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International Atomic Energy Agency

Review Report

IAEA Follow-up Review of Progress Made on Management of ALPS Treated Water and the Report of the Subcommittee on Handling of ALPS treated water at TEPCO's Fukushima Daiichi Nuclear Power Station

Vienna, Austria

2 April 2020

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REVIEW REPORT TO THE GOVERNMENT OF JAPAN

Vienna, Austria

2 April 2020

REVIEW REPORT

Official request of the Review: 10 February 2020

Location: IAEA Headquarters, Vienna, Austria

Organized by: International Atomic Energy Agency

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Issue Date: 2 April 2020

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EXECUTIVE SUMMARY

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. 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 four missions of the International Peer Review of the Roadmap (hereinafter referred to the "IAEA Peer Review mission"), in April 2013, in November/December 2013, in February 2015 and November 2018, respectively. Those missions aimed at assisting the Government of Japan in the implementation of the Roadmap as well as at enhancing international cooperation and sharing with the international community information and knowledge concerning the accident to be acquired in the future decommissioning process.

Contaminated water from Fukushima Daiichi NPS is treated by Multi-nuclide removal equipment (hereinafter referred to the "ALPS") and stored in tanks at the site. Within the scope of the current construction plan, the total tank storage capacity will be increased to approximately 1.37 million m^3 by the end of 2020, however all tanks are expected to be full around the summer of 2022. A series of advisory committees of the Government of Japan have been studying the solution to the problem of contaminated water, including handling of ALPS treated water, since 2013. All four IAEA Peer Review missions have also advised on this point. For example, a key advisory point of the last Review mission[1] was to recommend the Government of Japan to take a decision urgently on the disposal of "ALPS treated water" which keeps on accumulating in tanks stored on site.

The Subcommittee on Handling ALPS Treated Water (hereinafter referred to the "ALPS Subcommittee"), an advisory committee to the Government of Japan, concluded its report on 10 February 2020 to show available options for disposition of the ALPS treated water and submitted it to the Government of Japan. The report outlines the potentially available options for the disposition of the ALPS treated water. The Government of Japan provided IAEA the report as informing progress on the advisory point in the report of IAEA Peer Review mission in 2018. The Ministry of Economy, Trade and Industry requested IAEA to review the progress made in water management, including a review of the ALPS Subcommittee report, in an official correspondence dated 10 February 2020 through the Permanent Mission of Japan in Vienna.

[1] Advisory Point 1 of the IAEA Peer Review mission (5-13 November 2018) report (dated 31 January 2019):

"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 developed by TEPCO and approved by the NRA, supported by a communication plan ensuring a proactive and timely dissemination of information to stakeholders and general public are necessary."

Main Findings and Conclusions

The IAEA Review Team considers that the daily activities pertaining to water management (namely, implementation of the multi-layered approach including sub-drain and the "frozen soil wall" completed in 2018) are well managed, and have resulted in further improvements in the reduction of the ingress flow of water. The IAEA Review Team also notes the objective set in the revision of the Mid-and-Long-Term Roadmap issued in December 2019 to further reduce the contaminated water generation to an average of 150 m^3 per day within 2020 and 100 m^3 or less per day within 2025.

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 in the tanks containing tritium and other radionuclides.

The IAEA Review Team welcomes the progress made towards decision making, and the report of the ALPS Subcommittee issued on February 10th, 2020. The IAEA Review Team notes that this report has been prepared by the Subcommittee experts through an iterative process which has included hearings with the most directly involved stakeholders. The IAEA Review Team positively notes that this report addresses technical, non-technical and safety aspects necessary to make a decision.

Regarding the technical aspects, the IAEA Review Team considers that the recommendations made by the ALPS Subcommittee are based on a sufficiently comprehensive analysis and on a sound scientific and technical basis. The IAEA Review Team considers that the proposed objective of completing the disposition of the ALPS treated water by the time of the end of the decommissioning work is aligned with current international good practices. The IAEA Review Team considers the two options (namely controlled vapor release and controlled discharges into the sea, the latter of which is routinely used by operating nuclear power plants and fuel cycle facilities in Japan and worldwide) selected out of the initial five options are technically feasible and would allow the timeline objective to be achieved.

With the volume of ALPS treated water expected to reach the planned tank capacity of approximately 1.37 million m^3 around the summer of 2022, and taking into account that further treatment to meet regulatory standards for discharge before dilution and control of the stored water before disposition would be needed for implementation of any of the solutions considered by the Government of Japan, a decision on the disposition path should be taken urgently engaging all stakeholders.

The safe and effective implementation of the disposition of ALPS treated water is a unique and complex case expected to span several decades. The IAEA Review Team considers that it will therefore require sustained attention, safety reviews, regulatory supervision, a comprehensive monitoring programme supported by a robust communication plan, and proper engagement with all stakeholders.

Once the Government of Japan has decided on its preferred disposition option, the IAEA is ready to work with Japan to develop a framework to provide radiation safety assistance before, during and after the disposition.

