

# **IAEA Review of Safety Related Aspects of Handling ALPS Treated Water at TEPCO's Fukushima Daiichi Nuclear Power Station**

**Report 3: Third Review Mission to Japan after the Start  
of ALPS Treated Water Discharge (December 2024)**



**IAEA**

International Atomic Energy Agency

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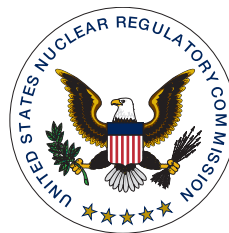
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**Report 3: *Third Review Mission to Japan after the Start of ALPS  
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## EXECUTIVE SUMMARY

In April 2021, the Government of Japan released its Basic Policy on Handling of ALPS Treated Water at the Tokyo Electric Power Company Holdings' (TEPCO) Fukushima Daiichi Nuclear Power Station (FDNPS). The approach outlined in the Basic Policy is to conduct a series of controlled discharges of ALPS treated water into the sea over many years. Following the announcement of this policy, the Government of Japan requested that the IAEA conduct a detailed review of the safety related aspects of handling ALPS treated water stored at FDNPS, applying the relevant international safety standards. The objective of the IAEA is to carry out this safety review, before, during and after discharges of ALPS treated water.

The IAEA review before the discharge was completed with the publication of the IAEA's Comprehensive Report on the Safety Review of the ALPS-Treated Water at the Fukushima Daiichi Nuclear Power Station (IAEA's Comprehensive Report) that was released on 4 July 2023. That report summarized and concluded the work carried out by the IAEA for two years before the discharge of ALPS treated water began. It also comprised the technical topics and activities to be revisited and corroborated by the IAEA at various times during the ALPS treated water discharges to assess the consistency of the water discharge activities with relevant international safety standards.

In September 2023, the IAEA and the Government of Japan signed a Memorandum of Cooperation that describes the IAEA basic framework for the safety review during the ALPS treated water discharges, as well as the monitoring and assessment activities carried out by the IAEA.

In October 2023, the IAEA carried out the first review mission since the start of ALPS treated water discharges from the FDNPS. The second review mission was conducted from 23 to 26 April 2024 to follow up on the findings from the IAEA's Comprehensive Report on the Safety Review. This third review mission was conducted from 9 to 12 December 2024, coordinated and led by a senior IAEA official, included 15 members, comprised of experts from the IAEA Secretariat and international experts who are designated members of the Task Force.

The scope of the review mission covered the main technical topics considered by the IAEA as part of its safety review before the start of discharges. These topics are noted below but are summarized in greater detail in the IAEA's Comprehensive Report. Additionally, as part of the mission's activities, the Task Force reviewed the status of the IAEA's independent corroboration of Japan's source and environmental monitoring programmes, and the onsite sampling and analysis activities conducted by IAEA experts at the FDNPS.

- Regulatory Control and Authorization
- Safety Related Aspects of Systems and Processes for Controlling Discharges
- Characterization of the Source
- Radiological Environmental Impact Assessment
- Source and Environmental Monitoring
- Involvement of Interested Parties
- Occupational Radiation Protection

During the mission, the Task Force received updates on the progress made by NRA, TEPCO, METI, and related organizations in their activities pertaining to the discharge of ALPS treated water under the approved implementation plan and national regulations and laws. Of note is that TEPCO presented the results of the Radiological Environmental Impact Assessment Report (REIA) that has been undertaken one year after the commencement of the discharges (operation stage). The Task Force had access to all relevant Japanese technical and regulatory experts and was provided with opportunities to inquire about specific issues. Additionally, the Task Force visited the FDNPS to directly observe the equipment and facilities for the discharge of ALPS treated water.

