PRELIMINARY SUMMARY REPORT

IAEA INTERNATIONAL PEER REVIEW MISSION ON MID-AND-LONG-TERM ROADMAP TOWARDS THE DECOMMISSIONING OF TEPCO'S FUKUSHIMA DAIICHI NUCLEAR POWER STATION UNITS 1-4

(Third Mission)

Tokyo and Fukushima Prefecture, Japan
9 – 17 February 2015

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PRELIMINARY SUMMARY REPORT TO THE GOVERNMENT OF JAPAN

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Mission date: 9 – 17 February 2015

Location: Tokyo and Fukushima Prefecture, Japan

Organized by: International Atomic Energy Agency

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Executive Summary

Following the accident at TEPCO's Fukushima Daiichi Nuclear Power Station (NPS) on 11 March 2011, the "Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4" (hereinafter referred to the "Roadmap") was adopted by the Government of Japan and the TEPCO Council on Mid-to-Long-Term Response for Decommissioning in December 2011. The Roadmap was revised in July 2012 and June 2013. The Roadmap includes a description of the main steps and activities to be implemented for the decommissioning of the Fukushima Daiichi NPS through the combined effort of the Government of Japan and TEPCO.

Upon the request of the Government of Japan, the IAEA organized two missions of the International Peer Review of the Roadmap, which were implemented within the framework of the IAEA Nuclear Safety Action Plan, in April 2013 and in November – December 2013, respectively. Those missions aimed at enhancing international cooperation and sharing with the international community information and knowledge concerning the accident to be acquired in the future decommissioning process.

The first mission was conducted from 15 to 22 April 2013 with the main purpose of undertaking an initial review of the Roadmap, including assessments of the decommissioning strategy, planning and timing of decommissioning phases and a review of several specific short-term issues and recent challenges, such as the management of radioactive waste, spent fuel and fuel debris, management of associated doses and radiation exposure of the employees, and assessment of the structural integrity of reactor buildings and other constructions. The Final Report of the first mission is available on the IAEA webpage (http://www.iaea.org/sites/default/files/missionreport220513.pdf).

After the first mission, the Government of Japan and TEPCO revising the Roadmap took into consideration the advice in the first mission report. The revised Roadmap entitled "Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4, revised 27 June 2013" is available on the website of the Ministry of Economy, Trade and Industry (METI) (http://www.meti.go.jp/english/press/2013/pdf/0627_01.pdf).

The second mission was conducted from 25 November to 4 December 2013. The objective of the second mission was to provide a more detailed and holistic review of the revised Roadmap and mid-term challenges, including the review of specific topics agreed and defined in the first mission, such as removal of spent fuel from storage pools, removal of fuel debris from the reactors, management of contaminated water, monitoring of marine water, management of radioactive waste, measures to reduce ingress of groundwater, maintenance and enhancement of stability and reliability of structures, systems and components (SSCs), and research and development (R&D) relevant to pre-decommissioning and decommissioning activities. The Final Report of the second mission is available on the IAEA webpage http://www.iaea.org/sites/default/files/IAEAfinal_report120214.pdf.

During the 58th IAEA General Conference held in Vienna from 22 to 26 September 2014, the intention to receive another IAEA mission was expressed by the representative of the Government of Japan, with the aim to continue to work together with the IAEA and the international community.

Following the request, the third Mission of the International Peer Review of Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4, involving 15 international experts, was implemented from 9 to 17 February 2015 (hereinafter referred to as the "Mission").

The objective of the Mission was to provide an independent review of the activities associated with revisions to the planning and implementation of Fukushima Daiichi NPS decommissioning. The Mission was conducted based on IAEA Safety Standards and other relevant safety and technical advice, aimed at assisting the Government of Japan in the implementation of the Roadmap. In particular, the Mission was intended to:

- Provide advice and commentary on both the safety and technological aspects of decommissioning, waste management and other related activities;
- Provide advice to improve the planning and the implementation of pre-decommissioning and decommissioning activities at Fukushima Daiichi NPS; and
- Facilitate sharing of good practices and lessons learned for decommissioning operations after the accident with international community.