Following are General Acknowledgements and Advisory Points and Specific Acknowledgement and Advisory Point with more technical implementing nature not directly related to the ALPS treated water disposition path are conveyed by the IAEA Review Team:

General Acknowledgments

Acknowledgement 1

The IAEA Review Team acknowledges the work done by the ALPS Subcommittee to identify possible options for handling of the ALPS treated water, including potential technologies to remove tritium, and to assess possible disposition paths. The IAEA Review Team also acknowledges the ongoing dialogue with relevant stakeholders, and especially with the local communities. The IAEA Review Team positively notes that this report addresses technical, non-technical and safety aspects necessary to make a decision.

Acknowledgement 2

The IAEA Review Team considers that the proposed objective of completing the disposition of the ALPS treated water by the time of the end of the decommissioning work is aligned with current international good practices. It is also in line with the strategy of risk reduction on the site and with the principle of "coexistence of reconstruction and decommissioning" stated in the Mid-and-Long-Term Roadmap.

Acknowledgment 3

The IAEA Review Team considers that the review of possible technologies for tritium separation has been undertaken appropriately based on the Tritiated Water Task Force assessment. The IAEA Review Team is not aware of a solution currently available for the separation of tritium commensurate with the concentration and the volume of ALPS treated water.

Acknowledgment 4

The IAEA Review Team considers that the methodology and criteria used for the down selection from the initial five options for the disposition of ALPS treated water to two (namely: controlled vapor release, and controlled discharges[2] into the sea, the latter of which is routinely used by operating nuclear power plants and fuel cycle facilities in Japan and worldwide) are based on a sound methodology for the purpose of decision making. The two options selected are technically feasible and would allow the timeline objective to be achieved. The IAEA Review Team considers that the three other options would need much more development, which – even if proved feasible – would not be compatible with the timeline. The IAEA Review Team also notes that the ALPS treated water will be further purified as necessary to meet the regulatory standards for discharge before dilution.

[2] 'Discharges' are defined in the IAEA Safety Standards as "a planned and controlled release of gaseous, aerosol or liquid radioactive substances to the environment" (GSG-9).

Acknowledgement 5

The IAEA Review Team considers that the methodology used to estimate prospectively the radiological impact of the two solutions is appropriate at this stage for the purpose of informing the decision on the possible solution, and would allow the initiation of discussions with the national regulatory body (The Nuclear Regulation Authority, NRA). The IAEA Review Team positively notes the level of understanding of the methodology to assess radiation exposures to the public, and the efforts of the Japanese experts to adjust the well-established UNSCEAR methodology to the specific case of Japan.

Specific Acknowledgment 1

The IAEA Review Team commends TEPCO for implementing a full set of 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.

General Advisory Points

Advisory Point 1

The IAEA Review Team holds the view 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, considering safety aspects and engaging all stakeholders, to ensure the sustainability of the decommissioning activities and of the safe and effective implementation of other risk reduction measures.

Advisory Point 2

The IAEA Review Team holds the view that after the decision on the disposition path is made by the Government of Japan, 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 including the characteristics of the discharges and an analysis of the environmental impacts, and including control of the water before disposition, in order to address radiation safety of the public, workers and environment.

Advisory Point 3

The IAEA Review Team holds the view that to support the implementation of the chosen disposition path, a robust comprehensive monitoring programme, supported by a local, national and international communication plan ensuring a proactive and timely dissemination of information to all stakeholders and general public are necessary.

Advisory Point 4

The IAEA Review Team notes that the IAEA Safety Standards advises that, at a later stage, a similar methodology to that of UNSCEAR, with additional site-specific data, is used when undertaking the prospective dose assessment to support an application for the authorization of discharges.

Specific Advisory Point 1

The injected water used to cool 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.

1. BACKGROUND, OBJECTIVES AND RANGE OF THE REVIEW

1.1. 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 Council on Mid-and-Long-Term Response for Decommissioning in December 2011. The Roadmap is available on the website of the Ministry of Economy, Trade and Industry (METI): https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/111221_02.pdf.

The Roadmap was revised in July 2012, June 2013, June 2015, September 2017 and December 2019. 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 four 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, in February 2015 and November 2018, 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 Peer Review 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: https://www.iaea.org/sites/default/files/missionreport220513.pdf.

After the first mission, the Government of Japan and TEPCO revised the Roadmap taking into consideration the advice of 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 METI: https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20180530_01b.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, retrieval 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 the 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: https://www.iaea.org/sites/default/files/missionreport041213.pdf.

The third mission was implemented from 9 to 17 February 2015. The objective of the third

mission was to provide an independent review of the activities associated with revisions to the planning and implementation of Fukushima Daiichi NPS decommissioning, including the review of the current situation of TEPCO's Fukushima Daiichi NPS, follow-up of the previous IAEA Peer Review missions conducted in 2013, review of the draft of the second revision of the Roadmap, review of the draft of the Strategic Plans for decommissioning developed by Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF), review of the progress and future plans, including R&D activities, in specific areas such as management of contaminated water, countermeasures against groundwater ingress issue, removal of spent fuel assemblies and damaged fuel debris from Units 1-4, management of radioactive waste and institutional and organizational issues (i.e., allocation of responsibilities among the relevant bodies, staffing and training of workers, safety culture, communication with the public and dissemination of lessons learned). The Final Report of the third mission is available on:
https://www.iaea.org/sites/default/files/missionreport170215.pdf.

