considering consistency with the approach already defined for the disposal of the Specified Waste.

There will be no limit on the quantity of soil that can be recycled in a year. The MOEJ explained that the quantity of recycled removed soil that can be in each structure is effectively limited as needed by the specifications mentioned in the technical guidelines needed to meet the dose target of 1 mSv/y.

The recycled soil will be used in projects that are managed by public bodies, not by private companies. The MOEJ will retain some responsibilities of the appropriate management of the recycled soil during the construction and maintenance period while the relevant public bodies will have their responsibilities in terms of the construction and maintenance of the structure itself. There will be an agreement between the MOEJ and the operator of the structure containing the recycled soil (e.g. national/local government) concerning the future management of the structure.

The MOEJ explained that there will be a period for public comment on the ministerial ordinance for the managed recycling of removed soil.

The MOEJ classifies the removed soil below the screening level that is currently being stored at the ISF as a potential resource.

FY2024 is the target year of the Technology Development Strategy. From FY2025 onward, it is necessary to accelerate the movement toward the managed recycling and final disposal and promote full-scale managed recycling. Hence, FY2024 is a key milestone for the managed recycling of removed soil programme. A variety of efforts based on the Technology Development Strategy have made steady progress, keeping in mind that one of major challenges is developing public understanding.

Presentations by the team of experts

Three members of the team of experts gave presentations related to regulatory aspects.

The first presentation described the graded approach to regulation in the UK and the introduction of the 'disposal for a purpose' option for low level radioactive waste that is used for filling voids or landscaping. This is similar to the 'recovery' option used for recycling and reuse of non-radioactive waste. In response to a question from the MOEJ, the expert also explained that UK regulations specify a different (higher) activity concentration level (1,000 Bq/kg) for the definition of 'radioactive' waste for historic radium 226 contamination of sites (an existing exposure situation). All other sites using Ra-226 for its radioactive properties have to apply a value of 10 Bq/kg.

The second presentation described the approach to specific clearance in Belgium. The regulation implements both unconditional and conditional (specific) clearance in Belgium. They are both related to the dose criterion of 10 microSv/y. For the latter, a license from the FANC is required in particular cases, based on a case specific radiological impact study. The example of removal of soil at the FBFC fuel assembly facility was used as an illustration of the regulation. It served at the same time as an introduction to the presentation on the FREMES system used for soil sorting and measuring (see section on clearance measurements).

The third presentation described the approach to clearance and specific clearance in Germany. The expert explained the German system of specific clearance and also how specific clearance levels were derived in case of using a landfill. Although the same activity concentration value of 8,000 Bq/kg applies for specific clearance of Cs-137 for disposal in a landfill site in the German ordinance, the conditions used are very different (different dose concept, different dilution on a landfill, different annual capacity etc.).

IAEA presentation on DS544

During the discussion on regulations and regulatory requirements, the subject of existing versus planned exposure situation came up with respect to the remediation activities outside the Fukushima site linked to the accident. The Japanese participants requested an update on the status of the new Safety Guide on Existing Exposure Situations (DS544).

The IAEA presentation showed that the drafting of the document is still in a preliminary state and discussions are ongoing with the ICRP on the new system for radiation protection. The IAEA has requested the ICRP to stabilize the situation to allow the development of this new safety guide and raise awareness and clarification about the concept of existing exposure situation with member states. Japan has requested to be involved in the drafting of the document and it is recognized by the IAEA technical officer that the situation in Japan can be used as input for discussions with the ICRP on the transition between emergency and existing exposure situations, as well as existing exposure situations and planned existing exposure situations.

Observations

The discussions between the team of experts and the MOEJ, and the observations made by the team of experts, are described here under broad topic headings. This section of the report focusses on the arrangements for the managed recycling of removed soil. The arrangements for final disposal were also discussed at the meeting and these are described in more detail in the section of this report on final disposal.

The team of experts recognized that considerable progress had been made for the consideration of the regulatory aspects for the managed recycling and final disposal of removed soil since the 1st IEM. The team of experts also noted that the MOEJ provided details of the justification of the approach to the final disposal and the managed recycling of removed soil taken by Japan. At this point, the general approach appears to be consistent with the IAEA Safety Standards. This will be further discussed at the next IEM.

Planned or existing exposure situation?

The IAEA Safety Guide GSG-18 discusses clearance of waste in planned exposure situations, and it also discusses the use of screening levels in existing exposure situations. There was discussion on whether a planned or existing exposure situation was appropriate and whether it differed depending on the region of Japan. The MOEJ noted that there was debate in Japan as to which situation was relevant and the team of experts noted that the ICRP is currently reviewing the transition from an existing exposure situation to a planned exposure situation after an accident.

The team of experts advised that this question is a matter of interest to radiation protection people but that other stakeholders do not care which situation is relevant, they are only interested in the fact that they will receive an additional dose and that radioactive materials will remain there.

The team of experts noted that the MOEJ approach for determining the activity limit for the managed recycling is consistent with the approach for the screening levels described in the IAEA GSG-18. The team of experts considers that the target dose of the additional dose of 1 mSv/y is a proper target for the managed recycling of removed soil in Japan. The team of experts also reviewed the calculations supporting the generic safety case of each use (used in the Basic Concept) and the appropriateness of 8,000 Bq/kg as a screening level. The generic safety case of each use was 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.

Furthermore, it is consistent with the international safety standards to consider optimization to aim to further reduce the dose below the target dose of 1 mSv/y, for example, using cover soil. The team of experts recognizes that the level of dose to be aimed through optimization approach will be determined in consultation with stakeholders as the optimization process is defined in the IAEA Safety Standards as follows:

"The process of determining what level of protection and safety would result in the magnitude of individual doses, the number of individuals (workers and members of the public) subject to exposure and the likelihood of exposure being "as low as reasonably achievable, economic and social factors being taken into account" (ALARA)."

When the dose that is being aimed at through the optimisation is considered with 10 microSv/y as a reference, the dose is very low because the order of 10 microSv/y is regarded as the level at which radioactive protection measures are no longer required (a trivial level of dose). The team of experts advised that demonstrating that they are achieving these very low or trivial levels of risk may increase public understanding and acceptance of the managed recycling proposals.

10 microSv/y is to be used as a reference in designing the structure, and after the recycled material is used in the structure, it is practically impossible and not required to measure 10 microSv/y on the ground. Also, it is not required to meet 10 microSv/y during abnormal situations (e.g. disasters) in the IAEA Safety Standards. Hence, the team of experts advised that it is important to explain the differences of meaning between 1 mSv/y and 10 microSv/y clearly, including the above-mentioned concept of 10 microSv/y.

Terminology: the managed recycling or final disposal, radioactive waste or non-radioactive waste?

The team of experts focused on the difference between the managed recycling of removed soil (as a resource where it is placed in an embankment without the intention to retrieve at a future date) and final disposal of removed soil that is unsuitable for the managed recycling.

The team of experts noted that the removed soil that is unsuitable for the managed recycling, even after a series of necessary treatment processes to collect the valuable stuff, is equivalent to 'waste' as defined in the IAEA Safety Standards because it has no further use and will be disposed of. The team of experts further noted that the removed soil that is disposed of would be described as radioactive waste according to the IAEA Safety Standards. Therefore, the team of experts is reviewing the approach to the final disposal of removed soil in the context of the IAEA Safety Standards for disposal of radioactive waste, also taking the graded approach into account, according to the level of radioactivity concentration of 'the radioactive waste' to be disposed of and noting that radioactive Cs is the dominant nuclide.

The team of experts noted that the need for continued special management of the removed soil once recycled into a structure is linked to the level of risk and hazard which the removed soil poses, and therefore as time progresses the management requirements of the structure where the removed soil is recycled will become the same as for any such structure built using other soils or materials, because radioactivity decays with the passage of time. Hence the team of experts advised that it may be useful to define the point at which it no longer requires 'special attention' in due course.

By analogy with the approach used for specific clearance (as described in the IAEA GSG-18), this could be when it is no longer considered to be 'radioactive'. As described in the IAEA GSG-18, in planned exposure situations, radioactive waste that is cleared using general clearance levels or specific clearance levels is defined as 'non-radioactive waste' once cleared. This is because radiation protection regulations no longer apply as the dose is trivial and optimised. Other waste standards continue to apply to its subsequent use or disposal, if applicable.

A similar approach could be used for soil that meets the screening levels once it has been placed in the structure and all radiation protection aspects have been addressed. The details on the approach to make the 'radioactive waste' to be released from radiation protection regulations can be addressed in the future.

The team of experts advised that in terms of radiation protection the point at which no 'special attention' is no longer required in planned exposure situations, is the level of the order of 10 microSv/y (a trivial level of dose). For screening levels, 'special attention' is no longer required when the dose to members of the public is optimised (ALARA) below the target dose level and further radiation protection measures would yield no additional benefit. The team of experts noted that the dose received by workers or members of the public is a more important concept than the radioactivity concentration in the material (Bq/kg): the dose is determined by the combination of the protection

measures and the radioactivity concentration in the material, not just by the radioactivity concentration in the material (Bq/kg). This is a difficult concept to communicate but it is important to do this.