The Government of Japan and TEPCO provided comprehensive information on the current status and future plans of the implementation on the Roadmap. The IAEA team assessed the information, and had extensive discussions with the relevant institutions in Japan, followed by a visit to TEPCO's Fukushima Daiichi NPS to look at the situations of the NPS site.

This preliminary summary report presents an overview of the main findings, acknowledgments and advisory points of the third mission. The final report will be provided to Japan by the end of March 2015.

Main Findings and Conclusions

As already stated in previous IAEA mission's reports, the safe decommissioning of TEPCO's Fukushima Daiichi NPS is a very challenging task that requires the allocation of enormous resources, as well as the development and use of innovative technologies to deal with the most difficult activities.

The IAEA team considers that Japan developed its efforts towards decommissioning the plant promptly after the accident, and since then, Japan has achieved good progress in improving its strategy and the associated plans, as well as in allocating the necessary resources towards the safe decommissioning of TEPCO's Fukushima Daiichi NPS. Since the previous IAEA missions the Government of Japan and TEPCO have been taking steps in implementing planned measures aimed to reduce nuclear risks from the site and progress towards the safe decommissioning of the accident plant.

The IAEA team considers that the creation in 2014 of a new branch of TEPCO, called Fukushima Daiichi Decontamination and Decommissioning (D&D) Engineering Company (FDEC), as the only responsible organisation for the safe implementation of the on-site radioactive waste management and decommissioning activities, is a good step forward to clarify responsibilities. In similar manner, the establishment of a national authority to develop the guiding strategy, namely the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF), is also seen as a good demonstration of the proactive attitude of the Government of Japan and TEPCO towards addressing the many difficulties at the site. Currently around 7,000 workers are working on-site to develop and implement decommissioning activities.

The situation on-site has been improved since the last IAEA mission in 2013. Several important tasks were accomplished such as completion of the removal of fuel from Unit 4; the improvement and expansion of contaminated water treatment systems; the installation of new tanks and associated systems for contaminated water storage; the operation of underground water bypass; and the clean-up of the site resulting in the enhanced working radiological environment. In this line should be also highlighted introduction of comprehensive monitoring programme of seawater including control by independent laboratories. The IAEA's Environment Laboratories in Monaco cooperate with Japanese and other international marine laboratories in a comparison of results of seawater analysis.

The IAEA team notes with appreciation that the Government of Japan and TEPCO have given due consideration to the advice provided in previous IAEA missions to enhance planning and safe implementation of decommissioning and radioactive waste management activities.

In spite of this progress, the situation remains very complex at the site, with a number of challenging

issues, such as the persistent underground water ingress to main buildings and the accumulation of contaminated water on-site; the long-term management of radioactive waste; as well as those related to the nuclear fuel removal and damaged fuel and fuel debris removal. Therefore the IAEA team encourages Japan to continue implementing and even enhancing its strategy to deal with these issues, so as to ensure safe decommissioning of the accident plant and management of the radioactive waste. The IAEA team also recalls advisory points of the previous missions related to the site boundary dose limits. Progress made in this area should be assessed in relation to considerations of the number of people exposed and their respective residence times.

Acknowledgements and Advisory Points

This report provides highlights of important progress (Acknowledgments) in 20 areas such as management of radioactive waste, management of contaminated water including countermeasures against groundwater ingress, removal of spent fuel assemblies and damaged fuel debris, and institutional and organisational matters.

The report also offers 15 Advisory Points where the IAEA team feels that current practices could be improved taking into account both international standards and the experience from planning and implementation of decommissioning programmes in other countries.

1. Review of current situation of TEPCO's Fukushima Daiichi NPS

Review of current situation of Fukushima Daiichi NPS is based on available information provided by the Japanese counterpart and inputs obtained during the site visit.

The IAEA team notes that the situation on-site has been improved in several areas since the last mission in November/December 2013. Completion of the removal of fresh and spent fuel from the spent fuel pool of Unit 4 is an important step towards removal of this type of fuel from all reactor units. Improvement and expansion of contaminated water treatment systems and installation of a new designed and more robust storage tanks and associated systems for contaminated water storage were done to strengthen capability of TEPCO to deal with contaminated water issue.

