



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

(Fourth Mission)

**Tokyo and Fukushima Daiichi NPS, Japan
5-13 November 2018**

**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**

(Fourth Mission)

**PRELIMINARY SUMMARY REPORT
TO THE GOVERNMENT OF JAPAN**

Tokyo and Fukushima Daiichi NPS, Japan

5-13 November 2018

PRELIMINARY SUMMARY REPORT

Mission date: 5-13 November 2018

Location: Tokyo and Fukushima Daiichi NPS, Japan

Organized by: International Atomic Energy Agency

Review Team:

Xerri, Christophe	IAEA/NEFW, Team Leader
Orrell, Andrew	IAEA/NSRW, Deputy Team Leader
Michal, Vladimir	IAEA/NEFW, IAEA Coordinator
Cruz Suarez, Rodolfo	IAEA/NSRW
Donovan, Jeffrey	IAEA/OPIC
Ermolaev, Aleksandr	Rosenergoatom, RF
Gonzalez Espartero, Amparo	IAEA/NEFW
Hirota, Masanori	IAEA/NEFW
Ljubenov, Vladan	IAEA/NSRW
Robbins, Rebecca	IAEA/NEFW
Thompson, Leo	Savannah River National Laboratory, USA
Umbara, Heru	BATAN, Indonesia
Weston, Rebecca	Sellafield Ltd, UK

Issue Date: 13 November 2018

BACKGROUND

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 (Tokyo Electric Power Company) Council on Mid-to-Long-Term Response for Decommissioning in December 2011. The Roadmap was revised in July 2012, June 2013, June 2015 and September 2017. 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.

At the request of the Government of Japan, the IAEA organized three 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, in November/December 2013 and in February 2015, 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 Government of Japan conveyed, in an official correspondence dated 24 August 2018 through the Permanent Mission of Japan in Vienna, its request to the IAEA to dispatch another mission, and the IAEA accepted the request in an official correspondence dated 10 September 2018. During the 62nd IAEA General Conference (Vienna, 17-21 September 2018), the intention to receive another IAEA mission was confirmed (Terms of Reference was signed) by the representative of the Government of Japan, with the aim to continue to work together with the IAEA and the international community.

Following this request, the fourth 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 13 international experts, took place from 5 to 13 November 2018 (hereinafter referred to as the "Mission").

The objective of the Mission was to provide an independent review of the planning and implementation of Fukushima Daiichi NPS decommissioning. The Mission was conducted based on the IAEA Safety Standards, technical guidance and other relevant good practice, aimed at assisting the Government of Japan in the implementation of the Roadmap.

The Government of Japan and TEPCO provided comprehensive information on the current status and future plans of the implementation on the Roadmap. The IAEA Review Team assessed the information, and had extensive discussions with the relevant institutions in Japan, as well as visiting TEPCO's Fukushima Daiichi NPS, to better understand the situation.

This Preliminary Summary report was submitted to METI (Ministry of Economy, Trade and Industry) on 13 November 2018 in Tokyo and published on METI and the IAEA websites. The final Mission report elaborating on the findings and conclusions of the Preliminary Summary report will be delivered by 31 January 2019.

Main Findings and Conclusions

Since March 2011, addressing the situation of the damaged plants of Fukushima Daiichi and moving towards decommissioning while ensuring safety for the workers and the population has remained a very challenging task, requiring resources, commitment, and innovation to tackle a unique situation. The IAEA Review Team considers that significant progress has already been accomplished to move Fukushima Daiichi from an emergency situation to a stabilized situation. This should allow to focus more resources for detailed planning and implementation of the decommissioning project of the whole site with considerations extended up to the completion of the decommissioning.

The organization put in place by the Japanese government, with clarified roles and responsibilities of the main actors – METI, NDF (Nuclear Damage Compensation and Decommissioning Facilitation Corporation), TEPCO's internal unit FDEC (Fukushima Daiichi Decontamination and Decommissioning Engineering Company), IRID (International Research Institute for Nuclear Decommissioning), JAEA (Japan Atomic Energy Agency) – allows for a more effective planning and the implementation of the waste management and decommissioning. Strong collaborative relationships among these organizations should be maintained.

The IAEA team considers daily activities of the site are well managed, for the areas reviewed. In this respect, many improvements have been recorded since the previous mission in 2015, in particular pertaining to water management (implementation of the multi-layered approach including sub-drain and recently the completion of the “frozen soil wall”), and solid waste management (construction of storage and volume reduction facilities). The IAEA Review Team also noted with appreciation the improvement of working conditions at the site.

The risk reduction strategy is being implemented at a pace commensurate with the challenges of the site-specific situation. In this respect the IAEA Review Team noted the progress being made towards the removal of spent fuel from Unit 3 and then Unit 1 and Unit 2. Looking towards fuel debris retrieval, the team noted with interest the investigations made in the reactors and the Research and Development effort which support this objective.

