Summary Report

The 3rd IAEA-MOE Experts Meeting on Environmental Remediation

Tokyo, Minami-Soma City, Date City

17 – 21 April 2017

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A. Introduction

The 3rd IAEA-MOE Expert Meeting allowed the IAEA team[1] to review current progress made with the remediation effort in the off-site areas affected by the accident at TEPCO's Fukushima Daiichi Nuclear Power Station. During the meeting, the MOE informed the IAEA team of the achievement of the "full-scale" decontamination in the Special Decontamination Area (SDA) (excluding the Areas where Returning is Difficult) based on the Decontamination Implementation Plan. The MOE also explained that the decontamination in the Intensive Contamination Survey Area (ICSA) was also near completion as of March 2017[2].

It was reported by the MOE that the ICSA encompassed 104 municipalities in 8 prefectures (i.e., Iwate, Miyagi, Fukushima, Ibaraki, Tochigi, Gunma, Saitama, and Chiba) in the beginning (92[3] as of March 2017), and that the SDA encompassed 11 municipalities in Fukushima Prefecture. The ICSA and SDA are shown in Fig.1 below. During the meeting, the MOE explained, as follows:

- the total areas where decontamination was implemented in the SDA included approximately 22,000 houses and approximately 15,700 ha (approximately 8,500 ha corresponding to farmland, approximately 5,800 ha to forests, and approximately 1,400 ha to roads);
- the peak number of evacuees was observed in June 2012 totalling approximately 164,000 inhabitants, in June 2015 this number dropped to approximately 112,000, and by the end of 2016, the number decreased further to approximately 72,000;
- it would be estimated that approximately 24,000 people, whose original living areas have been designated as Areas where Returning is Difficult, still remain evacuated; and
- a proportion of the evacuees has already resettled in other places and has shown no intention to return to their original houses.

The meeting covered four topical sessions:

- session one reviewed the outcomes of the environmental remediation works carried out at the off-site areas affected by the accident at TEPCO's Fukushima Daiichi Nuclear Power Station;
- session two discussed the lessons learned on remediation based on data collected in Date City;
- session three focussed on how to evaluate the effects of the "full scale" decontamination; and
- session four addressed how to best share the results from the applied technologies for decontamination and waste volume reduction with the international community.

[1] The IAEA team was composed of IAEA staff and international experts.

[2] In the ICSA area remediation works have been undertaken by the municipalities with the technical and financial support of the National Government. In the SDA the decontamination efforts were the responsibility of the Ministry of the Environment (MOE). The Areas where Returning is Difficult are those within the SDA where it is anticipated that residents will face difficulties in returning for a long time.

[3] The number of municipalities in the ICSA decreased mainly because the designation of an ICSA has been lifted for some municipalities.

Site visits to review the activities on soil-recycling conducted in Minami-Soma City and the incineration of combustible waste in a dedicated facility in Date City took place during the last day of the week.

This report summarizes the main findings of the IAEA team and some proposals of suggestions to the Japanese authorities for further consideration in progressing the environmental remediation and related works.