Operation of the underground water bypass, including a comprehensive control of radioactivity before discharging to the ocean is another measure to achieve sustainable situation on the site. The underground water is pumped before it reaches main buildings and structures of Fukushima Daiichi NPS.

The situation is however still complex due to the approx. 300 m^3 of groundwater ingress into the NPS buildings per day, resulting in increase of volume of contaminated water to be managed. As of February 2015, about 600,000 m^3 of contaminated water is stored on-site. More than half of this volume has been already treated.

Clean-up of the site continues to be one of the priorities to enhance working radiological environment for employees.

2. Follow-up of the previous IAEA decommissioning missions conducted in 2013

A detailed overview of recent status of implementation of the IAEA advisory points from the previous decommissioning missions were provided by the Japanese counterpart. From the viewpoint of statistics is roughly half of advisory points completed or close to completion while execution of

majority of other half continues. One very technical advisory point is being considered for the future implementation.

The IAEA team was impressed by enormous effort of Japanese counterpart to carefully consider all advisory points and to work on their effective implementation. It is obvious that serious intention and commitment to improve execution of the planned on-site activities is in place as common approach of all involved implementers.

The IAEA team considers as the most visible examples of implemented follow-ups from the previous IAEA decommissioning missions following ones:

- Formulation of basic considerations to prepare and to discuss radioactive waste end-points and decommissioning end-states with all relevant stakeholders;
- Improvements of variety of technical aspects of water, waste and spent fuel management practices and introduction of new measures to deal with recent on-site issues;
- Review of strategy for accumulated water management and development of comprehensive plan;
- Implemented measures to reduce occupational exposure and to keep radiation dose in the vicinity of the site below annual limit for the public;
- Improvements of various aspects related to the marine monitoring and assessment of potential radiological impact;
- Promotion of stakeholder involvement and establishment of enhanced communication and reporting channels with concerned parties.

More detailed overview of progress related to the strategy and planning for decommissioning and in regards to the specific areas such as water, waste and spent fuel management is presented in Sections 3 and 4 of this report.

To facilitate sharing of good practices and lessons learned with international community was included into the objective of both IAEA decommissioning missions. Japanese counterpart has to be appreciated for continuous dissemination of variety of technical and safety related information concerning the Fukushima Daiichi on-site activities with the international community. Recognized Japanese experts from various organizations are encouraged and supported to attend various international events, including those organized by the IAEA and OECD/NEA, to present and/or otherwise facilitate sharing of recent on-site practices and lessons learned worldwide.

Acknowledgement 1:

The IAEA team appreciates Japanese institutions for careful consideration of all advisory points from the previous IAEA decommissioning missions and for extensive effort to effectively implement them to the maximum extent possible.

3. Strategy and planning for the decommissioning of TEPCO's Fukushima Daiichi NPS

(3.1) Strategy and Planning, including revision of the Roadmap and development of NDF Strategic Plans for Decommissioning

The strategic objectives and policies related to decommissioning of the Fukushima Daiichi NPS are presented in the Roadmap.

"Strategic Plan for Decommissioning of Fukushima Daiichi NPS" (Strategic Plan), which should

provide an approach to conducting activities and making decisions, as well as set priorities in achieving the goals, will be developed by the NDF, a new governmental organization established in August 2014.

TEPCO, through the newly established organization "Fukushima Daiichi Decontamination and Decommissioning (D&D) Engineering Company" (FDEC), is preparing Implementation Plans, which are basis for licensing of the field activities, and is delivering decommissioning works.

The Roadmap will be revised during the first half of 2015. During the Mission, an outline of the Strategic Plan was presented, as well as the driving principles for its development, which is underway.