After the third mission, the Government of Japan and TEPCO took into consideration the advice given in the third mission report during the next revision of the Roadmap. The revised Roadmap entitled "Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station" (12 June 2015) is available on METI website:
https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20150725_01b.pdf.

Since the revision of Roadmap in June 2015, decommissioning and contaminated water management had progressed, and the site conditions has improved. The Roadmap was revised again and released on 26 September 2017 and is available on the METI website:
https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20170926_01a.pdf.

Following the request of Government of Japan in September 2018, the fourth mission of the International Peer Review of Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi NPS took place from 5 to 13 November 2018. The Government of Japan and TEPCO provided comprehensive information on the status and future plans for the implementation of the Roadmap. The IAEA Review Team assessed the updated information, and had extensive discussions with the relevant institutions in Japan, as well as visiting TEPCO's Fukushima Daiichi NPS, to better understand the current situation. The Final Report of the fourth mission is available on:
https://www.iaea.org/sites/default/files/19/01/missionreport-310119.pdf.

After the fourth mission, the Government of Japan and TEPCO took into consideration the advice given through the fourth mission report in the course of revising the Roadmap. The revised Roadmap entitled "Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station" (December 27, 2019) is available on METI website:
https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20191227_3.pdf

Contaminated water from Fukushima Daiichi NPS is treated by Multi-nuclide removal equipment (hereinafter referred to the "ALPS") and stored in tanks in the site. Within the scope of the current construction plan, the tanks are expected to be full around the summer of 2022. A series of advisory committees of the Government of Japan have been studying the solution to the problem of contaminated water, including handling of ALPS treated water, since 2013. All four IAEA Peer Review missions advised on this point. For example, a key advisory point from the last Review mission was to recommend the Government of Japan to take a decision urgently on the disposal of "ALPS treated water" that is accumulating in tanks stored on site.

On 27 September 2016, the Committee on Countermeasures for Contaminated Water Treatment established the ALPS Subcommittee on Handling ALPS Treated Water (hereinafter referred to as the "ALPS Subcommittee") to discuss the handling of the ALPS treated water from a wide-range of viewpoints, including societal perspectives, based on the options presented in the Tritiated Water Task Force Report. The ALPS Subcommittee published the report of its findings on 10 February 2020.

The Government of Japan provided this report to the IAEA informing the progress made against the sections "Management of ALPS Treated Water Stored in Tanks" and "Management of Contaminated Water and Countermeasures against Groundwater Ingress" of the 2018 IAEA Peer Review mission report related to the urgent disposal of 'ALPS treated water'. In addition, the Ministry of Economy, Trade and Industry in an official correspondence dated 10 February 2020 through the Permanent Mission of Japan, requested the IAEA review of the ALPS Subcommittee report in light of the Advisory Points in the fourth IAEA Review mission report.

1.2. OBJECTIVE

This Review is intended to follow up on the sections in the IAEA fourth Peer Review mission report (dated 31 January 2019) that address the "Management of ALPS Treated Water Stored in Tanks" and "Management of Contaminated Water and Countermeasures against Groundwater Ingress".

The objective is to conduct an independent review of the progress made in water management since the previous IAEA Peer Review and of the conclusions of the ALPS Subcommittee report to assist the Government of Japan in the implementation of the Roadmap.

The basis of the review are the IAEA Safety Standards, the relevant Safety Report Series publications, the relevant Nuclear Energy Series reports, the relevant IAEA TECDOCs and the conclusions of other IAEA Peer Review missions. Other publications used as references by Japan were also considered for the review (e.g. UNSCEAR 2016 Report on Sources, Effects and risks of ionizing radiation (published by United Nations Scientific Committee on the Effects of Atomic Radiation).

In particular, the Review is intended to:

- Provide considerations on the technological aspects and related safety considerations of water management, including the report of the ALPS Subcommittee;
- Provide considerations on the implementation of advisory points of the IAEA fourth Peer Review Mission report; and
- Facilitate sharing of good practices and lessons learned for related kind of operations after the accident with international community.

1.3. SCOPE OF THE REVIEW

The Review coves the following items:

Item 1: Review of ALPS treated water management status changes at TEPCO's Fukushima Daiichi NPS since the IAEA Peer Review mission in 2018;

Item 2: Review of how the advisory points provided by the IAEA Peer Review mission in 2018

or earlier were taken into account by the Government of Japan and the ALPS Subcommittee as well as review of the technical and scientific basis of the analysis of the disposition options considered by the ALPS Subcommittee (e.g., how was the methodologies of the ALPS treated water handling assessed and whether interaction with stakeholders took place, how the impact on the environment was addressed etc.); and

Item 3: Review of whether future actions to be conducted by the Government of Japan, proposed by the ALPS Subcommittee, are in line with the advisory points provided by the IAEA Peer Review mission in 2018 or earlier with respect to:

- Necessary steps for ALPS treated water disposition (i.e., the timeliness of deciding method of disposition of the ALPS treated water, additional decontamination (re-purification) measures, regulatory process, monitoring plan, research and development etc.); and
- Management of contaminated water before and during disposition of the ALPS treated water.

2. CONDUCT OF THE REVIEW

The Review, involving six IAEA professional staff, was conducted in February/March 2020 in Vienna, Austria. The list of IAEA experts involved and Japanese participants is provided in the Appendix. Internal work of the experts and web-conferencing (three) with the Japanese counterparts were the main modes of the Review itself.