Despite the improvements in addressing the root causes contributing to the generation of contaminated water, the IAEA Review Team continues to identify water management as critical to the sustainability of decommissioning activities, in particular the resolution of the disposition path for the ALPS (Advanced Liquid Processing System) treated water containing tritium and other radionuclides in tanks. With the volume of ALPS treated water expected to reach the planned tank capacity of 1.37M m³ within the coming three to four years, and considering current site facility plan for space allocations, and that further treatment and control of the stored water before disposition would be needed for implementation of any of the five solutions considered by the Japanese Government (as TEPCO expressed at the Sub-committee on handling of ALPS treated water, October 1, 2018), a decision on the disposition path should be taken urgently in engaging all stakeholders.

The IAEA Review Team notes with appreciation that the Government of Japan, NDF 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.

Considering the challenges ahead towards the safe decommissioning of the site, the IAEA Review Team encourages Japan to further strengthen programme and project management and related organizational structure for comprehensive and integrated planning for the completion of the site decommissioning.

While fuel debris retrieval is one of the most important and challenging issues, such planning shall also include sustainability and long-term aspects such as waste management including the waste streams which will come from the decommissioning of the facilities on site.

The implementation of the safe decommissioning of the plant is a unique complex case and expected to span several decades: the IAEA Review Team considers that it will therefore require sustained engagement with stakeholders, proper knowledge management, and benefit from broad international cooperation.

Acknowledgements and Advisory Points

This report provides highlights of important progress (Acknowledgments) in 17 areas covering current situation of TEPCO's Fukushima Daiichi NPS and Roadmap implementation, follow-up of the previous IAEA review missions, public communication, strategy and planning for the decommissioning, institutional and organisational issues and specific topics such as water management including management of ALPS treated water stored in tanks, spent fuel removal and fuel debris retrieval and solid waste management.

The report also offers 21 Advisory Points where the IAEA Review 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.

Following is a summary of Acknowledgments and Advisory Points:

1. CURRENT SITUATION OF TEPCO'S FUKUSHIMA DAIICHI NPS AND ROADMAP IMPLEMENTATION

The IAEA team's review of the current situation of Fukushima Daiichi NPS was based on advance information provided by Japanese counterparts in support of the review Mission, detailed discussions on extensive presentations from Japanese counterparts, and visits to the Fukushima Daiichi site and Naraha Centre for Remote Control Technology Development, JAEA.

While the situation remains complex and challenging, the IAEA Review Team notes that since the last mission in February 2015 the on-site conditions have markedly improved in many aspects, both technically and institutionally, with a noticeable evolution in safety and risk management. Such improvements include:

- The operation of countermeasures such as the subdrain repair and frozen soil wall to substantially reduce the production of contaminated water from approximately 490 m³/day average in FY2015 to approximately 200 m³/day average in first half of FY2018. As of October 2018, about 1,100,000 m³ of treated water is stored on-site, vs. 600,000

m³ noted in the February 2015 review;

- Preparations for removal of spent fuel from the Unit 3 pool are well advanced, with the removal of large rubble from the pool, and the installation of the dome roof, Fuel Handling Machine (FHM) and crane. Preparations for removal of spent fuel from the Unit 1 pool are progressing, with removal of the roof cover and wall panels allowing the clearing of the refuelling floor to proceed. Preparations for removal of spent fuel from Unit 2 are progressing with the installation of the antechamber allowing investigation and clearing of the refuelling floor;
- Identification of the fuel debris deposits in Units 1-3 has progressed, with internal PCV (Primary Containment Vessel) investigations ongoing supporting eventual fuel debris sampling and the development of retrieval methods;
- The management and storage of solid radioactive waste has benefitted from waste minimization strategies and waste segregation according to dose rate and waste type. Construction and operation of facilities for consolidation of storage and volume reduction treatment/incineration facilities are under way to address the accumulation of solid waste;
- Site clean-up and paving to enhance the working radiological environment for employees of TEPCO and its contractors (currently around 4,500 workers) has greatly increased the areas where ordinary clothing with disposable dust mask may be used. Improvements in the working environment supporting worker comfort and safety have been implemented;
- Deployment of mobile equipment for a response to earthquake / tsunami to higher elevation parts of the site has been implemented. That should ensure availability of means to provide cooling of the spent fuel and fuel debris and station power recovery after an earthquake / tsunami event. Establishment of a tide embankment, closing of building openings and treatment of stagnant water in the buildings are some of the measures that have been completed or are currently being implemented to mitigate the consequences of a potential tsunami event.

Overall, the leadership and management team demonstrated a strong sense of ownership and technical command of their respective project standings, and the strategies for achieving project objectives. In addition to the many technical changes positively affecting the current situation, the IAEA Review Team noted great improvement against 2015 Mission in the implementation of a safety culture by all levels of the workforce, supported by earnest safety review processes and feedback systems.