Acknowledgement 2:

The IAEA team acknowledges continuous efforts of the Government of Japan, TEPCO and other organizations involved, on development of a strategy and an integrated planning for decommissioning of Fukushima Daiichi NPS. These include planned revision of the Roadmap, and the development of the NDF's Strategic Plan. It is commendable that the Strategic Plan is driven by the principle of risk reduction, and that detailed studies and analyses are being performed to identify, quantify and prioritize risks, to develop risk reduction strategies and plural scenarios for the risk reduction related activities.

In addition, the IAEA team acknowledges further progress in developing and implementing a comprehensive R&D programme to support the decommissioning works, in particular activities of IRID and JAEA towards construction of Advanced Research Facilities and the establishment of the International Research Centre for Reactor Decommissioning.

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Advisory Point 1:

Giving the complex situation at the Fukushima Daiichi NPS site, associated with large uncertainties in relation to radiological and physical status of the facilities, long term decommissioning planning has to include consideration of numerous options and scenarios. There is a need to optimize planning efforts by narrowing down the number of options for consideration. Identification of future configurations of the Fukushima Daiichi decommissioning process would provide a contribution in that direction. The IAEA team encourages all stakeholders to continue discussions, initiated in the previous period, considering the future configuration. In addition to reduction of the number of options for consideration, identification of such future configuration will be an important input to the development of strategies and plans for management of very large amounts of radioactive waste, present now and expected to be generated during the decommissioning process.

The IAEA team encourages the Government of Japan to make the best use of TEPCO's growing experience of implementation activities on the site, in informing the revision of the Roadmap and development of the NDF's Strategic Plan.

(3.2) Institutional and organisational issues

Acknowledgement 3:

The IAEA team acknowledges the progress made by TEPCO in addressing the profound challenges arising from the accident. Transition from the stability of reactor operations to the inter-connected, diverse and evolving conditions embodied in waste management and decommissioning at a post-accident site has commenced, in a thoughtful and determined manner. As an example of this, the creation of a specific division within TEPCO to address the challenges at Fukushima Daiichi is

welcomed – "Fukushima Daiichi Decontamination and Decommissioning (D&D) Engineering Company" (FDEC). The IAEA team also notes the creation of the "Nuclear Damage Compensation & Decommissioning Facilitation Corporation" (NDF).

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Advisory Point 2:

Noting the recent introduction of the NDF, the IAEA invites the Government of Japan to consider how best to ensure the full clarity of responsibility of all the relevant actors.

Advisory Point 3:

Safety leadership, in all cases at the Fukushima Daiichi NPS site, is the primary responsibility of the Operator (TEPCO). Renewed emphasis on this aspect is particularly beneficial whenever national structures are undergoing significant change or in which large numbers of contractors are deployed. Therefore, the IAEA team strongly encourages TEPCO in their progress to reinforce safety leadership and safety culture, along with developing a Management System appropriate to radioactive waste management and decommissioning. This will provide mechanisms for *inter alia* effective control and supervision of operations on the site; robust safety justification; rigorous training, qualification and authorization of operators fulfilling defined safety roles; and systematic radiological protection.

(3.3) Preparation for licensing

The licensing issue has not been discussed in details during this Mission. During the previous two review missions, TEPCO explained that basis for licensing of activities are Implementation Plans, developed by TEPCO. Such Implementation Plans for activities describe how the objectives of the Roadmap and the strategic decisions of the NDF's Strategic Plan will be implemented. The Implementation Plans are supported by safety justifications/assessments and other supporting documents, as appropriate.

The regular licensing process for normal situations is difficult to be applied in the existing post-accident situation at the Fukushima Daiichi NPS site, so non-standard licensing/authorization process is being discussed between TEPCO and the Nuclear Regulation Authority (NRA). Such an approach to licensing has been approved by the Government of Japan. During this Mission an example of such authorization process for the temporary waste storage facilities on site has been presented and explained.

Acknowledgement 4:

The IAEA team acknowledges the efforts of the Government of Japan and the NRA to establish a licensing/authorization process for activities and facilities on the Fukushima Daiichi NPS site, as well as TEPCO's effort to implement that licensing/authorization process and NRA to evaluate and grant authorization, if appropriate.