The IAEA Task Force also discussed the details and activities carried out by IAEA staff since the start of the discharge including the continuous presence at the site, independent onsite analysis, discussions with TEPCO/METI and IAEA walkdowns through the facilities related to the discharge of ALPS treated water. The Task Force also noted the comprehensive approach of the IAEA sampling, independent

analysis and data corroboration activities related to the source and environmental monitoring programme conducted by Japan.

Based on the activities conducted by the Task Force during the mission, the IAEA's overall conclusions are in line with those highlighted in the first and second missions after the start of the discharge:

- The Task Force did not identify anything that is inconsistent with the requirements in the relevant international safety standards. Therefore, the IAEA can reaffirm the fundamental conclusions of its safety review as outlined in the 4 July 2023 Comprehensive Report.
- The Task Force highlighted that NRA has continued the comprehensive inspection plan, including its onsite presence regarding the safety oversight of the discharge of ALPS treated water.
- The Task Force confirmed that the equipment and facilities are installed and operated in a manner that is consistent with the Implementation Plan and the relevant international safety standards.
- The Task Force noted the importance of the IAEA's ongoing corroboration activities and the IAEA onsite independent test and analysis, in providing a comprehensive, transparent and independent verification of the accuracy and reliability of the data reported by TEPCO and the Government of Japan.

This mission report documents observations from the Task Force and reflects the discussions between the Task Force, TEPCO and the Government of Japan. This report was agreed upon by the IAEA Task Force and has been published by the IAEA on its public website.

## BACKGROUND

In April 2021, Japan announced its Basic Policy and soon after, the Japanese authorities requested assistance from the IAEA to monitor and review those plans and activities relating to the discharge of the treated water to ensure they will be implemented in a safe and transparent way, and they will be consistent with the IAEA's international safety standards. The IAEA, in line with its statutory responsibility, accepted the request made by Japan.

In July 2021, the IAEA and the Government of Japan signed the Terms of Reference for IAEA Assistance to Japan on Review of Safety Aspects of ALPS Treated Water at Tokyo Electric Power Company Holdings, Inc. (TEPCO) Fukushima Daiichi Nuclear Power Station (FDNPS) [1]. These terms of reference set out the broad framework that the IAEA will use to implement its review. Such a request to the IAEA, and its acceptance by the IAEA, is in accordance with the IAEA function described in Article III.A.6 of the IAEA Statute.

In September 2021, the IAEA sent a team to Tokyo, for meetings and discussions to finalize the agreement on the scope, key milestones and approximate timeline for the Agency's review. The team also travelled to the FDNPS to discuss technical details with experts at the site and to identify key activities and locations of interest for the Agency's review.

To implement the IAEA's review in a fully transparent and inclusive manner, the IAEA Director General established a Task Force. The Task Force operates under the authority of the IAEA and is chaired by a senior IAEA official. The Task Force includes experts from the IAEA Secretariat alongside internationally recognized independent experts with extensive experience from a wide range of technical specialties from Argentina, Australia, Canada, China, France, the Marshall Islands, the Republic of Korea, the Russian Federation, the United Kingdom, the United States and Viet Nam. These independent experts provide advice to the IAEA and serve on the Task Force in their individual professional capacity to help ensure the IAEA's review is comprehensive, benefits from the best international expertise and includes a diverse range of technical viewpoints.

The IAEA primarily conducted its review through the analysis of documentation provided by TEPCO, NRA, and METI; and holding review missions to further clarify questions and to ask for additional materials. The IAEA also conducted onsite visits to FDNPS periodically throughout 2021, 2022, 2023 and 2024. Six review missions to Japan were carried out between 2022 and 2023 and the corresponding technical reports were published. The reports issued after the first four review missions serve as progress reports and final conclusions are only presented for the first time in the Comprehensive Report which was published on 4 July 2023 [2].

On September 18, 2023, the IAEA and the Government of Japan signed a Memorandum of Cooperation that outlines the basic framework for the IAEA's ongoing safety review of the ALPS treated water discharges at FDNPS, as well as the associated monitoring and assessment activities conducted by the IAEA.