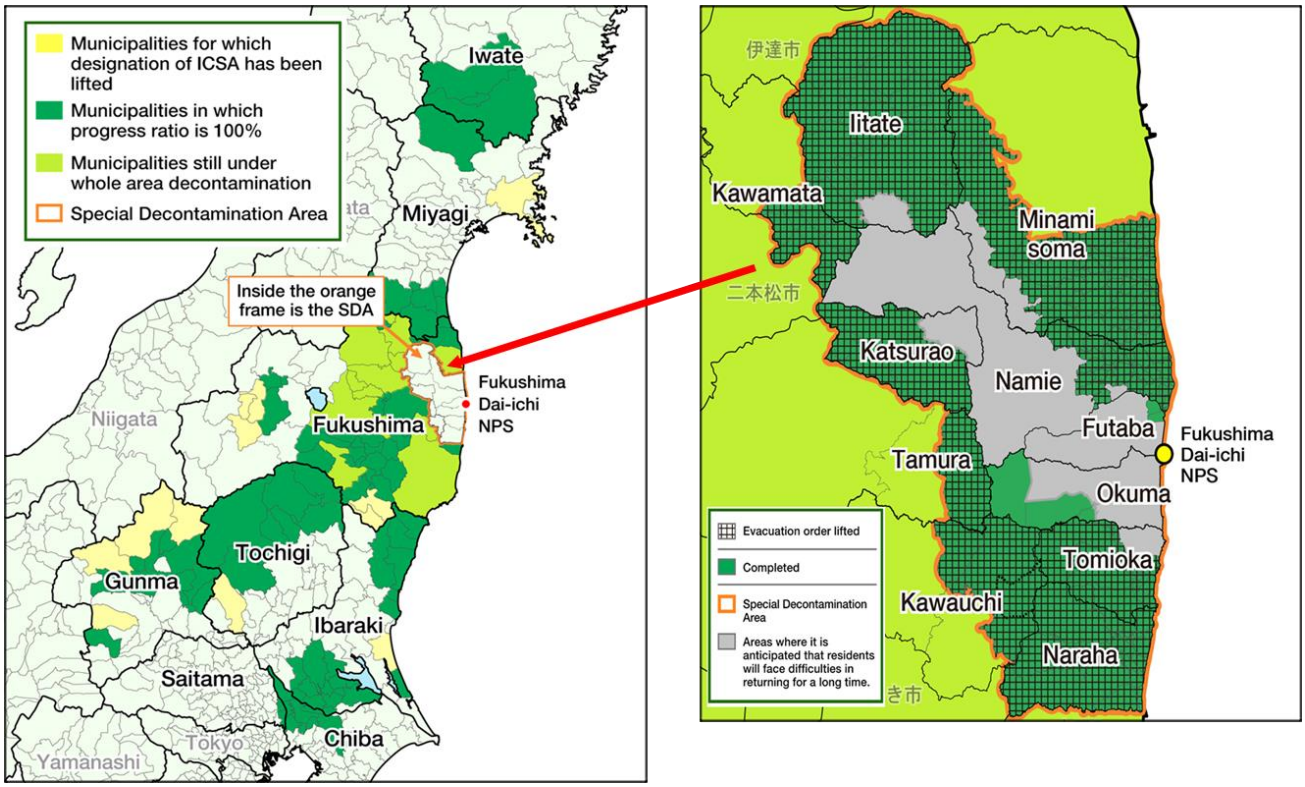

Fig.1. ICSA (as of 31 March 2017) and SDA (as of 1 April 2017)

B. Meeting Results

It was reported by the MOE that the "full-scale" decontamination was completed within the SDA according to the plans established by the MOE. According to the Act on Special Measures concerning the Handling of Radioactive Pollution, the target for areas where the projected annual effective dose[4] was 20 mSv or above was to "reduce the size of the areas step-by-step but as soon as possible"; and in those areas where the projected annual effective dose was below 20 mSv, the aim was to "reduce additional exposure dose rate to 1 mSv per year or less" in the long-term. The MOE explained that the overall process of remediation was strongly influenced by interactions with stakeholders to facilitate the return of evacuees to their homes and the provision of sustainable living conditions.

It was also reported that a broad range of techniques were used in the remediation strategies, according to the specific objects being decontaminated (e.g. houses and buildings, gardens, roads,

[4] Annual effective dose is subsequently referred to as 'dose'

schoolyards, farmlands and forests). These techniques included wiping off roofs and walls, high pressure washing, removal of fallen leaves, topsoil stripping, reverse tillage, etc.

The IAEA team was informed that the total volume of contaminated soil and waste generated from decontamination work was estimated to be up to circa 22 million m^3. It was explained that, prior to final disposal, the contaminated soil and waste would be sent to the Interim Storage Facility (ISF) where they would be managed for a period of 30 years following the start of the interim storage. The MOE has initiated a programme to investigate disposal options, and is, for example, conducting research on recycling and volume reduction techniques with a view to reduce the amount of waste going for disposal.

The results presented by the MOE enabled the IAEA team to conclude that significant progress has been made with the remediation in the offsite areas affected by the accident, and that steady progress on the ISF construction and soil/waste transportation to this facility has been made. As already mentioned, the milestone, namely, the completion of the "full-scale" decontamination in the SDA was achieved by the MOE, and because of this achievement, many municipalities in the SDA have had their evacuation orders lifted.

It was explained that the remediation process in the ICSA was implemented by the municipalities with the support of the MOE. In this regard, the accumulated experience and the ways of remediation work might have differed from municipality to municipality depending on prevailing circumstances in each of them.

The IAEA team views that it is important for the MOE to continue its efforts to share its experience of the "full scale" decontamination with both national and international communities through developing a series of decontamination reports.