The MOEJ plans to apply an approach that is consistent with that used for the disposal facility for the Specified Waste, and the approach is still under development.

Subsequent discussions explored the importance of clearly defining soil for the managed recycle and soil that is disposed of as waste using different terms. The team of experts noted that there may be advantages in describing the removed soil that will go for final disposal as 'waste' as defined in the IAEA Safety Standards in order to clearly differentiate this from the removed soil sent for the managed recycling.

It was explained by the MOEJ that the term 'radioactive waste' in Japanese regulations refers to radioactive waste from nuclear facilities and radioisotope users and does not include the removed soil as such. This difference in meaning needs to be taken into consideration in the consistency exercise with the IAEA Safety Standards (and supporting glossary). See also the discussion in III.5.

Independence of regulator

At the 1st IEM the team of experts noted that it is important that the regulator is independent from the operator. This is specified in the IAEA GSR Part 1 requirement 4, which states:

'Requirement 4: Independence of the regulatory body. The government shall ensure that the regulatory body is effectively independent in its safety related decision making and that it has functional separation from entities having responsibilities or interests that could unduly influence its decision making.

The team of experts therefore noted that, although a regulator may not be totally independent from government, it is important that the regulator can demonstrate their independence. The team of experts noted that the approach taken in Germany for waste disposal is to have a private company owned by the country acting as the operator.

The team of experts noted that following the accident, in line with relevant Japanese laws, the status of the MOEJ as both regulator and operator has been appropriate. It is important when implementing the full-scale managed recycling and final disposal in the future to ensure the independence of the regulatory function from the operating function.

The demonstration of independence can be done by reference to the six requirements for the independence of the regulatory body described in Paragraph 2.8 of GSR Part 1.

Agreement between the MOEJ and the operator of structure containing recycled soil

As the specific role sharing for implementation of the full-scale managed recycling projects is important to ensure safety, agreements between the MOEJ and the public bodies which operate the structures should be developed. The team of experts recommended that the generic form of the agreements is considered and presented in the technical guidelines so that the responsibilities of each party are clearly defined.

The team of experts recommended that a review of the safety performance and operational status based on the responsibilities of each party will be conducted after a specified time period so that the level of special control needed for radiation protection (e.g. radiation monitoring) can be adjusted as appropriate.

The generic form of agreement should be developed in consultation with the relevant public body that will be operating the structure. The team of experts noted that the MOEJ is cooperating with the relevant public bodies (e.g., Administrative organization in charge of agriculture and infrastructure) through the demonstration projects and will develop the ministerial ordinance and the technical guidelines. Strong cooperation with all the relevant ministries is essential.

Consultation on ministerial ordinance

The team of experts noted that public comments may be an important input into the process of the ministerial ordinance development. It also noted that the advice presented in these IEM reports may also be an input into the process.

Discussion on quantity of recycled soil that can be used

The team of experts noted that safety assessments of disposal facilities for radioactive waste commonly lead to a limit on the quantity that can be accepted in the facility, limits on the activity concentration of specified radionuclides and/or other radiation protection measures to meet the dose criteria. This is also the case for some safety assessments of specific clearance. In this analogy, the team of experts recommended that the safety assessment for recycled soil is examined to see if there is an underlying assumption on the quantity of recycled soil that is used in the constructions (e.g. per unit length of construction) to meet the dose criteria. If so, this should be specified in the technical guidelines.

Final disposal

The regulatory process for implementing final disposal is not yet developed. The team of experts recommended that the approach is the same or similar to that used for radioactive waste disposal, taking a graded approach into account, in accordance with the IAEA Safety Standards. The first step is for the MOEJ to undertake a review of this regulatory approach.

III.2 – Managed recycling and volume reduction

Japan position

The national government is making efforts to reduce the volume for final disposal by using treatment processes and by recycling suitable removed soil under the proper management by the public bodies (managed recycling).

The managed recycling of removed soil will be limited to public works projects for which the management entity and responsibility system are clearly defined, such as embankments and other

structural infrastructures that are not expected to be artificially altered over the long term. Examples are: Components of structural foundations for seawalls, coastal disaster prevention forests, road embankment materials, etc., soil covering materials for waste disposal sites, reclamation and filling materials in land development, agricultural land, etc. Other applications will be considered as necessary, and those deemed appropriate will be added to the list.

The sorting strategy for the managed recycling of removed soil will be based on screening levels (e.g. 8,000 Bq/kg or less) and then other aspects of the quality of soil will be adjusted so that it is suitable for the proposed managed recycling option (e.g. road embankments, agriculture). The quality adjustment criteria are under development. Once it is confirmed that the removed soil meets the relevant quality criteria, then it can be considered to be a resource material in the public works.

Additionally, the options under consideration for the removed soil that is currently more than 8,000Bq/kg include sorting and treatment processes and these processes may remove some radioactivity so that the removed soil or products to be recycled at the end of the process will be 8,000Bq/kg or less. Therefore, this processed removed soil or products may potentially be recycled, if it meets the other quality criteria.

The MOEJ is implementing demonstration projects on the managed recycling based on the Basic Concept for Safe Use of Removed Soil Processed into Recycled Materials compiled in 2016 (the Basic Concept) as a guideline, as well as working to encourage understanding throughout the nation.

Demonstration project for the managed recycling of removed soil in Nagadoro District, Iitate Vilage

Decontamination, infrastructure and other recovery efforts are now being carried out intensively in order to create environment for people to return. As part of these efforts, it was decided to create agricultural land in the agricultural recovery zone utilizing recycled soil and covering soil (see Figure III.2.1).

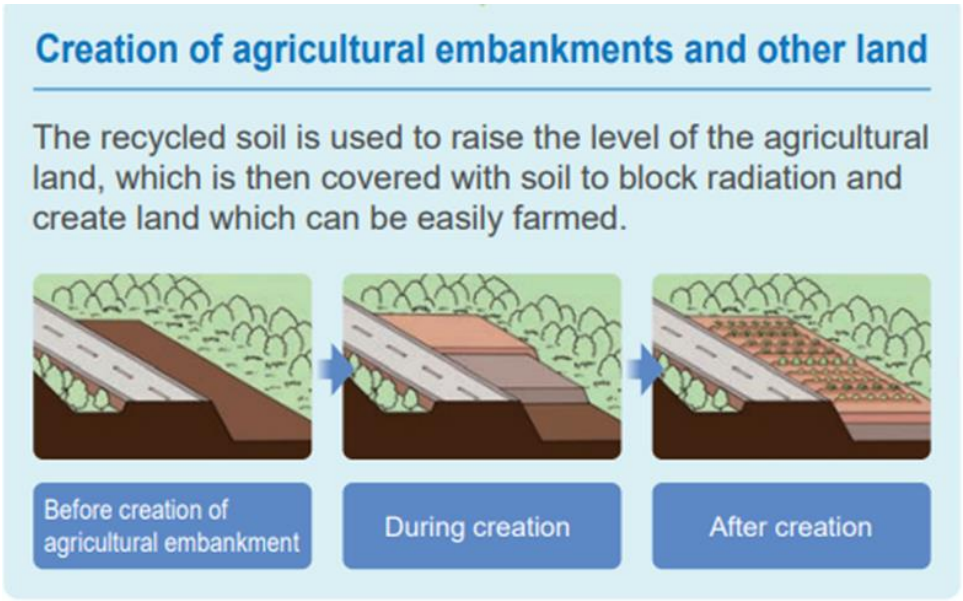


Figure III.2.1 Overview of the creation of agricultural embankment using removed soil.

The air dose rate at the boundary of the construction site did not change before and after the filling of the removed soil.

From May 2019, tests have been conducted on the cultivation of flowers and vegetables in a field (embankment) that had been experimentally created using removed soil. The tests included checking the transfer of radioactive caesium to plants and the effect on their growth. From April 2021, large-scale agricultural land development (approx. 22 ha) using the removed soil (approx. 230,000m^3) started. The following monitoring is carried out:

- Air dose rate (once a week),
- Radioactivity concentration in discharged water (once a week or at each discharge),
- Radioactivity concentration in air, groundwater and rivers (once a month),
- Individual radiation dose of worker engaged in embankment construction and test cultivation.

Measurement results for the radioactive caesium level in harvested food crops in FY2020 and FY2021 had a range of 0.1 -2.5Bq/kg and were significantly lower than the 100Bq/kg standard for radioactive caesium concentration in ordinary foods. The exposure dose of the workers was less than 1 mSv/y.