The Mid- and Long-Term Roadmap towards the decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station is in its fourth revision. Revisions of the Roadmap were issued twice between 3rd and 4th review missions to Japan. The scope of the current Roadmap relates to the management of clean-up activities for the Fukushima Daiichi site and the decommissioning of Units 1-6. The publicly available Roadmap provides visibility of the decommissioning activities at Fukushima Daiichi site and acts as a tool to engagement with the public and local communities.

In response to public concerns regarding the long time-scales for management of contaminated

water and decommissioning, METI made the decision to set clear short-term roadmap milestones in the fourth revision to the road map. In addition, recommendations from NDF led to an update of the fuel debris policy (partial submersion with side access to the PCV) and incorporation of the basic principles of containment and isolation as the approach to waste management.

Implementation of the Roadmap is elaborated through the NDF's annual Technical Strategic Plan last published in October 2018. Underpinning the Roadmap is an extensive research and development programme under the direction of NDF which involves several Japanese and international technical organizations.

Acknowledgement 1

The IAEA Review Team acknowledges the efforts by Japan in the development, implementation and communication of the Roadmap activities including incorporation of regular revisions. The establishment of advisory committees and consultations with Japanese and international experts bring useful contribution to the definition of the programme.

2. FOLLOW-UP OF THE PREVIOUS IAEA DECOMMISSIONING MISSION CONDUCTED IN 2015

Japanese counterpart has prepared detailed summary of responses to advisory points from the IAEA previous missions in 2013 and 2015. All the advisory points were accepted and comprehensive works on advancing their implementation have been carried out.

Regarding advices from 2015 Mission, Japan assessed that among 22 advices (15 advices from the Mission in February 2015 and 7 advices from the follow-up expert visit in April 2015) 11 advices continue to be implemented while 11 advices appear completed.

The IAEA Review Team recognizes an intensive effort by Japan to carefully address all advisory points and to work on their effective implementation. Significant examples of work on previous advisory points are as follows:

- Clarification of the roles and responsibilities of different institutions and organizations involved in planning, decision making and implementation of decommissioning works and related R&D activities (related to the Advisory Point 2 from February 2015);
- Comprehensive set of activities related to strengthening of safety culture, training of workers and communication with stakeholders (related to the Advisory Point 3 from February 2015);
- New methodology introduced and work done on assessments of existing risks and their prioritization (related to the Advisory Point 15 from February 2015 and the Advisory Point 5 from April 2015);
- Planning related to construction of facilities for storage and treatment of solid radioactive waste (related to the Advisory Point 11 from February 2015);
- Waste minimization, recycling and reuse of materials (related to the Advisory Point 8

from February 2015);

- Progress in R&D activities related to physical and radiological characterization of the fuel debris and to development of techniques for the fuel debris retrieval (related to the Advisory Point 4 from December 2013);
- Set of activities related to the management of groundwater and contaminated water and prevention of water leakages (related to the Advisory Point 10 from December 2013).

The IAEA Review Team agrees with the counterparts' summary of responses to advisory points from the previous missions, and with the proposed classification of actions as "completed" or "continue to be implemented". All the items marked as "completed" can be considered closed.

Acknowledgement 2

The IAEA Review Team appreciates the consideration given to the advisory points from the previous review missions and acknowledges the efforts of NDF, TEPCO and other Japanese organizations and institutions to effectively implement them into the arrangements and practices related to the decommissioning of the Fukushima Daiichi NPS.

3. MANAGEMENT OF ALPS TREATED WATER STORED IN TANKS

As stated in previous review missions, the IAEA Review Team is of the opinion that the present plan to store the ALPS treated water containing tritium and other radionuclides in above ground tanks, with a current capacity of 970,000 m³, can only be a temporary measure while a more sustainable solution is needed. As the IAEA Review Team believes that high level of transparency is needed, it sought clarifications from METI and TEPCO during the mission on the information which came to public light recently regarding the presence of radionuclides at higher concentration than current regulatory limit for discharge. The content of radionuclides in the tank and the technical feasibility to further treat this water were discussed.

Currently, the Government of Japan is considering five solutions including the possible resumption of controlled discharges to the sea, which are routinely used by nuclear power plants and fuel cycle facilities in Japan and worldwide, and for which a large amount of information is readily available.