The Japanese counterparts provided the Report of the ALPS Subcommittee and reference documents (see List of References provided by the Government of Japan). The reference documents were used by the experts for self-study and effective work during the Review. In addition, technical and safety related questions raised by the experts were addressed during web-conferences and subsequent exchange of information. Additional reference documents and comprehensive information were provided on request of the Review Team experts and introduced during web-conferences by the Japanese counterparts.

3. MAIN FINDINGS, ACKNOWLEDGEMENTS AND ADVISORY POINTS

3.1. THE SUBCOMMITTEE ON HANDLING ALPS TREATED WATER

A series of advisory committees of the Government of Japan have been studying solution to the problem of contaminated water, including handling of ALPS treated water, since 2013. All four IAEA Peer Review missions have advised on this point.

On September 27, 2016, the Committee on Countermeasures for Contaminated Water Treatment decided to establish the ALPS Subcommittee, an advisory committee to the Government of Japan, to discuss the handling of the ALPS treated water from a wide-range of viewpoints, including societal perspectives. The ALPS Subcommittee had its first meeting on November 11 in the same year.

The ALPS Subcommittee held hearings on the mechanism and actual conditions of reputational damage as well as the measures taken by the national and prefectural governments and others to address the issue. In addition, the ALPS Subcommittee organized explanatory and public hearing meetings to hear opinions regarding the ALPS treated water disposition path and concerns that could arise after the actual disposition. It has been also discussed that the reputational damage is not only associated with just Fukushima Prefecture, but Japan as a whole and that handling of the ALPS treated water should be examined after the thoughts and concerns from Japanese citizens are understood.

The ALPS Subcommittee concluded its report on 10 February 2020 to show the available options for disposition of the ALPS treated water and submitted it to the Government of Japan. The report outlines the potentially available options for the disposition of the ALPS treated water.

Acknowledgement 1

The IAEA Review Team acknowledges the work done by the ALPS Subcommittee to identify possible options for handling of the ALPS treated water, including potential technologies to remove tritium, and to assess possible disposition paths. The IAEA Review Team also acknowledges the ongoing dialogue with relevant stakeholders, and especially with the local communities. The IAEA Review Team positively notes that this report addresses technical, non-technical and safety aspects necessary to make a decision.

3.2. REVIEW OF ALPS TREATED WATER MANAGEMENT STATUS CHANGES SINCE THE IAEA PEER REVIEW MISSION IN 2018

At the Fukushima Daiichi NPS, there has been continuous cooling, as water has been poured on the melted fuel and fuel debris in the reactors, resulting in a certain amount of contaminated water being stagnant at the basement of the buildings. Due to the explosions within the reactor buildings and other incidents such as damage to the turbine buildings roofs, rainwater has been entering the reactor and turbine buildings, while groundwater has been entering them through

wall penetration by pipes, etc. The groundwater levels surrounding the buildings and contaminated water in the buildings are controlled to keep the groundwater level outside the buildings higher than the contaminated water level in the buildings, thus preventing contaminated water from leaking out of the buildings.

TEPCO continues to implement a comprehensive set of countermeasures to reduce the generation of contaminated water, to prevent leakages and uncontrolled releases into the sea, to purify the water by reducing the content of radionuclides and to store it safely on site. These measures are based on three strategies: 1) Removing the contamination source, 2) Redirecting groundwater away from the contamination source, and 3) Preventing leakage of contaminated water.

The ingress of groundwater and rainwater into the reactor buildings has been maintained at average levels of 100 m^3 per day on average in FY2018, due to the stable operation of the groundwater bypass, the sub-drain, the frozen-soil impermeable wall around the reactor and turbine buildings of the Units 1-4, and other countermeasures (i.e., paving surfaces on the site). The repair of the damaged building roof of Unit 1, planned to be completed in 2023, will further contribute to prevention of rainwater inflow. Although significantly reduced in comparison with the 440 m^3 per day in May 2014, the amount of the ingress of groundwater and rainwater still contributes to an annual increase of ALPS treated water of about 50,000-60,000 m^3 per year. ALPS treated water will continue to be generated for as long there is fuel debris in the reactor buildings that requires cooling, and stagnant water in the reactor and turbine buildings of the Units 1-4.

The recent revision of the "Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station" established new objectives to further reduce the generation of contaminated water to about 100 m^3 per day or less by 2025, and to reduce the amount of stagnant water in reactor buildings to about a half of that in the end of 2020 by 2022-2024.

In April-May 2019 TEPCO performed water injection reduction tests at the Unit 2, temporarily reducing the water injection rate from 3.0 to 1.5 m^3/h and from 3.0 to 0 m^3/h, and continuously monitoring the temperature change at the bottom of the reactor pressure vessel. The tests were performed with the primary purpose of optimizing the emergency response procedures, but the results are also useful for consideration of a potential future gradual reduction of cooling water injection, which will contribute to a reduction in the volume of contaminated water requiring ALPS treatment. The similar test was also performed at the Unit 1 in October 2019.