Road embankment demonstration project in the ISF

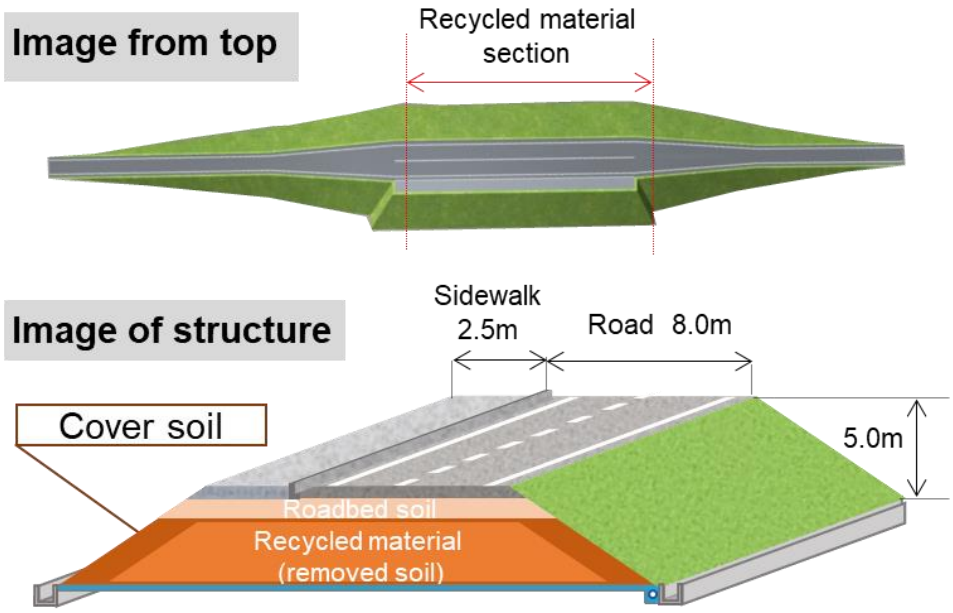


Figure III.2.2 Overview of the demonstration project of road embankment using removed soil.

The demonstration road embankment was built in accordance with the general road standard, Class 3-2 structure (traffic volume of 4,000 to 20,000 vehicles/day) with sidewalks (see Figure III.2.2). In order to confirm whether there would be any difference in "workability" and "stability of the structure" depending on the quality adjustment and auxiliary construction method, the structure was divided into four sections and each section was built to one of the following four patterns:

- (A) [Single unit] Removed soil only
- (B) [Single unit] Removed soil + auxiliary method (geosynthetic reinforcement material)

- (C) [Improved soil] Removed soil + slag mixture + quicklime mixture
- (D) [Improved soil] Removed soil + slag mixture + quicklime mixture + auxiliary method (geosynthetic reinforcement material).

During construction monitoring showed that:

- The air dose rate at the boundary of the construction site (upper right figure) did not change before and after the filling of the removed soil.
- The concentration of radioactive materials in the air during the filling of the removed soil was below the detection limit.
- The concentration of radioactive materials in the leachate from the fill was below the detection limit.

Monitoring of air dose rate and concentration of radioactive materials in the air and leachate will continue during maintenance of the structure.

The MOEJ update on demonstration projects on the managed recycling

Based on the demonstration projects in the Nagadoro District of Iitate Village (environmental regeneration project) and from the road embankment project in the ISF, the MOEJ is developing a formal system (approach) for the managed recycling of removed soil. The system consists of the ministerial ordinance on standards for the managed recycling of removed soil and the technical guidelines.

Technologies for recycling and volume reduction

The development of basic technologies required for volume reduction and recycling of removed soil and waste stored in the ISF will be completed by the end of FY2024. The demonstration system projects are as follows:

- Soil classification (from FY2018 – FY2019). Classification is a method of separating soil into fine particles (silt and clay) and gravel, since radioactive caesium tends to adhere to fine particles of the soil. It was confirmed that classification enables volume reduction of soil that contains more than 8,000Bq/kg (i.e. reduces the volume that does not meet the criterion for the managed recycling).
- Heat treatment (burning) (FY2016 – FY2017). Heat treatment is a method of collecting caesium by vaporizing radioactive caesium via heat treatment. Demonstration projects were performed for incineration ash and removed soil. It was confirmed that heat treatment can separate caesium and contribute to the volume reduction of removed soil and incineration ash.
- Ash cleansing and stabilization (ongoing since FY2022). Washing and dewatering tests showed that more than 99% of radioactive caesium has been transferred to the dewatered filtrate, and fly ash after dewatering has achieved water content of less than 40% and radioactivity concentration of less than 8,000Bq/kg. More than 99.9% of the radioactive caesium in the dewatered filtrate has been adsorbed by the adsorbent, and the volume of the stabilized body has been reduced to several tenths to one hundredth of the volume of the original fly ash.

- Chemical treatment is a method of separating caesium from soil by eluting radioactive caesium in the soil into the solvent using a solvent such as strong acid. Caesium in solution is recovered with an adsorbent, etc. Chemical treatment was evaluated as unsuited for large-scale treatment, given the amount of secondary waste and issues in scaling up the process.

Other presentations

A site visit to Nuclear Engineering Seibersdorf (NES Seibersdorf) facility was organised to view their processes for volume reduction and sorting of material. Presentations on the overall facility and the specific sorting facility, including a video were given, before the guided visit to the facility.

The US expert gave a presentation on examples of limited reuse of radioactive and non-radioactive material. This included the potential reuse of phosphogypsum for roadbeds in Florida, which the state has recently approved, though the US EPA has put the request on hold. The MOEJ is very interested and is following the progress in the US news.

Observations

The team of experts welcomed discussion of institutional arrangements, technical aspects (pre-treatment, potential types of structures for the managed recycling and monitoring), encouraging public understanding and lessons learned through the managed recycling demonstration projects**.**

The team of experts noted the progress that has been achieved in the demonstration projects for volume reduction and the managed recycling.

From clarification with follow-up discussion with the MOEJ, the following points were agreed upon by the team of experts:

- It was confirmed that radioactive caesium in soil is hardly eluted into water;
- Safety has been confirmed by the demonstration projects for the managed recycling of removed soil, and it is considered that necessary scientific findings have been obtained to provide the basis for the ministerial ordinance and technical guidelines;
- It was confirmed that the efforts have been progressing in accordance with the Technology Development Strategy and Process Chart; and
- The effectiveness of classification, heat treatment and fly ash cleansing technologies that have been developed so far as volume reduction technologies has been recognized. These volume reduction technologies result in different quantities of waste to be disposed of and they differ in cost and in other aspects. Therefore, an options comparison will be undertaken. Different disposal scenarios will be considered, each one based on a different combination of technologies for volume reduction.

Removed Soil vs disposal of waste terminology:

'Removed soil' is defined in the Act for Special Measures and is used as the terminology to distinguish with waste. Once it has been decided what amount or % is to be considered for final disposal, it will be treated as radioactive waste defined in the IAEA Safety Standards, also taking the graded approach

into account. Removed soil is the term, for example, which doesn't describe fly ash or secondary waste after heat treatment.

The team of experts noted that it is key for each process (e.g. screening, quality adjustment and treatment) to be applied for the managed recycling and final disposal to be elaborated to the public to clarify the difference between the removed soil that is potentially a resource material for the managed recycling and the removed soil that is not suitable for the managed recycling and therefore has to go for final disposal.

Managed recycling projects

The managed recycling can be done inside and outside Fukushima Prefecture, whereas the final disposal of material must be only done outside Fukushima Prefecture, as specified in the JESCO Act. The team of experts noted that experience with the successful managed recycling demonstration projects within Fukushima Prefecture will help the practical implementation of the managed recycling outside Fukushima Prefecture. Technology development will better help develop the managed recycling and disposal options and decisions.

The team of experts advised that after the MOEJ establishes ministerial ordinance and technical guidelines for the managed recycling of removed soil, implementation of model projects including outside Fukushima Prefecture are considered. Undertaken effectively, this model projects have the potential to increase public awareness and acceptance of the managed recycling.

III.3 – Clearance measurements

Japan position

The MOEJ's position is that the term "clearance" is not appropriate for the managed recycling of removed soil, since it refers to free use without any management for radiation protection. The MOEJ proposes to follow the approach described in the GSG-18, where 'screening levels' are used and MOEJ's approach to the managed recycling of the removed soil is introduced as an example of an approach using 'screening levels'. The derivation of these levels is based on radiological impact studies in line with the ones used for clearance levels. The dose target is 1 mSv/y, but through optimisation a further dose reduction to 10 microSv/y could be achieved.

As an illustration of the use of screening levels for the managed recycling, the MOEJ presented the progress on demonstration projects for the managed recycling of removed soil.

The experience of the demonstration projects in Fukushima Prefecture will allow the MOEJ to develop the system for the managed recycling of removed soil. The system will consist of the ministerial ordinance and the technical guidelines (See Figure III.3.1).