Under the current site facility plan regarding tank construction capacity of 1.37M m³, the storage of ALPS treated water is expected to reach full capacity within coming three to four years. The physical constraints of the site (the southern half of the site is largely occupied by the tanks, the northern half of the site is needed for waste storage and processing facilities) leave little room for additional tanks beyond 1.37M m³. Further treatment of the stored ALPS treated water may be conducted to reduce the radionuclides content to an authorized level as needed¹ before implementing any of the five solutions being considered by the Japanese Government (ground injection, controlled discharge into the sea, discharge as steam, discharge as hydrogen and solidification followed by underground burial). For all options, the disposition path of the water

¹ As TEPCO expressed at the Sub-committee on handling of ALPS treated water (October 1, 2018)

will require management, monitoring and control to ensure that the water to be dispositioned meets regulatory requirements.

Acknowledgement 3

The IAEA Review Team acknowledges the work done by METI to identify possible technologies to remove tritium and assess possible disposition paths. The IAEA Review Team also acknowledges ongoing dialogue with all stakeholders, and especially with the local communities. The IAEA Review Team also takes note of the statements issued by the Nuclear Regulation Authority (NRA) on this issue.

Advisory point 1

The IAEA Review Team holds that a decision on the disposition path for the stored ALPS treated water containing tritium and other radionuclides, after further treatment as needed, must be taken urgently, engaging all stakeholders, to ensure the sustainability of the decommissioning activities and of the safe and effective implementation of other risk reduction measures.

After the decision on the disposition path is made, TEPCO should prepare and submit to the NRA for authorization a comprehensive proposal for its implementation in conformity with laws and regulations, supported by such items as a safety assessment and analysis of the environmental impacts, including control of the water before disposition, to address radiation safety of the public, workers and environment.

To support the implementation of the chosen disposition path, a robust comprehensive monitoring programme and a communication plan are necessary to ensure regulatory compliance as well as proactive and timely dissemination of information to stakeholders and general public.

4. PUBLIC COMMUNICATION

TEPCO's communications policies have evolved in recent years, partly in response to delays or omissions in reporting on radiation data or events at the Fukushima Daiichi site. TEPCO's communications strategy is based on the principle that relevant information must be shared with the public in a timely, accurate and easy-to-understand manner in order to meet the needs and maintain the trust of all stakeholders, as well as to dispel any harmful rumours. This strategy, which includes the regular publication of radiation data on the TEPCO website, is also reflected in the latest revised Roadmap.

In early October 2018, however, TEPCO reported to the Sub-committee on handling of ALPS treated water that ALPS treated water stored on site contains other radionuclides besides tritium at levels above current regulatory release limits. While TEPCO has been posting these data on its website since 2015, the company had not provided an easy-to-understand explanation for it to the public.

Acknowledgement 4

The IAEA Review Team recognizes that TEPCO has strengthened its process for sharing information with the public, including by publishing radiation data on its website. In addition, the Government of Japan has set up the Sub-committee on handling of ALPS treated water which holds hearings for the public to ask questions and voice concerns, providing important feedback for members of the Sub-committee and officials.

Advisory Point 2

The IAEA Review Team advises to the Government of Japan and TEPCO to take a proactive and timely approach to communicating with the public on matters directly relevant to public concerns. This includes not only disclosing relevant information and data on a regular basis, but providing the general public the information in an easy-to-understand manner, including an explanation of its potential impact on the health and safety of the workforce and public as well as the protection of the environment.

5. STRATEGY AND PLANNING FOR THE DECOMMISSIONING OF TEPCO'S FUKUSHIMA DAIICHI SITE

STRATEGY AND PLANNING

The scope of the latest revision of the Roadmap (<http://www.meti.go.jp/english/earthquake/nuclear/decommissioning/index.html>) relates to management of clean-up of the Fukushima Daiichi site and the decommissioning of Units 1-6. The guiding principle underpinning the Roadmap is ensuring safety of the workforce, public and the environment through the prioritization of risk reduction measures. With the move from the emergency response phase and the transition towards controlled waste management and decommissioning activities, it is recognized there is a shift to a project orientation for addressing the key activities that contribute to risk reduction.

This project approach is incorporated into the 2017 revision of the Roadmap and focuses on the following programs: contaminated water management, fuel removal, waste management, fuel debris retrieval and communication. Each programme has specific mission objectives although the decommissioning end-state is difficult to define at this stage. Within TEPCO the programs are supported by functions related to safety and risk management, communication, HR management, supply chain management and knowledge management. To support this change of strategy TEPCO is anticipating to reorganize to provide greater alignment between the Roadmap and the projects.

Acknowledgement 5

The IAEA Review Team acknowledges the improvement that the Government of Japan, NDF, TEPCO and other organisations have made on revising and developing the strategy for the decommissioning of TEPCO's Fukushima Daiichi NPS. There is evidence of a risk prioritisation based on the radioactive content of the waste materials, as well as on their physical properties

and the conditions and environment in which they currently exist. This resulted in refocusing efforts on the removal of spent fuel and fuel debris retrieval, and aids the long-term planning and risk assessment of implementation initiatives.