In October 2023, the IAEA carried out the First Review Mission to Japan after the Start of the ALPS Treated Water Discharge and issued the corresponding report in January 2024. The second review mission was conducted in April 2024 and the IAEA issued the corresponding report in July 2024.

At the start of the review, the Government of Japan and TEPCO provided background materials with information pertaining to the proposed discharge of ALPS treated water. Subsequently, additional materials were provided upon request by the Task Force, or when ready for submission by TEPCO to the relevant Japanese authorities (e.g., NRA). This information was reviewed by the Task Force members and formed the basis for the review missions with relevant authorities and, ultimately, the Comprehensive Report.

The purpose of the review missions is to analyse whether the Japanese comprehensive plans to discharge ALPS treated water are being conducted in line with the relevant international safety standards. In order to reach that purpose, the Task Force review the reference materials submitted by the Government of Japan or TEPCO, seek clarification on technical issues, request additional information and observe onsite activities, as appropriate.

The IAEA’s review is organized into the following three major components, as summarized in Figure 1, to ensure all key safety elements are adequately addressed:

- **Assessment of Protection and Safety** – This component is focused on reviewing technical aspects of the Implementation Plan, Radiological Environmental Impact Assessment (REIA), and other supporting materials prepared by TEPCO as part of their submission for regulatory approval of the discharge of ALPS treated water. This component primarily involves TEPCO and the Ministry of Economy, Trade, and Industry (METI) and looks at the expected actions to be performed by TEPCO throughout the process, as defined in the relevant IAEA international safety standards.
- **Regulatory Activities and Processes** – This component is focused on assessing whether the Nuclear Regulation Authority’s (NRA) review and approval process is conducted in accordance with the relevant IAEA international safety standards. This component primarily involves NRA as the independent regulatory body responsible for nuclear safety within Japan; it is focussed only on the regulatory aspects relevant for NRA’s review of the discharge of ALPS treated water from the Fukushima Daiichi Nuclear Power Station.
- **Independent Sampling, Data Corroboration and Analysis** – This component includes all activities associated with the IAEA’s independent sampling and analysis that is and will be performed to corroborate the data from TEPCO and the Government of Japan associated with the discharge of ALPS treated water. Samples are analysed by IAEA laboratories as well as independent third-party laboratories. Additionally, this component also includes the corroboration of occupational exposure.