The IAEA team has suggested that the MOE, in cooperation with other relevant organizations in Japan, should focus its efforts to develop remediation plans targeting the Areas where Returning is Difficult in conjunction with the rebuilding of the infra-structure within the SDA. In this regard, it is important to develop plans for further lowering doses in the SDA following the full scale decontamination in order to meet the long-term goal of 1mSv per year. The plans should prioritise the activities and milestones to prepare for repopulation and recovery. Finally, while developing the 2nd decontamination report, the MOE may reach out to international stakeholders to identify the information that might enhance the completeness of the report. The IAEA team views that the IAEA could contribute, in this respect, by providing feedback on the MOE's report during the next IAEA-MOE meeting.

For the second session, an official of Date City presented the city's response and lessons learned following the accident at TEPCO's Fukushima Daiichi Nuclear Power Station. It was reported that, immediately after the accident, the mayor of Date City, with the support of the local community, decided to use municipality funds to implement immediate remediation works to protect the citizens from exposure to ionizing radiation and to promote the return of the citizens to their normal lives as soon as possible. The official of Date City mentioned that the decisions were made in the absence of pre-established laws or guidelines. It was also explained that the creation of the first Temporary Storage Site took place in October 2011 after an intense process of engagement with the technical experts (invited by Date City) and local stakeholders. At the present moment, there are 50 Temporary Storage Sites totalling 29 ha in inhabited area.

According to the presented information, the authorities of Date City and local community came to the conclusion that the removal of the soil was not an objective by itself, but rather one of the possible remediation techniques. The effectiveness of soil removal in reducing radiation exposure, several years after the accident was being questioned in the municipality. The distribution of personal passive dosimeters among the citizens in the city demonstrated that soil removal had a very limited impact on the level of individual doses. The potential of decontamination and its limitations were discussed with the citizens in Date City, leading to ideas such as "*No excessive decontamination is necessary*" and "*We are creating our area for ourselves!*" Therefore, Date city authorities and citizens came to the position that further soil removal should be reconsidered.

The IAEA team is of the opinion that experience accumulated by the municipalities regarding the engagement with the communities and interaction with the national government is of high relevance to illustrate practical aspects of stakeholder-related issues in a mass scale remediation effort after a major nuclear accident.

The IAEA team believes that the remediation efforts implemented in Date City, in particular, the early initiation of the decontamination of the school yards and houses are worth being highlighted. In this respect, the IAEA team notes that the Mayor's leadership and support from members of the public were the important factors that together contributed to the expedient implementation of protective and remedial actions. There were some key aspects of the remediation programme in Date City, such as:

- an objective to return to normal life as soon as possible being shared among the Mayer, municipal government and the citizens;
- the active role of the Decontamination Promotion Centres;
- the direct involvement of trusted and recognized experts, and
- the availability of financial resources within the local budget (and confidence that expenses could be charged to TEPCO at a later stage).

It was also reported by the official of Date City that the municipality faced various challenges to implement the remediation works, including the lack of proper national remediation policy and response framework; the influence of sometimes contradicting information in mass media; and the lack of practical experience in remediation and management of large volumes of the residual radioactive material.

The IAEA team believes that this would be the right time to start a process to review the national policy on environmental remediation (Act of Special Measures) in a way to provide alignment with the IAEA GSR Part 3, specifically by addressing the requirements contained in the chapter related with "Existing Exposure Situations". In this regard, the accumulated national experience should also be captured in reviewing the Act of Special Measures. The IAEA team also advises that due consideration be given to enhance the dialogue/interaction among the national government, Fukushima prefecture and municipalities concerned.

The effects of remediation in different areas (residential, farmland, forests and roads) were assessed by the MOE. Based on a large data set, it was shown that the average reduction in air dose rates in the SDA (excluding forest areas) was in the range between 40 – 60%. In forest areas this decrease was less effective being around 23%. It was also revealed that the remediation activities in the SDA generated approximately 8.4 x 10^6 m^3 of contaminated soil and waste. From this amount approximately 1.0 x 10^6 m^3 have already been transported from the temporary storage sites (TSS's) to

the ISF and incineration facilities[5]. In relation to the ICSA, the volume of contaminated soil and waste generated was 7.2 x 10^6 m^3 out of which 1.1 x 10^6 m^3 has been transported from the TSS's to the ISF and incineration facilities[6]. The IAEA team learned that the MOE would continue to manage the removed soil and to monitor the effects of remediation, and, whenever necessary, implement supplementary remediation and measures for reducing radiation doses in forests.