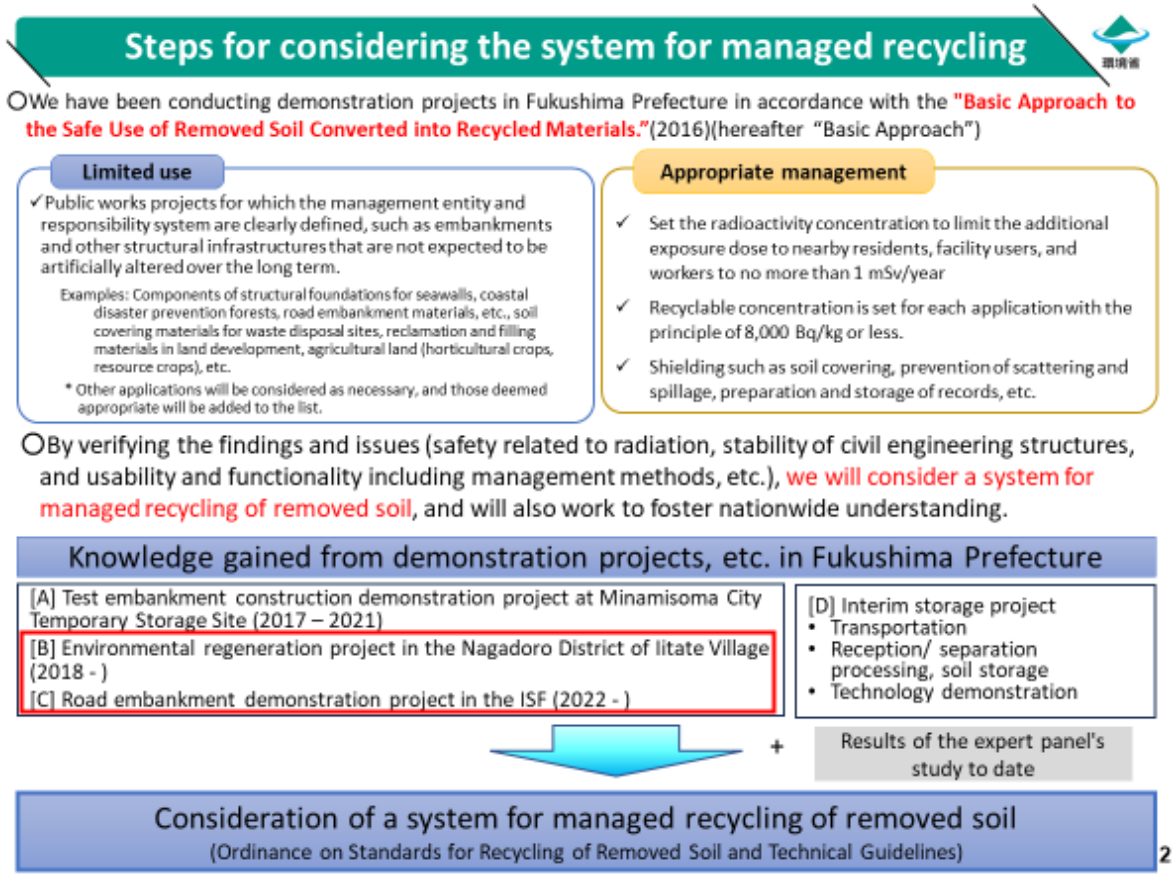


Figure III.3.1 Steps for considering the system for the managed recycling.

Methods of radioactivity concentration measurement

At some point, measurements of the activity concentration in the recycled material converted from removed soil are required, to verify compliance with the screening levels.

The MOEJ showed an example of radioactivity concentration measurement system.

One of the discussion points put forward by the MOEJ is "Methods for monitoring of radioactivity concentration, especially for a large amount of removed soil after quality adjustment".

This point is handled during the visit to the NES Seibersdorf, the sorting facility for contaminated soil. This is an example of a soil sorting methodology, based on the radiological content of the soil. The soil contamination level is verified against the radiological criteria for a specific nearby conventional landfill. This practical example of specific clearance is authorized by the Austrian regulator. It is noted that an agreement with the operator of the landfill is mandatory. The system is licensed and in operation since 2022 and over 1,000 tons have been cleared so far.

Another automated soil sorting system, called the FREMES (Free RElease MEasurement System), is presented by the NUKEM. This sorting system had been successfully used at large scale in 2 fuel cycle facilities, one in Dessel, Belgium (FBFC, 45,000 tons of material) and one in Angarsk, Russia.

The system is in an actual field proven, compliant with international standards, highly reliable, very precise in measurement, versatile and adaptable, easy to operate as well as mobile or centralized installation is possible.
Although no field experience exists for other radionuclides such as Cs-137, extensive calculations show that the FREMES system should perform in a similar way.

Observations

The team of experts noted the good progress made by the MOEJ concerning the demonstration projects in Fukushima Prefecture and has understood the need for methods for monitoring of radioactivity concentration, especially for a large amount of soil and removed soil after quality adjustment.

The team of experts highlights that:

- Both in the case of clearance and the managed recycling, sorting systems have been automated and can be used for large scale projects;
- Clearance levels and screening levels are based on the same process, therefore the sorting systems can be the same; and
- The scale at Fukushima is still different from any existing experience, but the systems presented and discussed during the meeting are a good source of inspiration for the soil sorting projects envisaged by the MOEJ.

III.4 – Public communication and stakeholder engagement

Japan position

The MOEJ position is that eight main steps lead toward final disposal of removed soil and waste stored in the ISF outside Fukushima Prefecture by March 2045.

The first four lead up to a strategic target year of FY2024, and during this phase, one of the main objectives is described as encouraging public understanding through information dissemination about:

- The managed recycling of removed soil with low concentrations of radioactivity; and
- Final disposal outside Fukushima Prefecture (presumably of removed soil with higher radioactivity concentrations more than the criterion as well as waste).

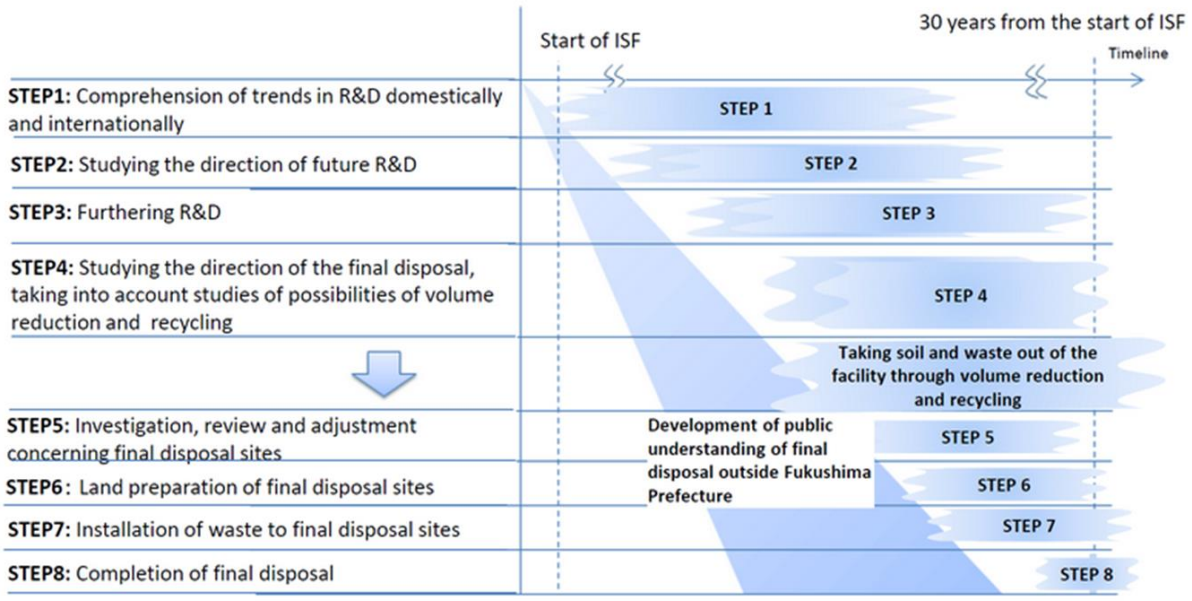


Figure III.4.1 Eight steps toward completion of final disposal by March 2045.

The MOEJ acknowledges that the focus of the main communications and targets for final disposal outside Fukushima Prefecture by March 2025 will change depending on the process adopted (see Figure III.4.2).

The MOEJ described the current communication target (setting the context) as:

- The policy for final disposal outside Fukushima Prefecture; and
- The importance of safety and the need for volume reduction and the managed recycling of removed soil.

From FY2025 up to March 2045 – the communication target shifts to focus on:

- Final disposal site planning, selection and construction outside Fukushima Prefecture; and
- Ways of communicating with and explaining benefits to local stakeholders related to the (as yet undetermined) candidate sites.