The ALPS multi-nuclide removal system continues to operate stably and reliably. The ALPS treated water is stored on site in welded-joint tanks, most of which have a capacity of around 1000 m^3 (977 tanks as of 20 February 2020). Double dikes have been constructed around the tank storage areas to mitigate against potential contamination of the surrounding area should any of the tanks leak. The total volume of ALPS treated water currently being stored is about 1.2 million m^3.

Mainly due to the efforts needed to implement other priority actions taken to reduce the dose levels at the site boundary to 1 mSv/year, the water treated with the ALPS system did not target the regulatory standards for discharge in its routine operation. The ALPS system has the capacity to routinely and consistently operates to remove 62 radionuclides, apart from tritium, below the regulatory standards for discharge into the environment. As of December 2019, approximately 28% of the total volume of the ALPS treated water stored in tanks meets the regulatory standards for discharge into the environment apart from tritium.

In the future, the stored ALPS treated water with radionuclides above the existing regulatory levels (~72% of the total volume of ALPS treated water as of December 2019) will be further purified as necessary by the ALPS system to meet the regulatory standards for discharge before dilution.

The water collected from the groundwater bypass and the subdrain systems is stored for radiological monitoring and treatment, if necessary, and is then discharged into the sea under an authorization by the regulatory body. The storage and discharge systems for that water are separate from the storage of the ALPS treated water. There have been more than 300 discharge campaigns for the water from the groundwater bypass and more than 1,000 discharge campaigns for the water from the subdrain. A total of around 1.4 million m^3 of water collected from the groundwater bypass and the subdrain systems has been discharged after a radiological monitoring performed by TEPCO and by an independent third-party to confirm satisfying the operational targets. An environmental monitoring program is ongoing.

Specific Acknowledgement 1

The IAEA Review Team commends TEPCO for implementing a full set of 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.

Specific Advisory Point 1

The injected water used to cool 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.

3.3. TRITIUM MANAGEMENT AND DISPOSITION OPTIONS CONSIDERED BY THE ALPS SUBCOMMITTEE

Tritium Disposition Options

The ALPS Subcommittee conducted a comprehensive assessment of the ALPS treated water disposition options presented in the 2016 Tritium Task Force Report. In addition, they also looked at other management options including continued storage (on-site and off-site) and tritium separation. Their assessment included looking at the options from both a technical and societal perspective as well as scientific fact checking of the underpinning assumptions and assertions.

As stated in the previous Review missions, the IAEA Review Team is of the opinion that to store the ALPS treated water containing tritium and other radionuclides in above ground tanks, can only be a temporary measure and more sustainable solution is needed. The ALPS Subcommittee report provides two possible solutions: controlled vapor release, and controlled

discharges into the sea, the latter of which is routinely used by operating nuclear power plants and fuel cycle facilities in Japan and worldwide, and for which a large amount of information is readily available.

Storage Options

The ALPS Subcommittee report presents a technical analysis of options for creation of additional storage capacity on-site (e.g. larger capacity tanks, underground tanks, sea-surface tanks) and highlights the shortcomings of each. These deficiencies include no significant increased capacity efficiency per unit area presented by alternative tank types and configurations and the potential for leakage and damage from natural disasters. The ALPS Subcommittee report also recognizes the operational constraints that construction of additional tanks on-site would present to the efficiency of the ongoing decommissioning activities. Many of the priority risk reduction decommissioning activities (for example, spent fuel and fuel debris retrieval and storage) will require space and flexibility to construct new facilities. Construction of new tanks on-site to store the newly generated ALPS treated water will limit the ability to accommodate these new essential facilities. In addition, ongoing storage rather than disposition is contrary to the important premise that disposition of the ALPS treated water will be complete on the same timescale as Fukushima Daiichi decommissioning activities.

It is the IAEA Review Team's assessment that the ALPS Subcommittee report's conclusion that increasing the on-site tank storage capacity to accommodate all generated ALPS treated water would not provide any benefits is rational and in line with the advice given in the 2018 Fourth Peer Review Mission Report related to ensuring the sustainability of Fukushima Daiichi decommissioning programme and effective implementation of all other necessary risk reduction measures. It is also important for the Review Team that at the time of making the decision on the optimal option for disposition it is noted that the operation of storage facilities also results in prolonged radiation exposures to workers.

Considering this conclusion, the ALPS Subcommittee also looked at the potential for off-site transfer and storage. The report outlines the challenges associated with off-site storage including identification and acquisition of a suitable site, regulatory and societal acceptance issues and the technical complexity of transferring safely large volumes of the ALPS treated water to another location. The ALPS Subcommittee concluded that off-site transfer and storage would require significant time and a wide range of advance coordination, that is not compatible with the timescales on which the Fukushima Daiichi will reach its capacity to store additional ALPS treated water.

From the data and analysis presented in the report, the Review Team concurs with the findings of the ALPS Subcommittee in this regard.

Tritium Separation Options

The Review Team notes that tritium separation does not provide a complete solution for tritium disposition and will also require some amount of further processing, storage and/or disposal. Nevertheless, tritium separation may facilitate, by reducing of the overall volume of tritiated water, the implementation of other disposition paths. However, given the challenges that surround the options that call for tritium disposal, pursuing tritium separation further at this time offers no clear advantage.