The IAEA team notes that the results presented on the remediation effectiveness consisted of diagrams showing an overall summary of the remediation efforts. The IAEA team considers that it would be more useful if the data of different cities (under different circumstances) could be presented, so that a better understanding of the variability in the effectiveness of the work done could be captured and subsequently analysed.

The IAEA team views that, at the moment, the classification of the amounts of soil according to the activity concertation intervals is based on information about where the soils came from and not on individual determinations of the activity concentration of the materials contained in each bag. The only measurement available for the bags is the exposure rate at the surface of each one of them. With that in mind, it is advisable to consider the adequateness of establishing straightforward procedures for sampling and analysing soils in the bags. By doing so, classification of quantities of contaminated soil per activity concentration intervals could be obtained. Provided that criteria dictating the management of soils are based on the activity concentrations this procedure could facilitate decisions on the best way to subsequently manage the soils contained in the bags.

It was also reported by Japanese experts that reduction in ambient dose rates did not necessarily lead to proportional reductions in individual doses, due to variability in the living habits of citizens in the affected areas and the spatial distribution of the contamination. It was also presented that the use of personal dosimeters has been recommended for more precise assessment of individual exposure.

The IAEA team emphasises the need to consider individual doses, as measured with personal dosimeters, to support remediation decisions. An optimized monitoring programme to follow-up the behaviour of the affected media (soil, vegetation, etc.) could be put in place. The possibility that the MOE publish/make available information on the amount of waste produced by various decontamination techniques was suggested by the IAEA team. This information will be very relevant in the planning of remediation works in the event of another unlikely wide scale accident.

The IAEA team learned from the experience of an "Investigation Committee" that was created by Tomioka Town to examine and verify the results of remediation works carried out by the MOE in that municipality in the SDA. It was shown that, while verifying and confirming the results of full scale decontamination carried out by the MOE, the Committee identified specific locations having higher air dose rates for subsequent follow-up decontamination. The Japanese expert explained that it would be expected that, upon return, the evacuees would likely resume their normal activities, including farming and the consumption of locally produced food items.

[5] As for January 2017

[6] As for January 2017

The IAEA team advises that a comprehensive health monitoring programme should be prepared to support the returning evacuees. Monitoring with whole body counters can also be proposed to assess the level of internal exposure.

The development of the ISF was presented as a key element in the overall waste management strategy. It was estimated by the MOE that the total area of the facility will occupy approximately 1,600 ha. From this, total 79% is private land and 21% is national and municipal land. The MOE explained that negotiations with landowners have been being carried out on a case-by-case basis, and that approximately 376 ha have been already contracted as of the end of March 2017.

It was explained that different strategies were being pursued by the MOE to manage the accumulation of soils. According to the MOE, one of them is the recycling/reuse of the contaminated soil to be used as part of base structure materials of coastal levees, seaside protection forests, freeway roads or cover materials for waste disposal sites which will not be artificially changed for a long time. A demonstration facility is being developed in the city of Minami-Soma (visited by the IAEA team)[7]. In this pilot testing, soils with activity concentrations below 3,000 Bq/kg will be tested for the use of embankment construction material. A pilot recycling plant has been set up where contaminated soil bags from a TSS will be first subjected to preliminary treatment, screening for caesium concentration, and quality control. After construction the test embankment and surrounding environment will be monitored for a certain period of time to evaluate the effectiveness of this approach. A water treatment plant has also been constructed at the site to treat any contaminated water resulting from seepage through the embankment. The plans are set in such a way that the dose to workers shall not exceed 1 mSv per year (during the construction or repair activities) and the dose to members of the public shall not exceed 0.01 mSv per year when the constructions are concluded. The IAEA team believes that the demonstration project will facilitate a better understanding and communication with citizens.

It is recognized by the MOE that effective engagement with the stakeholders will be needed to put these plans forward. In this regard, "study sessions" on the theme of the demonstration project have been carried out by the National Institute of Technology, Fukushima College, in cooperation with the MOE, in such a way that views and concerns of the students are being identified.