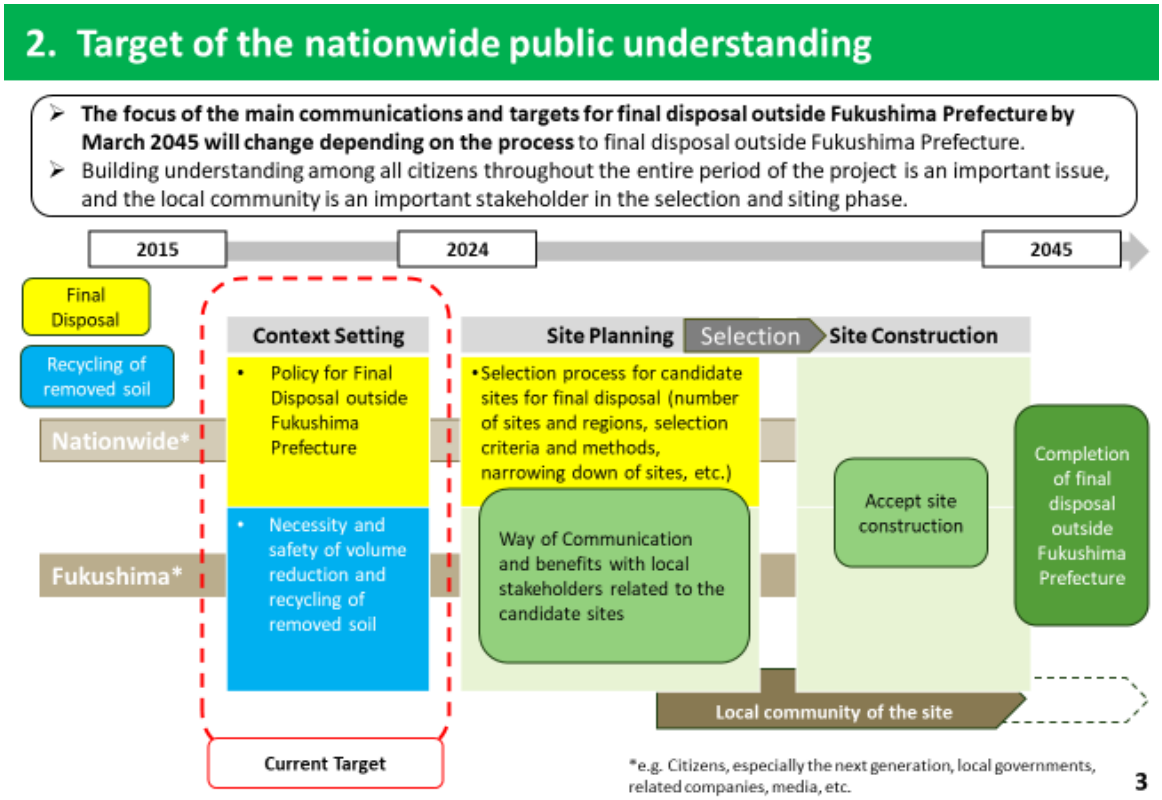


Figure III.4.2 Changes over time for targets of the nationwide public understanding.

Current Activities

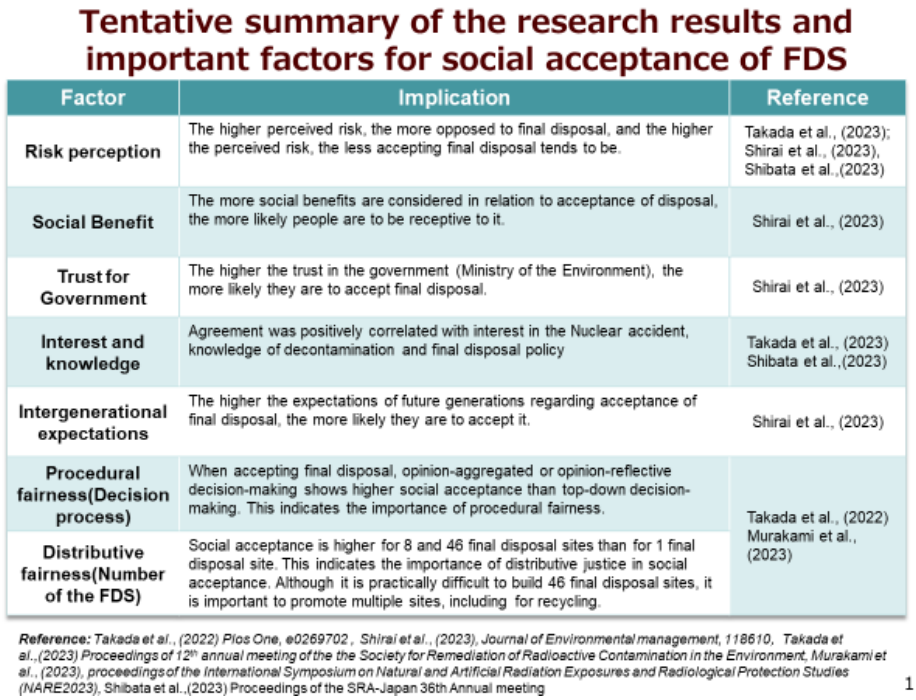
Research of the group of Japanese experts (AIST, Hokkaido University and Osaka University, representative: Tetsuo Yasutaka) on communication with stakeholders regarding the managed recycling of removed soil was introduced during the 2nd IEM. This included tentative results for the identification of key stakeholders and for building consensus at each step of the managed recycling and the disposal programme (see Figure III.4.3).

Some key research findings were:

- Trust and intergenerational expectations are critical factors influencing the acceptability of final disposal. Additionally:
    - Social benefits increase acceptability.
    - Personal benefits have limited impact.
    - Risk perception (dread factors) decreases acceptability.

Numerous information dissemination activities have been undertaken by the MOEJ Communications Promotion Team seeking to encourage an improved level of understanding among key stakeholders. These include a range of activities including a variety of face-to-face events and also web based approaches.

The MOEJ described the range of activities in their current plan which include a variety of stakeholders including the younger generation to encourage improved understanding. These include information dissemination and participatory activities. Approximately 3 per year “Dialogue Forums” have also been held over the past 3 years with both in person and on-line attendance.



Tentative summary of the research results and important factors for social acceptance of FDS

Factor	Implication	Reference
Risk perception	The higher perceived risk, the more opposed to final disposal, and the higher the perceived risk, the less accepting final disposal tends to be.	Takada et al., (2023); Shirai et al., (2023), Shibata et al.,(2023)
Social Benefit	The more social benefits are considered in relation to acceptance of disposal, the more likely people are to be receptive to it.	Shirai et al., (2023)
Trust for Government	The higher the trust in the government (Ministry of the Environment), the more likely they are to accept final disposal.	Shirai et al., (2023)
Interest and knowledge	Agreement was positively correlated with interest in the Nuclear accident, knowledge of decontamination and final disposal policy	Takada et al., (2023) Shibata et al.,(2023)
Intergenerational expectations	The higher the expectations of future generations regarding acceptance of final disposal, the more likely they are to accept it.	Shirai et al., (2023)
Procedural fairness(Decision process)	When accepting final disposal, opinion-aggregated or opinion-reflective decision-making shows higher social acceptance than top-down decision-making. This indicates the importance of procedural fairness.	Takada et al., (2022) Murakami et al., (2023)
Distributive fairness(Number of the FDS)	Social acceptance is higher for 8 and 46 final disposal sites than for 1 final disposal site. This indicates the importance of distributive justice in social acceptance. Although it is practically difficult to build 46 final disposal sites, it is important to promote multiple sites, including for recycling.	

Figure III.4.3 Tentative summary of the research results for social acceptance of final disposal site

Community development centred around the demonstration project in the Nagadoro District of Iitate Village in collaboration with local residents and local experts was described by the MOEJ as an example of good practice, and communication patterns of potential benefit for other communities have been studied and compiled in a booklet. It is understood that a focus on the benefits associated with the project will form an important part of the way forward.

The team of experts understands that there is also an intention to develop a plan for communicating with communities regarding potential sites for the managed recycling and final disposal.

Information on nuclides contained in removed soil

Separately, based on an advice of the team of experts in the 1st IEM, the MOEJ has begun to collate measurements of radioactivity concentration of nuclides other than radioactive Cs – such as Sr-90 and Pu-238, – with regard to the removed soil. The intention is to use this data to better inform third parties for reassurance that major potential radioactive materials derived from the Fukushima Daiichi NPS accident is being addressed.

Engagement Activities

The MOEJ described the numerous international engagement activities that have been undertaken. Efforts to publicize the demonstration project in the Nagadoro District of Iitate Village were also described. New initiatives are to be considered for implementation in the second half of the current fiscal year. These include the use of social media as well approaching target audiences through site visits to the ISF for:

- Local governments in and outside Fukushima Prefecture;
- Companies interested in Fukushima and environmental restoration measures; and
- Domestic and foreign media, international organizations

Observations

The team of experts welcomed that the efforts have been undertaken by the MOEJ to actively disseminate information about Japan's initiatives for the managed recycling and final disposal of removed soil and will continue to be disseminated domestically and internationally.

The team of experts noted that efforts to recycle removed soil generated from decontamination work also contribute to reconstruction and revitalization in Fukushima Prefecture. The findings of the advanced efforts for the managed recycling of removed soil can be used as a useful case study for reference by other countries and dissemination through international forums, publications and media, including cooperation with the IAEA, is encouraged.

It was highlighted that the team of experts was pleased to learn of the developing range of stakeholder engagement and associated research activity. The experts noted that the MOEJ makes a distinction between general public and other stakeholders, for the use of targeted engagement methods with key stakeholders including local communities (see Figure III.4.2).

The team of experts was pleased to see an evidence-based (research-informed) approach to understanding public and key stakeholder concerns and to support effective communication. The team of experts also welcomed efforts that are being made to ensure reliability and transparency of data of, such as the ISF management, demonstration projects for the managed recycling of removed soil.

The team of experts observed that the MOEJ's research has good alignment with international sampling methods used for capturing public understanding of radioactivity.