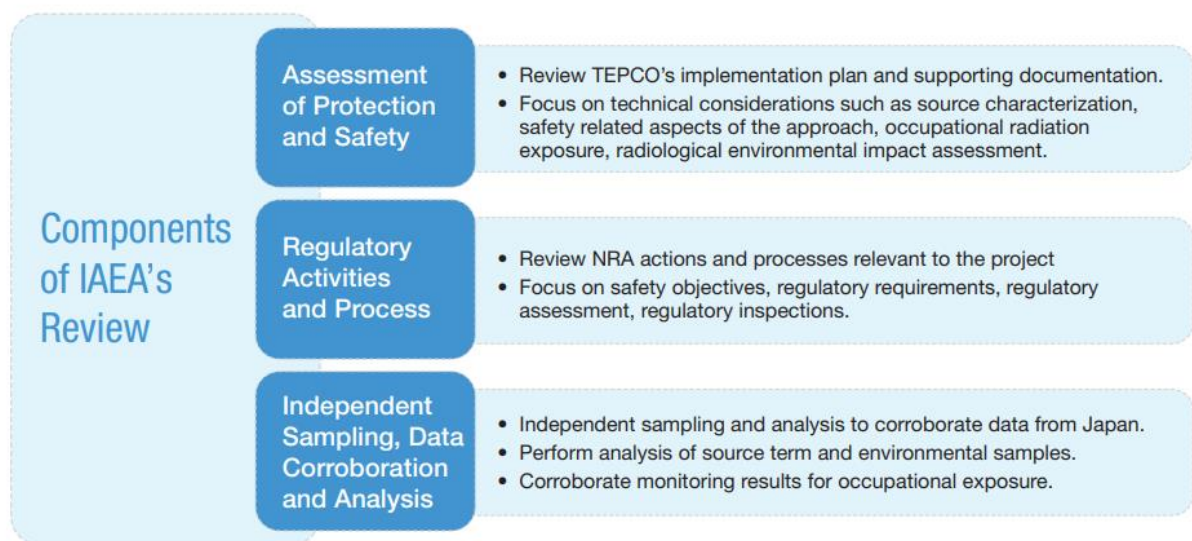


Figure 1: Components of the IAEA Review

Additional information on the IAEA’s review, as well as background information, documents, reports, and other publications can be found online at the dedicated website for the IAEA’s Fukushima Daiichi ALPS treated water discharge [3].



## MISSION ACTIVITIES IN DECEMBER 2024

### Discussions with TEPCO and METI

As planned, at the beginning of the mission, the Task Force met with officials and experts from TEPCO and METI. They provided the current status of the plan for the discharge of ALPS treated water for the Japanese 2024 Fiscal Year (FY) and the discharges carried out in 2024; the details are given in Table 1.

Fiscal Year 2023 (1<sup>st</sup> April 2023 to 31<sup>st</sup> March 2024)

- 4 Batches discharged (batches: 1 to 4).
- Total ALPS treated water discharged: approx. 31,145 m<sup>3</sup>.

Total tritium activity discharged in 2023 FY: approx. 4.5 TBq

Fiscal Year 2024 (until the current mission)

- 6 Batches discharged (batches: 5 to 10)
- Last batch (batch: 11) to complete the Fiscal Year planned to discharge in March 2025

Total tritium activity discharged in 2024 FY: approx. 10.3 TBq (In addition to this, approx. 3.0 TBq is planned to be discharged in the last batch (batch: 11).)

*Table 1: Summary of Batch Discharge Information from the ALPS in FY 2023 and FY 2024 (up to December 2024)*

### FY2023

Management number	Discharged tank group	Tritium concentration	Commencement of discharge	Completion of discharge	Amount of discharge	Amount of tritium radioactivity
23-1-1	Group B	140,000 Bq/L	Aug 24, 2023	Sep 11, 2023	7,788m <sup>3</sup>	1.1 trillion Bq
23-2-2	Group C	140,000 Bq/L	Oct 5, 2023	Oct 23, 2023	7,810m <sup>3</sup>	1.1 trillion Bq
23-3-3	Group A	130,000 Bq/L	Nov 2, 2023	Nov 20, 2023	7,753m <sup>3</sup>	1.0 trillion Bq
23-4-4	Group B	170,000 Bq/L	Feb 28, 2024	Mar 17, 2024	7,794m <sup>3</sup>	1.3 trillion Bq

### FY2024

Management number	Discharged tank group	Tritium concentration	Commencement of discharge	Completion of discharge	Amount of discharge	Amount of tritium radioactivity
24-1-5	Group C	190,000 Bq/L	Apr 19, 2024	May 7, 2024	7,851m <sup>3</sup>	1.5 trillion Bq
24-2-6	Group A	170,000 Bq/L	May 17, 2024	Jun 4, 2024	7,892m <sup>3</sup>	1.3 trillion Bq
24-3-7	Group B	170,000 Bq/L	Jun 28, 2024	Jul 16, 2024	7,846m <sup>3</sup>	1.3 trillion Bq
24-4-8	Group C	200,000 Bq/L	Aug 7, 2024	Aug 25, 2024	7,897m <sup>3</sup>	1.6 trillion Bq
24-5-9	Group A	280,000 Bq/L	Sep 26, 2024	Oct 14, 2024	7,817m <sup>3</sup>	2.2 trillion Bq
24-6-10	Group B	310,000 Bq/L	Oct 17, 2024	Nov 4, 2024	7,800m <sup>3</sup>	2.4 trillion Bq