Recognizing that the existing licensing process for normal situations is difficult to be applied in the complex post-accident situation, a non-standard licensing/authorization process is being discussed and applied, based on demonstrating compliance with prescribed set of general safety requirements. Such process was applied to the authorization of recently completed removal of the spent fuel from the Fukushima Daiichi NPS Unit 4.

In addition to the process involving licensing/authorization by the NRA, there is a robust internal process in place within TEPCO, for internal safety evaluation and approval of works by the TEPCO's

Nuclear Safety Management Committee and Decommissioning Safety Committee.

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Advisory Point 4:

The IAEA team encourages TEPCO to engage with the NRA in establishing clear criteria, based on risk assessment, for determining which activities require the NRA authorization and which activities can be evaluated and approved internally by the TEPCO's Committees responsible for safety.

TEPCO is encouraged to strengthen its Committees responsible for internal safety evaluations, including consideration of involving external independent experts in the safety evaluation process.

(3.4) Public relations and communication

Acknowledgement 5:

The IAEA team notes that the Fukushima Advisory Board has been active since its creation, providing a useful channel for strengthening public communication and stakeholder involvement in the decommissioning of Fukushima Daiichi NPS and contaminated water management. This is in line with Advisory Point 2 of the first mission as well as Advisory Point 4 of the second mission.

Acknowledgement 6:

TEPCO has intensified its public communication efforts, including by using social media and 'risk communicators' – engineers trained in communication to reach communities. In line with Advisory Point 3 of the second mission, TEPCO has intensified communication with the workforce, including contractors.

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Advisory Point 5:

Recognizing intensified communication efforts through the dissemination of comprehensive information, the IAEA team urges METI and TEPCO help lay audiences understand the relevance of this information by basing it on the health and safety aspects of both the workforce and the public, as well as protection of the environment. The IAEA team also encourages TEPCO to promote understanding by intensifying and widening its efforts to promote an interactive dialogue, including by engaging its social media audience by responding to comments and questions. Thorough analysis of how the media and the public understand disseminated information should be used to improve future communication.

(3.5) Prioritisation and Hazard Reduction

Acknowledgement 7:

The IAEA team welcomes the start of transition towards a safety assessment approach within TEPCO which takes account of several relevant factors, including workforce dose, protection of safety systems and prevention of radiological discharges.

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Advisory Point 6:

The IAEA team encourages TEPCO to develop an integrated plan for decommissioning and radioactive waste management at Fukushima Daiichi NPS. In developing this plan, certain activities will deserve more prompt attention, and consideration of the approach adopted to address this will be beneficial. The chosen approach should be firmly founded on minimising impacts to human health and on protecting the environment. It should also consider how inter-dependencies between the steps of radioactive waste management, maintaining a clear view of long-term safety, can be considered and how waste disposal may properly be assessed. Independent advice and challenge to the emerging plan is also likely to be valuable.

4. Review of specific issues

(4.1) Management of radioactive waste

Immediately after the accident of the Fukushima Daiichi NPS, a process of management of all types of generated waste has been established in an emergency situation and in urgent conditions with the essential objective to reduce the dose to workers and at the boundaries of the site. Radioactive waste management mainly consists of sorting the different material and debris by their physical state (e.g. concrete, wood, rubble, etc.) while also measuring the contact dose rates of the different materials.

The main target for the management of the radioactive waste is recently to store them in dedicated temporary storage facilities located on the site.

Acknowledgement 8:

The IAEA team acknowledges that the government has created an organizational framework, comprised of, for example NRA, FDEC, NDF, IRID and JAEA, that used effectively can enhance the safety of the wastes arising from an expedited decommissioning by embracing long-term waste management principles. The IAEA team recognizes the effort and accomplishment of the FDEC in reducing worker exposure, dose at the site boundary and facilitating site operations for decommissioning, by the accumulation of contaminated material and debris into temporary storage.

Acknowledgement 9:

The IAEA team acknowledges that the FDEC endeavours to use good engineering principles in the design and configuration of the temporary storage locations and their design are reviewed by the FDEC safety committee and approved by the NRA when required. The IAEA team further recognizes that the FDEC develops and maintains information on the physical contents of each temporary storage location and its debris form with minimal radiological characterization for surface dose rate.