The ALPS Subcommittee report outlines the technical concept of tritium separation whereby

removal of bulk tritium occurs leading to a smaller volume high-concentration tritium containing water stream and a large volume low-concentration tritium containing water stream. The resulting low-concentration tritium water stream is either recycled (in the case of NPPs) or discharged to the environment. The high-concentration tritium stream will be stored.

Mature tritium separation technologies routinely deployed world-wide (e.g. CANDU NPPs) are not applicable for ALPS treated water due to its relative low concentration of tritium and large volume. Application of such a separation technology would also offer no advantage with respect to the overall volume of tritium containing water requiring storage.

The Review Team agrees with the conclusion that existing tritium separation technologies are neither technically feasible nor provide an advantage in terms of volume of the ALPS treated water requiring storage.

During 2014-2016, Japan conducted research and development to demonstrate the feasibility of alternative tritium-separation technologies. The committee concluded that from the results of these demonstrations none of these alternative technologies were close to being technically mature to merit further consideration for realistic consideration at this time. The Review Team agrees with these findings.

Nevertheless, the Review Team encourages Japan in its ongoing commitment to continue to monitor emerging technologies and technology developments to ascertain whether a technology shows promise in the future and accommodate them in its future plans, notwithstanding the already remarked urgency for finding a sound disposal solution.

Process of Down-selection of Tritium Disposition Options

The Tritiated Water Task Force assessed five options for the ALPS treated water disposition:

- Geosphere injection;
- Controlled discharge into the sea;
- Controlled vapor release;
- Hydrogen release; and
- Underground burial.

The Task Force assessed each option against several criteria: technical feasibility, regulatory feasibility, duration, cost, scale, secondary waste, radiation exposure to workers.

The Review Team considers that the ALPS Subcommittee's assessment methodology and approach to be appropriate and comprehensive. The selection criteria are well-chosen, and the analysis made against each criterion is technically sound and objective.

In their assessment of the five options the ALPS Subcommittee considered that there was no precedent for deployment of three of the options (i.e., geosphere injection, hydrogen release and underground burial). In addition, for each of these first-of-a-kind options, there are significant unresolved technical and regulatory uncertainties and risks that will need addressing.

The Review Team concurs with the ALPS Subcommittee's assertion that these three options are technically immature and unproven and implementation of any of them will require resolution of challenging unresolved issues. The uncertainties posed by these options introduce a high degree of risk, in terms of operational safety, technology development, licensing and societal acceptance if disposition of the ALPS treated water is to be complete on the same timescale as completion of decommissioning implementation.

The ALPS Subcommittee therefore moved forward with a more detailed assessment of the two remaining options (i.e., controlled vapor release and controlled liquid discharge into the sea) on the basis that these were technically mature, viable options for which implementation precedent exists either within Japan or internationally. Given the time constraints (i.e., disposition of ALPS treated water should occur on the same timescale as Fukushima Daiichi decommissioning) and importance of societal acceptance, the Review Team finds reasonable to focus on the technically mature options for which precedents exist and a large amount of information is available, because it is more likely to lead to a successful outcome.

The ALPS Subcommittee report outlines the advantages and disadvantages of each option.

The Review Team considers the ALPS Subcommittee analysis of the two options is sufficiently comprehensive, based on a sound scientific and technical basis and based on sound past and current practice precedents (e.g. controlled vapor release after the TMI accident and routine operational tritium discharges from NPPs worldwide including Japan) and established good practices (e.g. sea monitoring). As advised in the IAEA fourth Peer Review mission report, the implementation of the chosen ALPS treated water disposition should be accompanied by a comprehensive environmental monitoring programme and proactive and timely dissemination of information to stakeholders and the general public.

General Acknowledgements

Acknowledgement 2

The IAEA Review Team considers that the proposed objective of completing the disposition of the ALPS treated water by the time of the end of the decommissioning work is aligned with current international good practices. It is also in line with the strategy of risk reduction on the site and with the principle of "coexistence of reconstruction and decommissioning" stated in the Mid-and-Long-Term Roadmap.

Acknowledgement 3

The IAEA Review Team considers that the review of possible technologies for tritium separation has been undertaken appropriately based on the Tritiated Water Task Force assessment. The IAEA Review Team is not aware of a solution currently available for the separation of tritium commensurate with the concentration and the volume of ALPS treated water.

Acknowledgement 4

The IAEA Review Team considers that the methodology and criteria used for the down selection from the initial five options for the disposition of ALPS treated water to two (namely: controlled vapor release, and controlled discharges into the sea, the latter of which is routinely used by operating nuclear power plants and fuel cycle facilities in Japan and worldwide) are based on a sound methodology for the purpose of decision making. The two options selected are technically feasible and would allow the timeline objective to be achieved. The IAEA Review Team considers that the three other options would need much more development, which – even if proved feasible – would not be compatible with the timeline. The IAEA Review Team also notes that the ALPS treated water will be further purified as necessary to meet the regulatory standards for discharge before dilution.

General Advisory Points

Advisory Point 1

The IAEA Review Team holds the view 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, considering safety aspects and engaging all stakeholders, to ensure the sustainability of the decommissioning activities and of the safe and effective implementation of other risk reduction measures.