All radionuclides discharged are below regulatory requirements, referring to the sum of the ratios to legally required concentrations of radioactive substances being less than 1. There has been no

abnormality in parameters, operational limits and sea area monitoring since the commencement of discharge. Regarding the regulatory control and authorization, the optimization of protection and safety during the operational phase is an ongoing subject under review by the Task Force. During the discussion, TEPCO stated that they had no plans to increase the annual amount of tritium they are discharging at this stage. In this respect, the ALPS discharge plan is aligned with the Basic Policy on handling of the ALPS treated water issued by the Government of Japan in April 2021.

There have only been 10 batches discharged and the priority is to ensure that the discharge operation is safe in line with the requirements and the international safety standards. TEPCO said that any proposal for the increase of the annual amount of tritium they are discharging (and the activity concentration in the discharged water) would need to be discussed with the Government of Japan. TEPCO and METI stated that they need to build a track record of safe discharges before discussing the review of the national requirement for the annual amount of tritium discharged. It is noted that, as shown above, Japan has been slowly increasing the total amount of tritium discharged each fiscal year and in FY 2025, the plan is to discharge a total of 15 TBq of tritium. This value is below the national requirement of 22 TBq.

TEPCO went on to explain that they are successfully transferring water from one storage location to another in order that tanks can be emptied. They mentioned a plan to dismantle empty water tanks at the site, primarily to clear space needed to store nuclear fuel debris to be retrieved from the damaged reactors and to make enough space for the on-going decommissioning.

The Task Force acknowledged that there had been no change to the discharge limit but reminded TEPCO that the Task Force had already indicated its intention to “review NRA’s approach to reviewing and potentially revising discharge limits in response to TEPCO’s ongoing optimization of protection and safety” and a timeline for revisiting this discharge limit needs to be set. The Task Force noted that both enabling decommissioning of FDNPS, and revising ALPS treated water discharge limit with its associated risks are important factors to consider when optimizing protection and safety in the future and that it is the responsibility of TEPCO to suggest options to NRA.

TEPCO presented the Radiological Environmental Impact Assessment Report (REIA) undertaken one year after the commencement of discharge (operation stage) in which TEPCO has used a source term that is equivalent to the discharge of ALPS treated water into the sea during the first year of operation, starting in August 2023. The Task Force noted that aside from the source term and meteorological and oceanographic data, that are now based on the actual data for the assessment period, no other simulation model, parameter values and assumptions have been changed. TEPCO stated that it is too early in the operation phase for any changes to have been observed in the habits of the local population.

TEPCO presented the results of the REIA, which show the predicted activity concentrations in marine foods and the annual committed effective doses. The Task Force noted that the results of the effective doses calculated based on the actual discharge in the first year are very low, as was the case in the REIA undertaken before the start of operation. The predicted annual committed effective doses are in the order of 0.00001 mSv. The Task Force asked TEPCO to present the revised doses as a function of radionuclide so that it can be seen if the major contributors to the dose have changed.

The Task Force also noted that the sea area monitoring results over the first year are generally consistent with the results of TEPCO's dispersion modelling of each batch and welcomed the results that were presented during the mission. This provides further confidence in the ALPS REIA, as the same modelling techniques were used to simulate future seawater activity concentrations for this assessment.

While TEPCO indicated that the monitoring data could not provide a full validation of the dispersion model, the Task Force encouraged TEPCO to disseminate more widely some results or a statement about the positive findings. The results of the ocean dispersion simulation for tritium in the discharged ALPS treated water were presented, using meteorological and oceanographic data actually observed

over the one year period following the commencement of discharges. The results were also compared with the results of the predictive assessment made in the previous REIA. It is important to mention that as the dispersion simulation does not reproduce the tritium concentration at a certain point and time, TEPCO was concerned that their dissemination without a clear detailed explanation could be construed as being very negative.