Acknowledgement 10:

The IAEA team considers that the research carried out by the JAEA on the different phases of predisposal management (characterization, treatment, conditioning, storage) of the waste from the water treatment is commendable and should be continued.

Acknowledgement 11:

The FDEC recognizes the benefits of implementing clearance processes and permitting material reuse

and recycle for wastes generated during decommissioning, and thereby facilitate the long-term waste management.

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Advisory Point 7:

The IAEA team is of the opinion that the FDEC could better employ long-term radioactive waste management principles (beyond the segregation, relocation and dose reduction/shielding currently performed) such as more complete waste characterization, conditioning, and packaging. While the IAEA team holds that the FDEC could deploy such principles in its present efforts, it appreciates that waste management strategy, direction and criteria are forthcoming from the NDF.

Advisory Point 8:

The NDF is urged to give priority to issuing the waste management strategy that will enable the FDEC to implement (after the demonstration of safety and proper licensing) processes appropriate for safe long-term radioactive waste management such as waste minimization, treatment and conditioning, packaging, release, recycling, etc.

Considering that most of the contaminated rubble is likely to have only surface contamination and could be easily decontaminated to a certain extent, the IAEA team suggests that benefits of conditional clearance should be explored and implemented if appropriate, with the vision of reducing the overall amount of radioactive waste to be managed.

Advisory Point 9:

The IAEA team encourages the FDEC to reflect in its organizational structure and staffing the importance and scale of the radioactive waste management workscope. Additionally, the supporting institutions, such as JAEA, are encouraged to ensure sufficient human and technical resources are available for radioactive waste management and to support the FDEC with reliable and sustainable waste management capabilities, including the development of on-site technical capabilities.

Advisory Point 10:

The IAEA team encourages the FDEC to continue working on developing a waste inventory providing reliable physical, chemical, radiological and volumetric information, even prior to availability of the new Analysis Centre, to support future strategic planning and decisions for the waste streams. The IAEA team encourages the FDEC to continue to implement Advisory Point 8 from the previous decommissioning mission regarding the need to establish a sound radiological characterization of the waste and waste classification scheme which will enable the FDEC to further develop its strategy for the processing, storage and disposal of the waste.

Advisory Point 11:

The IAEA team recommends the long-term and operational safety of the temporary storage facilities (for emplacement, storage and retrieval phases) be evaluated for both normal and potential accident conditions, in line with the hazard of the various waste generated.

(4.2) Management of contaminated water, including ingress of groundwater

TEPCO has made progress in managing the treatment and storage of contaminated water, and in controlling the ingress of groundwater to reactor and turbine buildings. Large volumes of contaminated water from reactor and turbine buildings were successfully treated. The risk associated with storing the treated water with high levels of other radionuclides in numerous above ground tanks at the site is being mitigated.

Significant steps in controlling the ingress of groundwater into the reactor and turbine buildings were taken. These included the installation and operation of a set of pumping wells to reduce the flow of groundwater towards the buildings, sealing of sea-side trenches and shafts, and the rehabilitation of the subdrain system. Introduction of additional measures to reduce groundwater ingress, such as frozen (ice) wall and facing of surface areas, is on-going.

Acknowledgement 12:

The IAEA team reconfirms TEPCO's success in treating large volumes of highly radioactive water, accumulating continuously in the reactor and turbine buildings, to remove gamma emitting caesium radionuclides upfront and using the treated water after desalination to maintain stable cooling of the damaged cores. The cumulative volume treated by the two operating caesium removal systems is now more than 1 million cubic metres, with high caesium removal efficiency achieved consistently. TEPCO has recently added strontium removal capability to these treatment systems. Removing strontium upfront along with caesium would facilitate further management of the treated water.