Advisory Point 2

The IAEA Review Team holds the view that after the decision on the disposition path is made by the Government of Japan, 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 including the characteristics of the discharges and an analysis of the environmental impacts, and including control of the water before disposition, in order to address radiation safety of the public, workers and environment.

Advisory Point 3

The IAEA Review Team holds the view that to support the implementation of the chosen disposition path, a robust comprehensive monitoring programme, supported by a local, national and international communication plan ensuring a proactive and timely dissemination of information to all stakeholders and general public are necessary.

3.4. PROSPECTIVE DOSE ASSESSMENT USING UNSCEAR MODEL

The Review Team considered the methodology used by ALPS Subcommittee to assess the possible radiation exposures to the public from releases to the atmosphere and discharges into the sea of the ALPS treated water including tritium and other radionuclides, for the options being considered for management of the ALPS treated water. The methodology is based on the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Methodology for Estimating Public Exposures due to Radioactive Discharges [Sources, Effects and Risks of Ionizing Radiation, UNSCEAR 2016 Report to the General Assembly, Scientific Annex A].

The UNSCEAR methodology is defined for the assessment of individual doses from a unit discharge of each of the key radionuclides to atmosphere and seas. The individuals considered are those living in the area local to the point of discharge with their habits being indicative of most people living in that area. The UNSCEAR methodology employs published dose coefficients to estimate doses from external and internal exposure.

The radiation exposure pathways considered in the assessment are (i) for the liquid discharges into the sea, internal exposures due to ingestion of seafood and external exposures from sediments deposited on sandy beaches, and (ii) for atmospheric discharges, external exposures from the atmosphere and soil and internal exposures from inhalation and ingestion of food.

The assessment was carried out for 64 radionuclides, including tritium and Carbon-14. The

assumption used for the assessment of annual doses to members of public was that all volume of the ALPS treated water stored in tanks is discharged in one year, and similar amounts are discharged during following 100 years (with the highly conservative hypothesis that more contaminated water could be generated). The assessment includes factors to consider bioaccumulation and the doses resulting from progeny of the radionuclides considered.

The UNSCEAR methodology is considered to provide best estimates of radiation exposures based on regional data, such as fish consumption average in the Asia-Pacific region. In order to include more realistic assumptions at the local level, for example, Japan adopted higher consumption rates of fish (one of the dominant exposures pathways) using data from national surveys.

The IAEA Review Team discussed with the counterpart the details of the assessment in a web conference. The outcome of these discussions led the Review Team to conclude that the methodology used to estimate prospectively the radiological impact of the two options considered for discharge of the ALPS treated water is appropriate at this stage and is in accordance with the recommendations in the IAEA Safety Standards for the purpose of informing the decision on the possible solution and initiating discussions with the national regulatory body.

The IAEA Safety Standards (GSG-9) recommends that, at a later stage, a similar methodology with some additional site specific data and conservatism is considered when undertaking the prospective dose assessment to support an application for the authorization of discharges.

Acknowledgement 5

The IAEA Review Team considers that the methodology used to estimate prospectively the radiological impact of the two solutions is appropriate at this stage for the purpose of informing the decision on the possible solution, and would allow the initiation of discussions with the national regulatory body (NRA). The IAEA Review Team positively notes the level of understanding of the methodology to assess radiation exposures to the public, and the efforts of the Japanese experts to adjust the well-established UNSCEAR methodology to the specific case of Japan.

Advisory Point 4

The IAEA Review Team notes that the IAEA Safety Standards advises that, at a later stage, a similar methodology to that of UNSCEAR, with additional site-specific data, is used when undertaking the prospective dose assessment to support an application for the authorization of discharges.

REFERENCES

List of the IAEA Reference Documents

Safety Standard Series

SF-1	Fundamental Safety Principles: Safety Fundamentals	2006
GSR Part 1	Governmental, Legal and Regulatory Framework for Safety: General Safety Requirements (Rev. 1)	2016
GSR Part 2	Leadership and Management for Safety	2016
GSR Part 3	Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards	2014
GSR Part 4	Safety Assessment for Facilities and Activities (Rev. 1)	2016
GSR Part 5	Predisposal Management of Radioactive Waste: General Safety Requirements	2009
GSR Part 6	Decommissioning of Facilities: General Safety Requirements	2014
GSR Part 7	Preparedness and Response for a Nuclear or Radiological Emergency: General Safety Requirements	2015
GSG-1	Classification of Radioactive Waste: General Safety Guide	2009
GSG-3	The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste	2013
SSG-40	Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors	2016
GSG-9	Regulatory Control of Radioactive Discharges to the Environment	2018
SSG-47	Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities	2018
RS-G-1.7	Application of the Concepts of Exclusion, Exemption and Clearance: Safety Guide	2004
WS-G-5.1	Release of Sites from Regulatory Control on Termination of Practices: Safety Guide	2006
WS-G-6.1	Storage of Radioactive Waste: Safety guide	2006

Safety Report Series

SRS No. 19	Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment	2001
SRS No. 44	Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance	2005
SRS No. 45	Standard Format and Content for Safety Related Decommissioning Documents	2005
SRS No. 64	Programmes and Systems for Source and Environmental Radiation Monitoring	2010
SRS No. 77	Safety Assessment for Decommissioning	2013