Related to the frequency of the review and further update of REIA, TEPCO mentioned that such a period is not defined in the Japanese regulations, but it was considering reviewing the REIA every 10 years, or sooner if a significant change occurs that warrants a review. The Task Force indicated its full support for TEPCO's review of the REIA after the first year of operation of the discharge of ALPS treated water. It also supports the approach taken by TEPCO to carry out periodic reviews of the REIA moving forward even if nothing changes. It acknowledged that there is nothing in the international safety standards that dictate a specific review period but suggested that it might be prudent to review the REIA more frequently than every 10 years, especially in the early years when so much additional information is being acquired.

The Task Force discussed the status of the safety related aspects and processes for controlling the discharges, in particular the implementation of the maintenance plans for the equipment, structures and systems. Regarding operations related to the discharge of ALPS treated water, the Task Force noted that operation procedure manuals, including actions to be taken in the event of an alarm, are established, as well as operator training. Regarding maintenance and inspections, based on the facility management policy specified in the implementation plan, a long-term inspection plan is established, and maintenance and inspections are conducted in accordance with the implementation plan.

The Task Force also noted that there are several activities related to the inspections of the different facilities related to the discharge of ALPS treated water that TEPCO carried out in a voluntary manner, in addition to the prescription in the implementation plan. TEPCO presented an overview of the maintenance plan for the Measurement/Confirmation Facility (Mechanical Items), the maintenance plan for the transfer facility, the dilution facility and the discharge facility and the result of the inspections. TEPCO provides regular explanations to NRA safety inspectors stationed at the site regarding the discharge and inspection results of the ALPS treated water dilution/discharge facility as part of operational safety inspections. The ALPS treated water discharge status, including the discharge results and other information, is regularly reported to a dedicated NRA Committee on Specified Nuclear Facility Monitoring and Assessment Study. The Task Force noted that NRA safety inspectors conduct onsite attendance and checking as part of operational safety inspections and there is always at least one inspector onsite 24 hours. As a global conclusion, TEPCO stated that they have not identified any operational problems.

TEPCO provided the Task Force with a detailed description of the analyses of radionuclides undertaken in each batch of ALPS treated water in the measurement/confirmation tanks prior to discharge. Activity concentrations of tritium measured daily during the discharge of all ten batches were presented, with six new batches completed since the last meeting corresponding to the 2024 FY. These results showed that the tritium activity concentrations in the discharged ALPS treated water for all batches were far below the Basic Policy limit of 1,500 Bq/L and the operational discharge suspension limit (700 Bq/L) (Table 2, Figures 2 and 3) and consistent with the expected values based on the discharge concentration for each batch. TEPCO also demonstrated with data that the sampling conducted in the vicinity around FDNPS has shown that the tritium concentration in seawater remains well below the operational discharge suspension limit (700 Bq/L) set for activity concentrations of tritium in seawater at the 10 locations within three kilometres of the power station.

Table 2: Criteria used by TEPCO for Analysis Results for Quick Tritium Measurements

Location	Discharge Suspension Level (Bq/L)	Investigation Level (Bq/L)	Detection Limit (Bq/L)
Within 3km of the site (10 locations)	700	350	~10
Within a 10km square in front of the site (4 locations)	30	20	~10

*\*Note – Historical range for seawater across Japan ranges from around 0.043 Bq/L to 20 Bq/L*

The Task Force was also presented with results from weekly tritium measurements in seawater at the same monitoring locations. These analyses employ more sensitive analytical techniques with detection limits of 0.1 Bq/L (Electrolytic method) and 0.4 Bq/L (Distillation method), enabling detection of low tritium concentrations though requiring longer processing times. The results confirm that tritium activity concentrations in seawater are generally low, with levels beyond approximately 10 km from the FDNPS discharge point being indistinguishable from historical background tritium levels in Japanese coastal waters (Figure 2). The highest measured concentration to date was 50 Bq/L, recorded at sampling location T-0-1A (the point closest to the discharge outlet) on October 28th, 2024. As this sensitive monitoring continues and more data accumulates, a more comprehensive understanding of tritium distribution patterns will emerge.