The target of nationwide public understanding is challenging. Numerous ways have been used. The team of experts encourages use of The Great East Japan Earthquake and Nuclear Disaster Memorial Museum to encourage public understanding as one good example. Other similar public information centres would help.

The team of experts would like to see a clear master plan including stakeholder engagement and communication that explains how the various communication elements fit together for the forthcoming stages of the project from FY2025 onwards. This is particularly important. From Step 5 the master plan should identify who will be engaged, on what topics, how, and when.
It should include the various options for pre-treatment and disposal to be put forward.

Managing expectations and maintaining trust

All communications should ensure a clear distinction between:

a. Removed soil with 8,000 Bq/kg or less to be recycled; and
b. Removed soil above 8,000 Bq/kg that it is proposed to send for final disposal outside Fukushima Prefecture (potentially for some of which after treatment including volume reduction)

Care should be taken to distinguish between these two elements of the project in all stakeholder engagement. Consistent terminology is needed when describing final disposal facilities that are under consideration for the effective safe management of the material to be disposed of.

The team of experts considers that it is important to carefully explain to local communities in Fukushima Prefecture that the managed recycling of removed soil can be implemented, for example, for horticultural, agricultural or road embankments in Fukushima Prefecture as well as elsewhere in Japan, which could contribute to reconstruction of the affected areas.

The Nagadoro demonstration project is very good for long-term understanding of how removed soil can be safely recycled and the team of experts recommends that it continues.

Overall, the team of experts was pleased to see the extent of work being undertaken in stakeholder engagement and communication, while there is much to do in a very short period of time in preparing for the next steps.

For managed recycling projects that are planned inside and outside Fukushima Prefecture from FY2025 onwards, sufficient time for public communication and stakeholder engagement effort will be needed. The public will question why this place has been selected and ask what the financial and social benefits associated with hosting the project are. Concerns about radiation management (e.g. monitoring), prevention of run-off soils from heavy rain, typhoon etc. will need to be addressed even though radiation risk from potential natural disaster events during the managed recycling of removed soil is not deemed to be high.

Building Trust

- Local community, key stakeholder and public confidence in the programme will be central to the success of the project.
- Trust in the process will rely upon demonstrating:
    - Accountability;
    - Honesty, openness and transparency;
    - Listening and responding to concerns;
    - Being consistent in what you say; and
    - Following technical best practice.
- Good ways of building trust include:
    - Working closely with other trusted third parties such as respected community leaders, doctors, high school teachers, university professors;
    - Maintaining a local presence for the duration of the project (so that you are not seen as an “outsider”; and
    - Responding quickly to questions and requests.

- The team of experts noted that following the accident, in line with relevant Japanese laws, the status of the MOEJ as both regulator and operator has been necessary. It is important when implementing the full-scale managed recycling and final disposal in future to ensure the independence of the regulatory function from the operating function.

- Trust in the safe disposal of radioactive waste will depend on meeting international good practice. The MOEJ will need to ensure and explain that the preliminary safety case and the subsequent management of safe disposal will follow that good practice.
- Measurements of radioactivity concentration of nuclides other than radioactive Cs – such as Sr-90 and Pu-238 – with regard to the removed soil – could help with transparency, and better inform stakeholders for reassurance. This information will need to be presented perhaps using before and after comparisons carefully.

Effective Consultation

- There remains a need of an overall master plan including for local community, key stakeholder and wider public engagement for Step 5 onwards (in FY2025 onwards).
- It would be useful for effective communication with the public to clarify what is to be proposed both in terms of the disposal site identification method, technical proposals and in terms of the engagement strategy for the next steps, in FY2025 onwards.
- The following good practices in risk communication should be useful:
    - Keep communication material clear and simple;
    - Use consistent terminology;
    - Explain the (direct and indirect) social benefits as well as the safety considerations;
    - Undertake research into community and stakeholder expectations and their consultation needs;
    - Pilot-test communication materials; and
    - Consider providing training for communicators.

Effective communication and meaningful stakeholder engagement are essential for the success of the next stages of the project. The MOEJ should ensure a sufficiently resourced programme of public and stakeholder engagement activities to support the project from FY2025 onwards (see Figure III.4.1).

III.5 - Final disposal

Japan position

The MOEJ's position is that the MOEJ is considering ministerial ordinance on final disposal of removed soil while one for the Specified Waste was established. There are already two types of final disposal facilities of the Specified Waste set in 2011 (see Figure III.5.1):

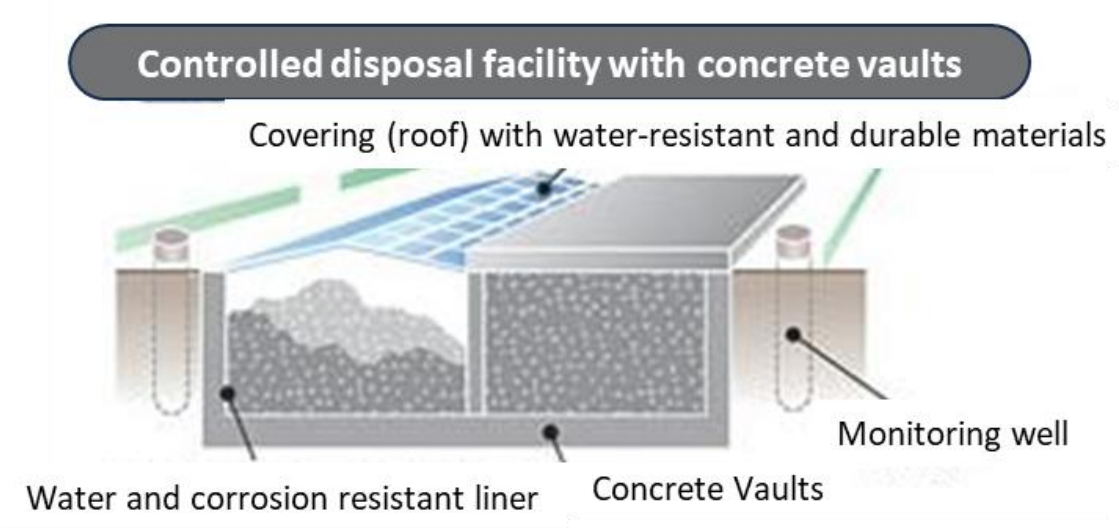


Figure III.5.1 (a) Final disposal facility for the Specified Waste with more than 100,000 Bq/kg.

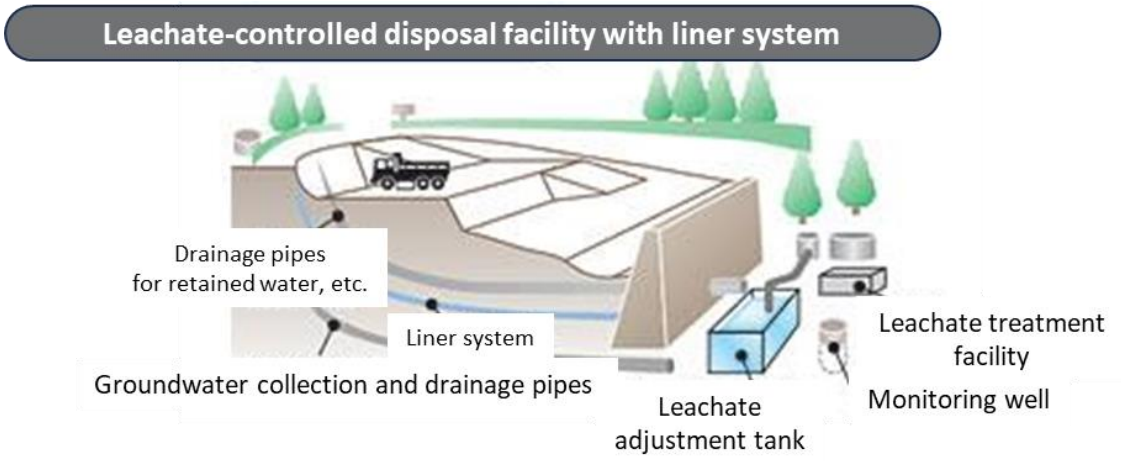


Figure III.5.1 (b) Final disposal facility for the Specified Waste with 100,000 Bq/kg or less.

The second type of final disposal facility of the Specified Waste is realised and in operation in Fukushima Prefecture since 2017.

The amount and specific radioactivity concentration of removed soil transported to the ISF until the end of FY2022 (March 2023) is presented in the following figure (see Figure III.5.2). Therefore, in total more than 12.3 mill. m³ were transported to the ISF, 94% of the materials is soil and approx. 24.5% of the material is above 8,000 Bq/kg (see Figure III.5.2).

This would lead to an amount of more than 3 mill. m³ removed soil for final disposal. The strategy envisages the complete final disposal of removed soil generated by decontamination measures by 2045 outside Fukushima Prefecture.