Advisory Point 3

The IAEA Review Team advises the Government of Japan and NDF to prepare themselves now in order to develop during Phase 3 an integrated plan for the completion of decommissioning of the entire Fukushima Daiichi site, including all six units, the ancillary waste treatment and storage facilities, and the management of all forms of radioactive waste arising during the decommissioning activities. Careful consideration should be given to the assumptions used and how to express the inherent uncertainties involved. In order to successfully produce such a plan, significant effort is expected to be required to determine the options and scenarios that lead to a credible plan for the long term.

PROJECT MANAGEMENT

Progress has been made within both NDF and TEPCO on implementation of their programme and project management approaches. It is essential that NDF and TEPCO are coordinated in the focus and priorities to be addressed through the alignment of the NDF Strategic Plan and the TEPCO implementation plans. Because of the complexity and inter-dependency of the programmes, particularly with the growth in waste inventory, it is not always immediately apparent what the overarching goals and focus are. The programme management approach, alongside other tools, can be used to confirm the relative priorities, constraints, inter-dependencies and map the decisions that need to be taken, and importantly, by when.

Given the long timescales involved in accessing and assessing the fuel debris to be retrieved, many solutions are being designed and evaluated before the full nature and properties, or indeed location, of the debris is known. The projects and programmes associated with retrieval and the subsequent treatment and storage are therefore subject to significant uncertainty. This brings the likelihood of late design changes; which will consequently impact on safety assessment, training and construction, as well as operating requirements.

TEPCO indicated it recognizes that the evolution of the Fukushima Daiichi project, starting from emergency response and stabilization to long term decommissioning and waste management, will require different planning and project management capabilities. Improvements to enhance the project management capabilities are being implemented including the development of a Work Breakdown Structure (WBS) and the use of more sophisticated project management tools. A Project Management Organization (PMO) in TEPCO has been established and is working with the Program Supervision & Support Office (PSO) in NDF, to implement full project management by the spring 2020.

Acknowledgement 6

The IAEA team believes that the establishment of the PMO is a good decision and the use of more sophisticated project management tools will improve TEPCO's project delivery and analysis capabilities.

Advisory Point 4

The IAEA Review Team recommends that TEPCO use the project management tool to its full potential by developing a resource loaded schedule for each individual project or activity identified in the WBS and integrating those schedules into a master Fukushima Daiichi project schedule. Integrating all of the individual project activities into a master schedule will help identify constraints on resources, potential conflicts and insertion points for new technology from R&D activities.

Advisory Point 5

The IAEA Review Team advises that programme and project decision making focus on management of the uncertainties, and hence risks to delivery of the schedule and overall programme.

R&D TO SUPPORT DECOMMISSIONING PROJECT***Acknowledgement 7***

The IAEA Review Team appreciates the substantial efforts being undertaken to plan and carryout research and development (R&D) activities to support the Fukushima Daiichi decommissioning. Substantive R&D project outcomes have been produced thus far and capable state-of-the-art facilities with strategic domestic and international cooperation have been established. In particular, the Decommissioning R&D Partnership Council structure appears to be an adequate approach to identify and prioritize R&D needs with input from all relevant parties.

Advisory Point 6

TEPCO has demonstrated a robust approach to technology selection, development and deployment, and is aware of the challenges and risks associated with first-of-a-kind technology deployment that inevitably give rise to schedule uncertainties. The IAEA Review Team advises TEPCO to consider implementation of international good practice approaches to technology maturation and deployment as well as development of contingency plans to accommodate any schedule delays.

SUPPLY CHAIN AND MANAGEMENT SYSTEM

Supply chain management and interface management have to be controlled by the operator. When planning and implementing decommissioning or radioactive waste management activities, project managers responsible for carrying out the work must effectively monitor the subcontractor delivery and/or implementation activities. This becomes more important when managing complex interfaces such as with international partners and suppliers. Effectively managing these interfaces will decrease the likelihood of inaccurate execution of design solutions and the occurrence of unexpected situations during procurement and installation of equipment.

Provisions for unexpected situations during decommissioning activities should also be considered.

Provisions might include technical measures as well as organizational alternative actions to be implemented in case that unexpected events occur. The latter is an advisable approach for any nuclear facility under decommissioning but is a more complex challenge for the Fukushima Daiichi facility facing post-accident challenges.

Advisory Point 7

The IAEA Review Team recommends that TEPCO review and strengthen their interface management processes especially for complex situations involving multiple parties and international suppliers. Emphasis should be placed on ensuring the parties understand the technical specifications and programmatic requirements. Periodic joint progress reviews including reviews and inspections at the locations where work is performed are essential to ensuring that interface issues are identified and managed at the earliest possible time to avoid impacts later in the project.