Down blending of more contaminated soils with less contaminated ones was suggested by the IAEA team as a procedure to be carefully considered, taking all safety considerations into account. Mixing and blending of residual materials with other materials of similar characteristics, (e.g. as part of construction materials for dams, roadbeds, or waste disposal cells on the footprint of the remediation site; during ploughing of soil), may occur during remediation. Such an approach could be considered when and where there is a need or convenience for enabling residual materials to be safely recycled or reused.

[7] The adoption of this approach has indeed been recommended during the 1st IAEA Mission to Japan. In the Mission report it was formulated (Advice #5) that: "…The Team encourages the relevant authorities to revisit the issue of establishing realistic and credible limits (clearance levels) regarding associated exposures. Residues that satisfy the clearance level can be used in various ways, such as the construction of structures, reclamations, banks and roads. The IAEA is ready to support Japan in considering revised, new and appropriate criteria". (https://www.iaea.org/sites/default/files/preliminaryfindings2011.pdf)

Volume reduction of combustible waste from decontamination is being addressed by incineration. A dedicated rotary kiln type incineration facility (visited by the IAEA team) has been constructed in Date City. The facility has a processing capacity of 130 ton per day and will process 154,000 ton of these wastes until 2020 when the facility will be decommissioned[8]. The ashes (bottom and fly) resulting from incineration — approximately 200 kg for every 1000 kg of waste feed — are being stored at the site in super bags and will be transported to the ISF. Typical values of the ambient dose equivalent rates at the surface of the bags are 2.0 and 6.0 μSv per hour for the bottom and fly ashes, respectively. Apart from volume reduction, incineration helps eliminate the upsetting odour that results from the decomposition of the organic matter in such waste upon prolonged storage. It was reported that 30,000 ton of these wastes will remain untreated due to the negotiated deadline to decommission the plant.

As the MOE moves ahead in implementing waste management activities and construction of facilities (e.g. ISF, treatment plants, etc.), the IAEA team advises that the MOE consider conducting safety assessment of these activities and facilities and have it evaluated by an independent agency. This would be in line with the advice provided in the report of the remediation mission in 2013[9].

In all actions implemented by the MOE, the stakeholder engagements were an essential part of the remediation process. Many of the decisions have been driven by the stakeholders, especially in the ICSA area where the municipalities were in charge of remediation. Some of the adopted decisions are being reconsidered by the stakeholders in terms of their appropriateness

The IAEA team notes that it would be helpful for the MOE to assess the overall practices of stakeholder engagement in the decision-making process and extract important lessons learned. If considered appropriate, reorient future practices accordingly, especially during the repopulation of the evacuated areas and continuous remediation to reach the long term clean-up goal.

Conclusions

The IAEA team joining the 3rd IAEA-MOE Experts Meeting reinforces the view that this type of dialogue is extremely useful as it allows the exchange of experience/information, gaining insight on the progress being made with the remediation of off-site areas affected by the accident and identifying the challenges to be overcome. To the extent possible, the IAEA team provides considerations/suggestions that can be appreciated by Japanese authorities in order to address such challenges. Consideration of specific approaches of the Japanese authorities by the international community may also be beneficial to have a wide range of stakeholders reassured that the activities being implemented conform to good international practices or make sense from the technical/scientific point of view.

[8] The plan, which has been negotiated with local stakeholders, includes the complete removal of the facility from the site.

[9] "The Mission Team encourages the responsible organization(s) to carry out appropriate demonstrations of the safety of the facilities and activities for the management of contaminated materials, in particular for long-term activities, and to allow for their independent evaluation". (https://www.iaea.org/sites/default/files/final_report230114.pdf)

Once again, it is evident that progress is continuously being made with the remediation activities in Japan, and a milestone for completing the planned decontamination has been met on the timescales originally foreseen. Major challenges remain in the future management of the decontamination wastes and soils. Pursuing recycling options with proper safety assessments should not only be acknowledged but encouraged. There is a definite requirement for extensive stakeholder engagement to assist in understanding the rationale behind each option, and to clarify, in a transparent manner, all the potential controversial points so that a consensus can be reached on optimized/sustainable management options. Upon a request, the IAEA can provide support to Japan in this effort.

In addition to the points indicated in the main body of this report — that can be seen as activities to be considered by the MOE for further implementation — in this concluding section it could be highlighted that there is the need to capture the whole discussions held during the IAEA-MOE meetings (eventually expanding each topic as to capture the inputs of a broader number of experts in a dedicated report to be developed by the IAEA to share the lessons learned by Japan with the international community in a more comprehensive manner).