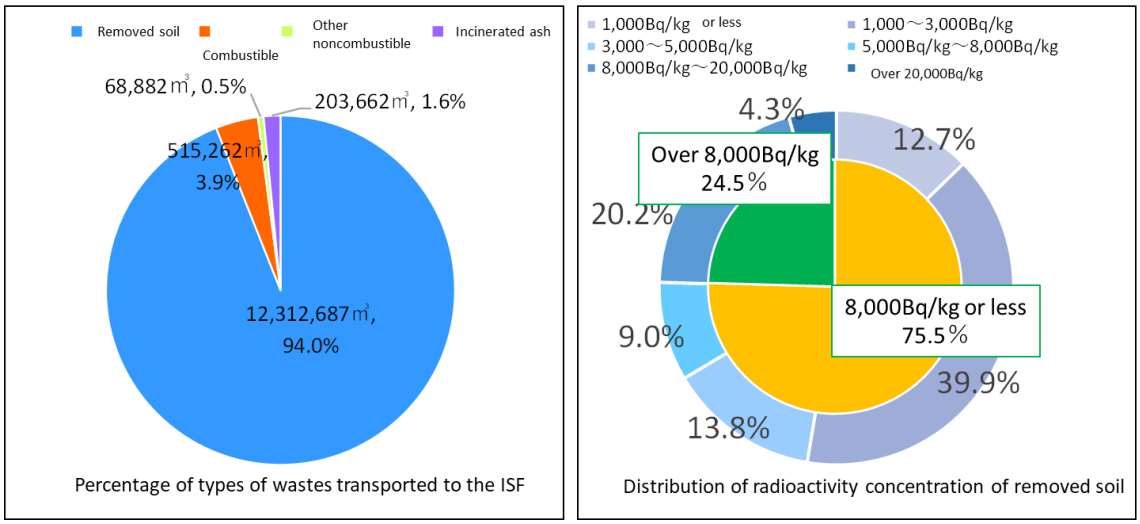


Figure III.5.2 Amount and radioactivity concentration of removed soil transported to the ISF (as of March 2023).

Options to reduce the volume of final disposal by several measures are under consideration. As an example, a treatment process is shown in the following Figure III.5.3. This can reduce the volume of final disposal by several orders of magnitude.

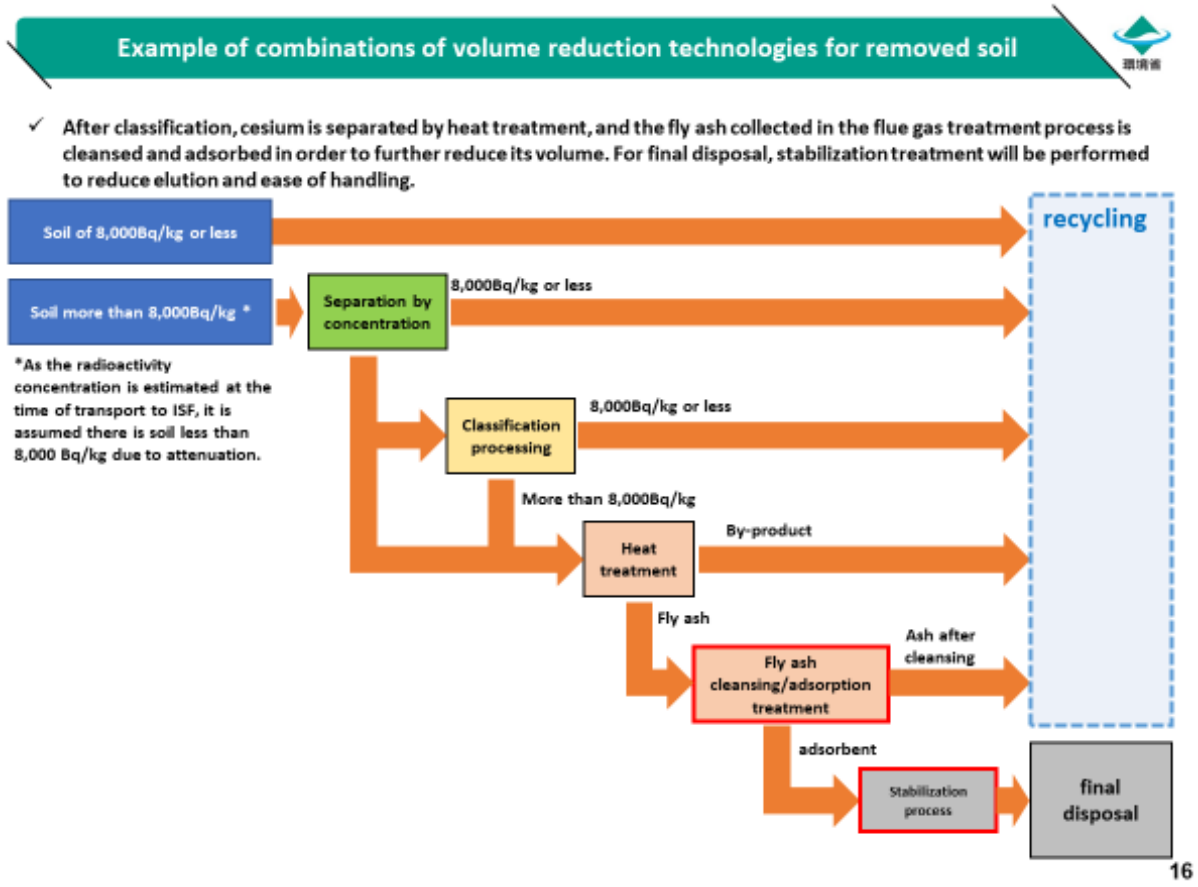


Figure III.5.3 An example of measures under consideration for volume reduction of removed soil

As next steps the MOEJ is planning

- to consider a basic concept for final disposal of removed soil;
- to develop a waste inventory;
- to show a few potential cases as final disposal option; and
- to conduct a basic safety assessment for a few cases.

Presentation by the IAEA

The IAEA presented the basic principles for radioactive waste management. This is that e.g.:

- Safety has to be ensured by passive means as far as possible;
- Understanding of the disposal safety system has to be demonstrated by the operator;
- A safety case is developed providing information about multiple safety functions and barriers; and
- Management systems and quality assurance have to be applied to all safety-related activities, systems and components throughout all steps of development and operation of a disposal facility.

The different IAEA documents related to disposal of radioactive waste and their hierarchy were explained including the most relevant safety requirements.

Observations

The baseline for the observations by the team of experts are mainly the IAEA principles, standards and guidelines. The team of experts notices that for fulfilling the IAEA Principle 7: Protection of present and future generations, it is necessary to keep the generation of radioactive waste to the minimum practicable level by means of appropriate design measures and procedures, such as the recycling and reuse of material (Principle 7, para 3.29). The team of experts explains that the management system and procedures designed by the MOEJ so far for the managed recycling of removed soil can be appropriate according to this IAEA principle.

The different tasks and responsibilities of government, regulatory body and operator are explained in the SSR-5. A safety case and supporting safety assessment are required to be prepared and updated by the operator, as necessary, at each step in the development of a disposal facility, in operation and after closure. The safety case and supporting safety assessment are required to be submitted to the regulatory body according to the IAEA Safety Standards. Communication with stakeholders on the safety and next steps of final disposal should be started in FY2025 once the achievements of the Technology Development Strategy are complied.

The screening level of 8,000 Bq/kg is a criterion for the managed recycling of removed soil. This criterion is in good accordance with other national criteria (for example criteria in EU countries) and suitable to differ between Low Level Waste and Very Low Level Waste or Exempt Waste according to the IAEA´s classification of waste (See Figure III.5.4).

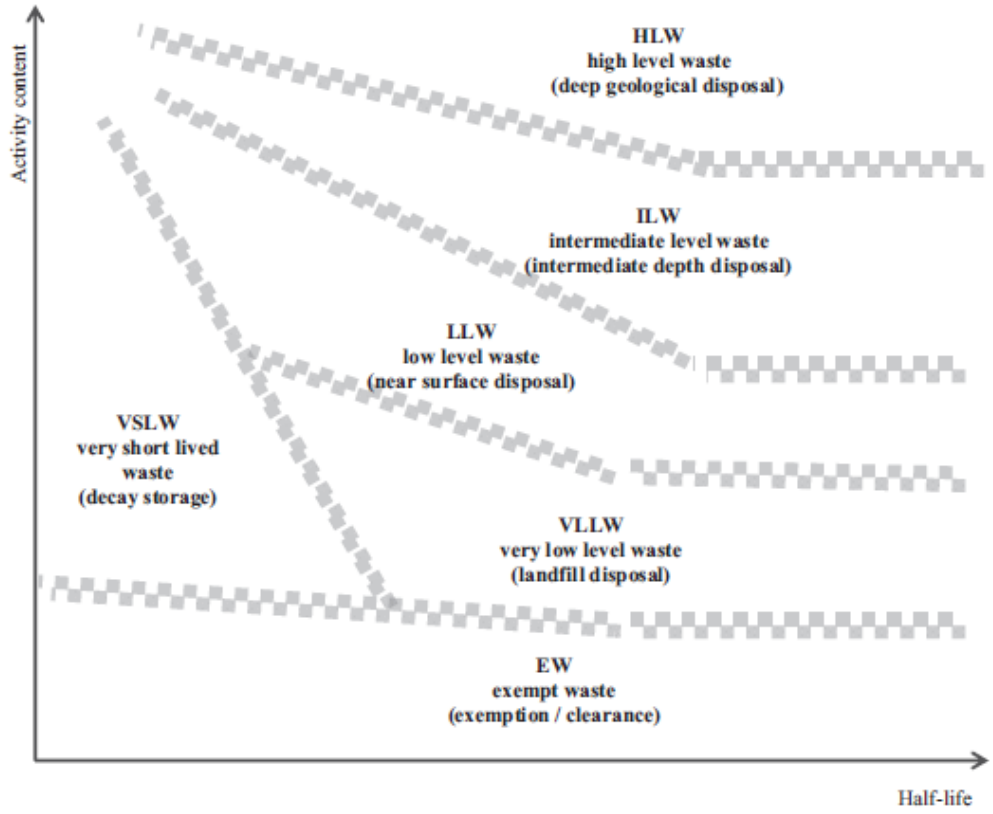


Figure III.5.4 Conceptual illustration of the waste classification scheme described in GSG-1 of the IAEA.