6. INSTITUTIONAL AND ORGANISATIONAL ISSUES

The report of the previous mission recognised the profound nature of the change from nuclear power plant operations, to site stabilization activities during transition, and into radioactive waste management and decommissioning activities. It is also recognised the unusual nature of this transition for Fukushima Daiichi, where the speed and urgency required in responding to the nature of the situation is beyond the norm of a standard decommissioning site. Japan has responded to the significant changes at the site with changes to the institutions surrounding these activities. During the 2015 Mission, NDF was a new body and there has been significant development of its role in the subsequent three years. With the complexity of the developing situation and the number of actors, it is essential to continually clarify and reinforce the roles and responsibilities of the various institutions and organisations, throughout the layers of all those institutions and organisations.

ROLE AND INTERACTION BETWEEN NDF AND TEPCO

Acknowledgment 8

The IAEA Review Team acknowledges the establishment and full operational status of the NDF and of the TEPCO's Fukushima Daiichi Decontamination and Decommissioning Engineering Company. The IAEA Review Team acknowledges the clarification of the roles and responsibilities of the main actors: METI, NDF, TEPCO (FDEC), IRID, JAEA, and the attention given to the coordination of their respective roles and responsibilities.

Advisory Point 8

The IAEA Review Team takes note of the additional roles given to NDF, and the corresponding interactions between NDF and TEPCO. In the current scheme, NDF has an operational role of strategic planning and the role of oversight of TEPCO, while TEPCO has the responsibility for the implementation as a licensee. The IAEA Review Team advises Japan to ensure clear

accountability of respective roles and responsibilities between and among NDF and TEPCO, and to create the condition for TEPCO to have the necessary ownership of the solutions that it will implement.

LICENSING PROCESS

Acknowledgement 9

The IAEA Review Team acknowledges that TEPCO has a now well established monthly and weekly communication with NRA, organized within a transparent framework.

Advisory Point 9

In complex situations such as the post-accident situation of the Fukushima Daiichi site, some specific regulatory and licensing criteria may need to be defined when the criteria used in normal situations cannot be applied. The IAEA Review Team advises METI, NDF and TEPCO to maintain engagement with NRA to develop a common understanding of the safety requirements for the performance of the decommissioning of the site and to optimize the risk reduction strategy.

KNOWLEDGE MANAGEMENT

Effective realization of the full spectrum of knowledge management principles is essential to maintaining the necessary technical expertise and competences required for nuclear power programmes and other nuclear technology.

Appropriate technical expertise must be developed and kept available throughout the programme life-cycle. Advanced and specialized knowledge in nuclear engineering and science is required for the safe and effective licensing, maintenance and decommissioning of nuclear technology-based systems, which may have long life-cycles in changing contexts.

The ability of organizations that operate or utilize nuclear technology to take safe decisions and actions can be affected by knowledge gaps or knowledge loss. Appropriate knowledge management methods and supporting technology are needed to establish and manage nuclear knowledge, competencies, information and records, work processes, data interpretation, and analysis and verification techniques.

Effective knowledge management systems help achieve these objectives.

Advisory point 10

The IAEA Review Team encourages TEPCO to develop knowledge management systems that encompass all facets of the relevant workforce (TEPCO and subcontractors) considering the specific requirements of the conditions and life-cycle stage of the site's facilities for the next several decades.

TRAINING AND HUMAN RESOURCES DEVELOPMENT

TEPCO created the Nuclear Education and Training Centre that operates at Fukushima Daini NPP. The education and training programme was designed by adopting the Systematic Approach to Training (SAT), which is globally recognized and practiced. All pertinent site work functions are broken down into knowledge and skill elements, and the required training points for each element are clearly specified. Lesson plans are developed by incorporating these required training points into teaching materials. The effectiveness of the programme is regularly evaluated at each organizational level in TEPCO. A group responsible for the planning function and a group managing the training delivery were established.

An education and training programme is provided, which is necessary for human resource development across the entire NPP including decommissioning. Furthermore, education and training courses for each category of technology related to Fukushima Daiichi decommissioning work have been set up to maintain and improve the technological capabilities.

Acknowledgment 10

The IAEA Review Team endorse the creation of the Nuclear Education and Training Centre to facilitate the human resource development function, and which is now consolidated into an organization directly under the control of Director of the Nuclear Power & Plant Siting Division, thereby utilizing resources more efficiently. The IAEA Review Team also acknowledges that the education and training programme is designed following the Systematic Approach to Training.

Advisory point 11

The IAEA Review Team recommends that TEPCO and the PMO utilize the integrated project management tool to maintain an estimate of the number and categories of workers required during different phases of the Fukushima Daiichi project. This would include tracking worker demographics to identify hiring and training requirements.