Acknowledgement 13:

The IAEA team acknowledges TEPCO's efforts to mitigate the risk associated with storing large volumes of radioactive water, containing high levels of ^{90}Sr remaining after caesium removal, in numerous above ground tanks at the site. In order to augment the treatment capacity of the ALPS and the High Performance water treatment systems (ALPSs), which remove ^{90}Sr as well as all other residual radionuclides (except tritium), TEPCO has established a number of additional treatment systems dedicated specifically to removing ^{90}Sr. Their prioritizing of the bolted flange type tanks for removing ^{90}Sr is well placed, considering the higher risk of storing ^{90}Sr bearing water in these tanks. Even though strontium treated water would still require final polishing with the ALPSs, by removing at least 99% of the ^{90}Sr this approach is enabling TEPCO to reduce the inventory of radioactivity in the tanks and associated risk substantially. More than half of the nearly 600,000 cubic metres of water stored in tanks has been treated so far using the ALPSs and strontium treatment systems and TEPCO expects to complete the treatment of the remaining water in the next few months.

Acknowledgement 14:

The IAEA team commends TEPCO for mobilizing the resources needed to successfully build sufficient storage capacity for contaminated water and to generally improve the safety of storage. These measures include replacement of bolted flange type tanks with newly constructed fully welded tanks, construction of dykes with enhanced water holding capacity, and provision of covers to deflect rainwater from the dykes so that the dykes can perform their intended safety function of containing potential leaks from the tanks. Again, prioritizing the bolted flange type tanks for implementing this rainwater management measure is well placed because of the vulnerability of these tanks to develop leaks.

Acknowledgement 15:

The IAEA team commends TEPCO for its efforts to address contamination in the very complicated area of infrastructure East of the Turbine Buildings with its many potential connections between the Turbine Building and the sea resulting from intentional cooling system design, ground water contamination, radionuclides connected with debris in this area, and potential leakage from the Turbine Buildings connected to the Reactor Building. Significant efforts are underway to address elements of these potential pathways including addressing the contaminated water in the Seawater Pipe Trench, however this will be a very difficult area in which to control the migration of contamination.

Acknowledgement 16:

The IAEA team considers the groundwater by-pass system designed to control the ingress of groundwater to reactor and turbine buildings has been successfully put in operation. After six months of operation, and related measures to control leaking to building, groundwater ingress has been reduced by about 25% or 100 m^3 per day. We further acknowledge that the success of the groundwater bypass operation involved extensive communication and engagement with the many stakeholders and the public in general on the nature of the operation and the measures taken to minimize possible risks to the environment or the public. It is an important milestone in gaining the public trust and should be helpful for implementing future strategies for managing contaminated water issues.

Acknowledgement 17:

The construction of frozen (ice) wall enclosing the area around Units 1-4 on the sea-side and land-side are in various stages of completion. The ice wall on the mountain side will be placed in between the buildings and the groundwater bypass wells, resulting in further prevention of groundwater flow towards the reactor buildings.

Acknowledgement 18:

The IAEA team notes that the rehabilitation of the subdrains and the construction of a treatment system for pumped subdrain water are nearly complete. As the subdrains are placed in operation, they are expected to further reduce the groundwater ingress by about 150 m^3, and to near zero following the installation of the land-side ice wall. The IAEA team appreciates TEPCO's planning to ensure that pumping from the subdrains is carried out while preventing the outflow of contaminated water from the buildings. After controlling the ingress of groundwater, TEPCO also plans to seal leakage points on reactor and turbine building walls.

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Advisory Point 12:

While recognizing the usefulness of the large number of water treatment systems deployed by TEPCO for decontaminating and thereby ensuring highly radioactive water accumulated at the site is not inappropriately released to the environment including the adjacent Pacific Ocean, the IAEA team also notes that currently not all of these systems are operating to their full design capacity and performance. The IAEA team encourages TEPCO to continue on-going efforts to improve the utilization of these treatment systems. In their planning of water treatment schedules, TEPCO is advised to take into consideration that testing and optimising the operating conditions of complex multi-stage water treatment systems can take time, particularly for those technologies that are new and being deployed under field conditions for the first time.