Technical Report Series

TRS No. 307	Management of Abnormal Radioactive Wastes at Nuclear Power Plants	1989
TRS No. 321	Management of Severely Damaged Nuclear Fuel and Related Waste	1991
TRS No. 346	Cleanup and Decommissioning of a Nuclear Reactor After a Severe Accident	1992
TRS No. 389	Radiological Characterization of Shutdown Nuclear Reactors for Decommissioning Purposes	1998
TRS No. 395	State of the Art Technology for Decontamination and Dismantling of Nuclear Facilities	1999
TRS No. 399	Organization and Management for Decommissioning of Large Nuclear Facilities	2000
TRS No. 401	Minimization of Radioactive Waste from Decontamination and Decommissioning of Nuclear Facilities	2001
TRS No. 408	Application of Ion Exchange Processes for the Treatment of Radioactive Waste and Management of Spent Ion Exchangers	2002
TRS No. 421	Management of Waste Containing Tritium and Carbon-14	2004
TRS No. 431	Application of Membrane Technologies for Liquid Radioactive Waste Processing	2004
TRS No. 441	Management of Problematic Waste and Material Generated During the Decommissioning of Nuclear Facilities	2006

Nuclear Energy Series

NG-T-2.3	Decommissioning of Nuclear Facilities: Training and Human Resource Considerations	2008
NW-T-2.5	An Overview of Stakeholder Involvement in Decommissioning	2009
NW-G-1.1	Policies and Strategies for Radioactive Waste Management	2009
NF-T-3.6	Management of Damaged Spent Nuclear Fuel	2009
NW-G-2.1	Policies and Strategies for the Decommissioning of Nuclear and Radiological Facilities	2011
NW-T-1.8	Mobile Processing Systems for Radioactive Waste Management	2014
NW-T-2.7	Experiences and Lessons Learned Worldwide in the Cleanup and Decommissioning of Nuclear Facilities in the Aftermath of Accidents	2014
NP-T-3.16	Accident Monitoring Systems for Nuclear Power Plants	2015
NW-T-2.8	Managing the Unexpected in Decommissioning	2016
NW-T-1.14	Status and Trends in Spent Fuel and Radioactive Waste Management	2018
NW-T-2.10	Decommissioning After a Nuclear Accident: Approaches, Techniques and Implementation Considerations	2019

Technical Documents (TECDOC)

TECDOC-1336	Combined Methods for Liquid Radioactive Waste Treatment: Final Report of a Coordinated Research Project, 1997–2001	2003
TECDOC-1394	Planning, Managing and Organizing the Decommissioning of Nuclear Facilities: Lessons Learned	2004
TECDOC-1478	Selection of Decommissioning Strategies: Issues and Factors	2005
TECDOC-1515	Development of specifications for radioactive waste packages	2006
TECDOC-1537	Strategy and Methodology for Radioactive Waste Characterization	2007
TECDOC-1579	New Developments and Improvements in Processing of Problematic Radioactive Waste: Results of a Coordinated Research Project, 2003–2007	2007
TECDOC-1602	Innovative and Adaptive Technologies in Decommissioning of Nuclear Facilities: Final report of a Coordinated Research Project, 2004-2008	2008
TECDOC-1638	Setting Authorized Limits for Radioactive Discharges: Practical Issues to Consider	2010
TECDOC-1702	Planning, Management and Organizational Aspects in Decommissioning of Nuclear Facilities	2013
TECDOC-1817	Selection of Technical Solutions for the Management of Radioactive Waste	2017
TECDOC-1876	Modelling of Marine Dispersion and Transfer of Radionuclides Accidentally Released from Land Based Facilities	2019

Other IAEA Publications

NEA/IAEA/EC	International Structure for Decommissioning Costing (ISDC) of Nuclear Installations	2012
IEM Report	IAEA Report on Decommissioning and Remediation after a Nuclear Accident, International Experts' Meeting, 28 January – 1 February 2013, Vienna, Austria	2013

List of References provided by the Government of Japan

Primary document:

Report of the Subcommittee on Handling of the ALPS Treated Water, 10 February 2020, https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20200210_alps.pdf

Background/supporting documents:

Final Reports of previous IAEA Review missions (measures taken or to be taken, progress made and current status, issues/challenges, perspective and future plans, etc.)

The Outline of the report of the Subcommittee on Handling of ALPS Treated Water, Agency for Natural Resources and Energy, METI, 10 February 2020, https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20200210_alps_sum.pdf

The Outline of the Handling of ALPS Treated Water at Fukushima Daiichi NPS, Agency for Natural Resources and Energy, METI, February 2020, https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20200203_current_status.pdf

Tritiated Water Task Force Report, June 2016 https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20160915_01a.pdf

Progress and Milestones on Fukushima Daiichi Decommissioning Mid-and-Long-Term Roadmap (the outline provided by METI)

Radiation concentrations measured at the multi-nuclide removal equipment (ALPS) outlet (as of November 30, 2019), http://www.tepco.co.jp/en/decommission/progress/watertreatment/images/exit_en.pdf

UNSCEAR 2016 Report on Sources, Effects and risks of ionizing radiation (published by United Nations Scientific Committee on the Effects of Atomic Radiation), https://www.unscear.org/unscear/en/publications/2016.html

APPENDIX: LIST OF PARTICIPANTS

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