SAFETY AND RADIATION PROTECTION

As previously stated the role of the site operator to maintain safety remains paramount, with a solid foundation of a nuclear safety culture and leadership critical to achieving this. TEPCO is progressing well to reinforce safety culture; after holding the IAEA “Safety Culture Workshop” TEPCO adopted WANO’s 10 Traits of a “Healthy Nuclear Safety Culture”. Headquarters management, site executives, chief engineers and all employees in the nuclear department are engaged in the safety culture programme. A proven aspect in improving the safety performance of teams is having a more diverse team so that different styles of thinking are brought to bear on problems.

Acknowledgement 11 (Safety leadership and safety culture)

The IAEA Review Team recognises the safety leadership that TEPCO, who have primary responsibility as Operator and Licensee, have shown in the period since the last mission in

developing a safety culture at the Fukushima Daiichi site. They have made significant progress in addressing their understanding of the expectations and requirements of the nuclear safety culture in a decommissioning environment. In addition, the IAEA Review Team applauds the adoption of the WANO Traits of a Nuclear Safety Culture and the implementation of systems to measure their organizational performance, with review of the results of the safety culture programme.

Acknowledgment 12 (Occupational Radiation Protection Programme)

Measures for occupational safety and health management have been enhanced at the TEPCO Fukushima Daiichi NPS as required by the Ministry of Health, Labour and Welfare guidelines from August 2015. Radiation Protection Programme, Guidelines for dose exposure reduction management and Guidelines for organization and operation of ALARA committee has been reviewed and revised. Those guidelines are in full practical implementation under the TEPCO's Committees responsible for risk management.

The site working conditions are improved because of the paving action at the site, better work planning by the ALARA Committee, improvement on the protective gear and real-time radiation monitoring. The workers dosimetry and health surveillance programme takes into consideration the demanding and difficult working conditions.

Advisory Point 12 (Safety leadership and safety culture)

The IAEA Review Team encourages TEPCO to promote the safety culture of all workers on site including its contractors, and to continue to consider the specific requirements of the conditions and life-cycle stage of the site's facilities that differ from a normal operating environment, and continue to develop a safety culture management system appropriate to radioactive waste management and decommissioning.

Advisory Point 13 (Occupational Radiation Protection Programme)

TEPCO is encouraged to provide for further optimization of radiation protection exposure by analysing the workers exposure data for all facilities and types of operation, so as to identify optimization options and dose reduction factors. This is valuable information for current and future actions at the site.

INTERNATIONAL COOPERATION

Acknowledgement 13

The IAEA Review Team acknowledges the development of bilateral cooperation on a number of important topics such as Research and Development, risk assessment and prioritization or communication, and the adoption of internationally recognized practices. The IAEA Review Team also acknowledges the proactive stance of Japan to share with international community the status of decommissioning activities.

Advisory point 14

The IAEA Review Team advises Japan to further develop a broad array of international cooperation in all domains. Such international cooperation has the potential to bring significant benefits to the safe decommissioning of the Fukushima Daiichi site and to increase knowledge sharing with the international community. The Review Team encourages Japan to draw upon the global diversity of international good practices, and to integrate and adapt them to fit the unique Fukushima Daiichi site situation.

7. SPECIFIC TOPICS**MANAGEMENT OF CONTAMINATED WATER AND COUNTERMEASURES AGAINST GROUNDWATER INGRESS*****Acknowledgement 14***

The IAEA Review Team commends TEPCO for implementing the full set of the countermeasures against the groundwater ingress into the damaged facilities and against leakage of contaminated water from the buildings and from the site, thus contributing to reduction in the generation of contaminated water and to the protection of the workers, public and the environment, and the management of the site boundary dose.

Advisory point 15

The injected water cooling of the fuel debris mixes with ingressed water and contributes to the generation of contaminated water. The IAEA Review Team encourages TEPCO to perform analyses of the needs for continuous cooling and, depending on the results, to consider further reducing the amount of injected water, ending injected water cooling at some point, or establishing a closed cooling loop.

SPENT FUEL REMOVAL AND FUEL DEBRIS RETRIEVAL

Access to the spent fuel pool is very challenging in Units 1-3 due to the extensive accident debris and contamination. Unit 3 has progressed very well with the clearing of the refuelling floor, subsequent addition of shielding, construction of the protective domed roof and installation of the fuel handling machine and crane. As each unit presents unique conditions, TEPCO appropriately considers options for managing risks of spent fuel and fuel debris retrieval.

The IAEA Review Team recognizes the significant R&D effort around fuel debris and appreciates the effort to share worldwide the experiences and knowledge gained on fuel debris retrieval and management through international organizations. CLADS (Collaborative Laboratories for Advanced Decommissioning Science) in JAEA can play an important role in allowing experts from abroad to help and support Japan in the characterisation of this material and using the results to further the international understanding of the behaviour of fuel in accident conditions. The international cooperation developed by METI, NDF and IRID is also bringing useful benefits.