Advisory Point 13:

The IAEA team is of the opinion that the present plan to store the treated contaminated water containing tritium in above ground tanks, with a capacity of 800,000 cubic metres, is at best a temporary measure while a more sustainable solution is needed. Therefore the present IAEA team reiterates the advisory point of the previous decommissioning mission:

"The IAEA team believes it is necessary to find a sustainable solution to the problem of managing contaminated water at TEPCO's Fukushima Daiichi NPS. This would require considering all options, including the possible resumption of controlled discharges to the sea. TEPCO is advised to perform an assessment of the potential radiological impact to the population and the environment arising from the release of water containing tritium and any other residual radionuclides to the sea in order to evaluate the radiological significance and to have a good scientific basis for taking decisions. It is clear that final decision making will require engaging all stakeholders, including TEPCO, the NRA, the National Government, Fukushima Prefecture Government, local communities and others".

The IAEA team recognizes the need to also consider socioeconomic conditions in the consultation process and to implement a comprehensive monitoring programme to ensure that there is no detrimental impact on human health and the environment. In this regard the IAEA is ready to continue providing assistance in implementing such a comprehensive sea water monitoring programme.

Advisory Point 14:

The IAEA team advices that TEPCO should consider producing a better calibrated, robust groundwater model, which will allow TEPCO to continuously evaluate and optimize the performance of various countermeasures, such as the land-side ice wall, pumping from bypass wells, and the operation of sub-drains. An improved model, and a continuously updated, detailed map of water levels, chemical composition, and radioactivity concentrations around the entire site (including under the higher ground west of the groundwater bypass wells), will help to provide a baseline for monitoring and controlling the migration of any radioactivity from surface contamination.

As the multiple water capture, water treatment, and water storage activities are highly interdependent and complex, TEPCO may also consider implementing a "systems analysis" with associated system dynamics computer tools to help understand the integrated set of contaminated water management activities both on the land and sea-side, assess volumes of water and waste production, the impact of shifting schedules, as well as the interdependency of water management, waste management, and future decommissioning activities.

(4.3) Removal of spent fuel assemblies and damaged fuel debris

Since the last peer review mission in December 2013 the removal of all pooled fuel from Unit 4 has been completed. Over this time period TEPCO have also demonstrated their commitment to reducing dose exposure to its workers and in the longer term through the introduction of a 'Dose Reduction Plan for Reactor Buildings'. To compliment dose reduction plans measures to prevent the spread of contamination during rubble, pooled fuel and fuel debris removal have received considerable attention.

Recently a review of the plans for pooled fuel and fuel debris removal from Units 1 & 2 has been undertaken. This has resulted in sub-options of one of the primary options in both cases. The sub-options are based on early pooled fuel removal which has been identified in the Roadmap.

Acknowledgement 19:

The IAEA team recognizes the substantial efforts made by TEPCO and its sub-contractors in removing the 1,331 spent fuel assemblies from the Unit 4 by November 5, 2014, within one year of

the first fuel assembly being removed, and all fuel assemblies by December 22, 2014 (1,533 new and spent fuel assemblies). A commitment to reducing worker dose through the incorporation of shielding materials in Unit 4 until a dose reduction of 72% was achieved and supporting activities which enabled the fuel removal from Unit 4. Supporting activities included the removal of 1,004 spent fuel assemblies from the Common Spent Fuel Pool (now accommodated in 19 new dry storage casks) to the Temporary Cask Custody Area and releasing storage space in Unit 6 to enable the storage of 180 new fuel assemblies.

Acknowledgement 20:

The IAEA team acknowledges the efforts being made to minimize the spread of contamination through the incorporation of learning from Unit 3 debris removal operations and the introduction of dust counter measures. The continued commitment to reduce dose exposure is also recognized in particular the introduction a 'Dose Reduction Plan for Reactor Buildings'. These measures will benefit both workers and any potential impact on the local population.

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Advisory Point 15:

Whilst activities which lead to short-term gains demonstrates a positive attitude in reducing risks as early as practical, this needs to be considered in the framework of overall safety and the overall risk reduction. The IAEA team encourages the NDF to conduct a risk analysis in relation to pooled fuel and fuel debris plans; taking into account conventional safety and cumulative dose to workers.