The team of experts expects that removed soil that will be sent for final disposal, including waste as a result of different treatment measures like heating and fly ash cleansing, can be assigned as Low Level Waste according to the IAEA´s classification scheme. Therefore, the disposal concept of a near surface disposal facility as illustrated by the MOEJ in a first step can be appropriate.

The lifetime with the different steps is illustrated in the following Figure III.5.5.

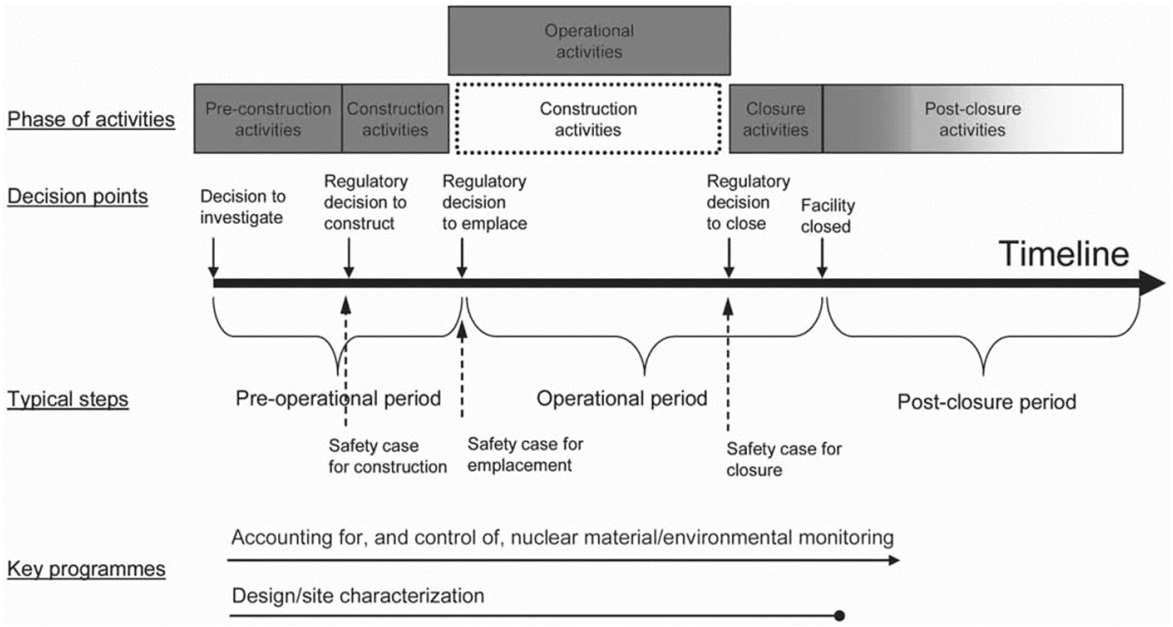


Figure III.5.5 Timeline to illustrate the development, operation and closure of a nuclear surface disposal facility described in SSG-29 of the IAEA.

Based on the current data of the removed soil a total amount of more than 12 mill. m³ already exists. 75% of this soil has an activity concentration of 8,000 Bq/kg or less. By additional measures the amount of remaining soil with an activity concentration of more than 8,000 Bq/kg can be reduced by several orders of magnitude.

This leads to different outcomes in terms of the quantity that will require final disposal:

- Large volume of removed soil with low activity concentration and a need of relatively short-term safety
- Small volume of high activity concentration and a need of relatively long-term safety.

An options assessment study will be performed by the MOEJ. The MOEJ will present the results of this assessment in view of feasibility of options for final disposal.

The team of experts notes that procedures are available and in use to assess and compare different options (Best Practicable Environmental Option as an example by UK).

The team of experts notes that in case that it would be absolutely difficult to secure location(s) for the managed recycling, final disposal of such removed soils would be required by March 2045.

The team of experts notes that according to the illustration of the timeline above, the following processes could be anticipated, within the next 22 years regarding the final disposal facility outside Fukushima Prefecture:

- The site selection process will be defined and implemented (a desktop exercise could be helpful as a starting point);
- The site selection process will be successfully finished;
- One (or more) disposal facility (facilities) will be planned, and a safety case will be delivered;
- The disposal facility (facilities) will be constructed and in operation; and

- The waste disposal methodologies and standards for waste treatment and disposal are closely inter-related, therefore, the treated waste, which will be confirmed to be safely disposed of, in line with the disposal standards based on the safety case, will be packaged, transported to and landfilled in the disposal facility (facilities).

According to the IAEA Safety Standards (SSR-5 No. 2.7) the team of experts considers that this entire process for the disposal facility requires an authorizing procedure. The team of experts notes that there are a lot of challenges to be addressed to realize the final disposal outside Fukushima Prefecture by March 2045 and therefore the team of experts suggests that a holistic strategy and timeline for the final disposal outside Fukushima Prefecture should be defined by the MOEJ.

The status for the MOEJ on the timeline presented above is on the very beginning. The MOEJ will consider whether there should be only one, or more than one, disposal facility (facilities).

The team of experts suggests that the MOEJ define the process of site selection after the achievements of the strategy will be complied. The process needs a clear description with selection parameters. The team of experts notes that the number of sites to be investigated increases the efforts in a decisive manner.

The MOEJ explained earlier that final disposal of removed soil unsuitable for the manged recycling and contaminated waste such as ash will be in a facility for near surface disposal outside Fukushima Prefecture. The facility will be designed so that it can accept the waste with highest activity concentration.

The team of experts recommends that a generic safety case is performed to demonstrate the safety of a site (sites) for near surface disposal for the expected quantity and activity concentrations of this waste. The safety assessment should also be performed to explore the additional safety features that may be needed in order for an actual facility (facilities) for near surface disposal to accept the waste with highest levels of activity concentration to be specified in the future.

During discussion the MOEJ gave the additional information that Japanese standards for radioactive waste exist for waste originating in the nuclear facilities and radioisotope users. The removed soil is out of scope of these regulations. The MOEJ makes clear, that according to the Japanese legislation, removed soil, which is dedicated for disposal, is defined as removed soil. The team of experts notes that the terminology used in this context in the IAEA documents is radioactive waste defined in the IAEA Safety Standards. However, irrespective of the terminology, radiation protection aspects have to be considered. As described in III.1, the team of experts recommends that the removed soil for final disposal should be treated in a way consistent with the IAEA Safety Standards relevant for radioactive waste taking into account the graded approach, especially if treatment increases the activity concentration and changes the physical form (e.g. from soil to ash).

The MOEJ will deliver by the 3rd IEM an initial safety case with several different cases of disposal facilities depending on amount and activity concentration. The safety case will be evaluated by the relevant expert review committee of the MOEJ.

The team of experts recommends that a sensitivity analysis should be included within this initial safety case. The approach for ensuring safety of final disposal taken by the MOEJ and its consistency with the IAEA Safety Standards will be further discussed at the 3rd IEM.

Annex 1 – Agenda of the 2nd IEM

Day 1: October 23rd (Mon.)

- Session 1: General Overview of the Strategy and the progress made for initiatives for volume reduction and the managed recycling of removed soil after the 1st IEM
- Session 2: Regulations and regulatory aspects
    - Institutional arrangements and regulatory aspects for the managed recycling and final disposal of removed soil
    - Graded approach to regulation of exemption
    - Regulations about specific clearance

Day 2: October 24th (Tue.)

- Visit to Soil Sorting Facility at Nuclear Engineering Seibersdorf, Austria
- Session 3: Clearance measurements

Day 3: October 25th (Wed.)

- Session 4: Communication and stakeholder engagement
    - Progress made after the 1st IEM
    - Research on communication with stakeholders regarding the managed recycling of removed soil
    - Building trust with key stakeholders and the public
- Session 5: Final disposal
    - Progress made after the 1st IEM
    - Key parameters influencing the results of dose assessments

Day 4: October 26th (Thu.)

- Session 6: Discussion about additional questions raised during the meetings
- Session 7: Discussion of preliminary observations based on the 1st and 2nd IEM

Day 5: October 27th (Fri.)

- Session 8: Summary of the 2nd Experts' Meeting, etc.