Acknowledgment 15 (Spent fuel)

The IAEA Review Team acknowledges the careful and deliberate approach to the spent fuel removals across the site. The team recognizes the many good practices such as; the adaptation of safety controls to the conditions in each Unit, providing hands-on training of the workers, using dummy fuel and casks on the remote operation of the new FHM and crane in Unit 3 before starting the real operation, and measures taken to reduce dust production during rubble and spent fuel removal operations for the radiological protection of the workers and the environment.

Acknowledgment 16 (Fuel debris)

The IAEA Review Team also acknowledges significant progress is achieved in clarification of the fuel debris distribution inside the reactor building of Units 1-3 since the 3rd Review Mission, and the step-by-step approach (from internal PCV investigation, fuel debris sampling and characterization, small scale retrieval to bulk retrieval) currently considered for the fuel debris retrieval.

Advisory Point 16 (Spent fuel)

The IAEA Review Team advises to take measures to ensure enough storage capacity will exist among the common spent fuel pool and dry cask storage areas to accommodate all spent fuel on site from Units 1-6.

Advisory Point 17 (Spent fuel)

The IAEA Review Team advises that the different categories and characteristics of all fuel assemblies on the site be fully considered with regard to conditions affecting its safe management (retrieval, transport and storage). Substantial international experience is available in the management of both intact and damaged BWR spent fuel (e.g. USA, Germany, etc.) that may be drawn upon. While there are as yet no indications of fuel assemblies damaged by the accident, the plan should incorporate the ability to design and store, in the pool and casks, all anticipated fuel assembly conditions.

Advisory Point 18 (Fuel debris)

The IAEA Review Team advises that before the commencement of the fuel debris retrieval activities, there should be a clear implementation plan defined to safely manage the retrieved material. TEPCO should assure that appropriate containers and storage capacity are available before starting the fuel debris retrieval. Sufficient characterization (e.g. estimation of criticality, hydrogen emission, neutron activity, thermal condition, parameters of neutron-multiplying medium, etc.) of the fuel debris environment will support successful safe debris retrieval and design of related facilities and equipment including containers.

Advisory Point 19 (Fuel debris)

Whilst significant progress is achieved in estimation of the fuel debris distribution inside the reactor building of Units 1-3, there is recognition that more must be done. The IAEA Review Team supports continuing efforts to more precisely understand the fuel debris distribution inside each unit, and the associated level and distribution of radiation encountered.

MANAGEMENT OF RADIOACTIVE WASTE

The management of solid radioactive wastes is an on-going, complex challenge for the Fukushima Daiichi project because of the accumulating large volumes and diverse types of wastes combined with the limited space to store and manage the wastes on site. The wastes include rubble (concrete and metal), felled trees, used protective clothing, contaminated soil, and secondary wastes from water treatment such as sludges and adsorption towers. The current volume of post-accident waste is reported to be in excess of 400,000 m³ and the volume is projected to increase to 770,000 m³ in ten years without additional countermeasures, respectively to 250,000 m³ with implementation of currently planned measures such as volume reduction. The management of these wastes is complicated because without further characterisation and disposal concept only temporary stabilization and storage measures can be implemented. Countermeasures are being deployed to stabilize and reduce the volumes of wastes to allow for on-site storage until final disposal decisions can be made. In addition to the accumulating solid waste arising from the initial site decontamination and fuel retrieval preparations, there is a substantial volume of additional waste that will arise once decommissioning of the defueled units, and the existing and future support facilities begins in earnest.

Acknowledgement 17

The IAEA Review Team is of the opinion that good progress has been made with this very complex series of decommissioning and waste management projects in the face of many significant challenges and constraints. Good progress has been made in establishing strategies to reduce the volume of wastes, create storage capacity and enhance the stability of wastes by using methods such as incineration and dewatering.

Advisory Point 20

The IAEA Review Team recommends that, in considering the overall duration of the Fukushima Daiichi decommissioning activities, the Mid- and Long-term Roadmap and other planning documents address operational waste present on site at the time of the 2011 accident and the present production of waste from the initial site decontamination and fuel retrieval preparations. In addition, the IAEA Review Team encourages to envisage the generation of waste arising from the decommissioning of 6 units and supporting facilities through the completion of decommissioning, recognizing that at this point in time, significant uncertainty exists in the decommissioning approach and thus the volumes involved. This will help ensure there is an adequate allocation of resources to manage, characterize, treat and dispose of these wastes and that the work activities for these wastes can be properly sequenced with other activities.

Advisory Point 21

The IAEA Review Team encourages the NDF and TEPCO to continue to actively explore the application of waste hierarchy principles to minimize the volume of material consigned for disposal. Routine use of pre-treatment techniques of sorting, segregation and decontamination of solid material after collection will create opportunities for recycle of material as well as providing the possibility to remove material from regulatory control. The IAEA Review Team encourages the Government of Japan to support TEPCO in such approach.