Figure 3 presents tritium activity concentrations in seawater samples collected from locations within 700 m of the discharge outlet, including monitoring points maintained by NRA, MOE, Fukushima Prefecture, and TEPCO. The data are plotted chronologically to show activity concentration trends since discharges began in August 2023. While most measurements remain close to the regional background level of 0.1-1 Bq/L, some samples collected during discharge periods (highlighted by grey shaded columns in Figure 3) show temporarily elevated concentrations relative to this background. Notable peaks include measurements of 14 Bq/L in October 2023, 21 Bq/L in June 2024, and 50 Bq/L in October 2024. In all cases, concentrations rapidly returned to background levels after discharge operations ceased. The analytical methods employed for these measurements have detection limits of 0.1 Bq/L (electrolytic method) and 0.4 Bq/L (Distillation method), with variations depending on specific analytical protocols and measurement durations.

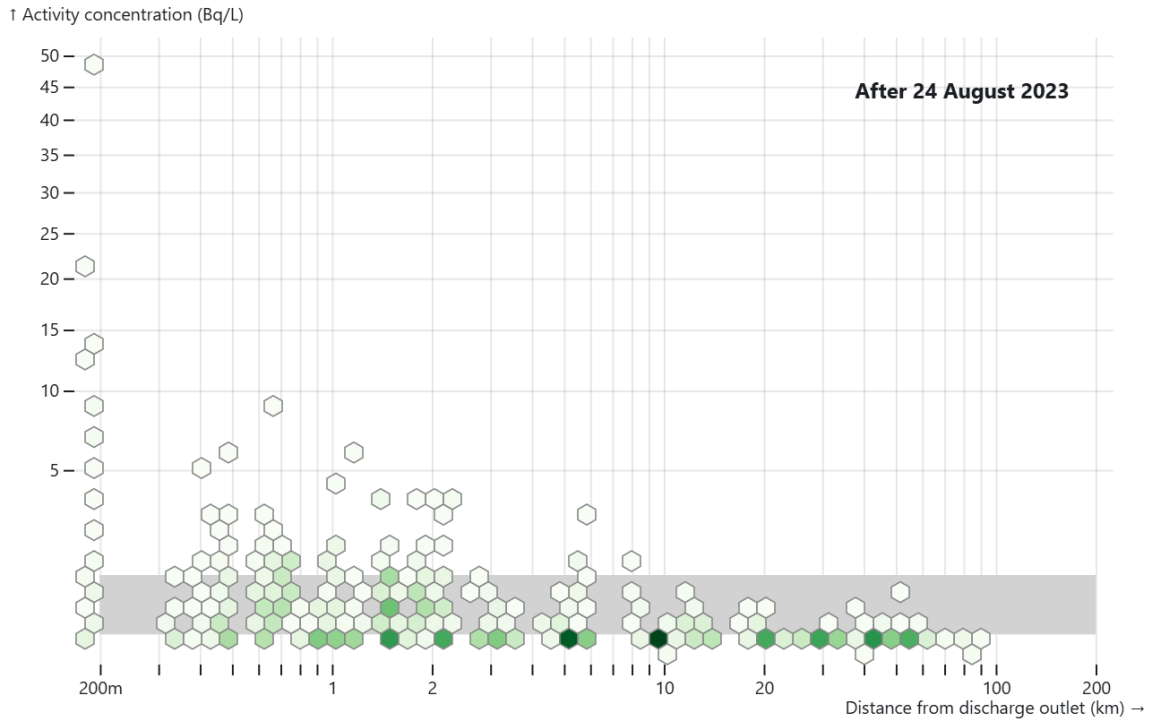
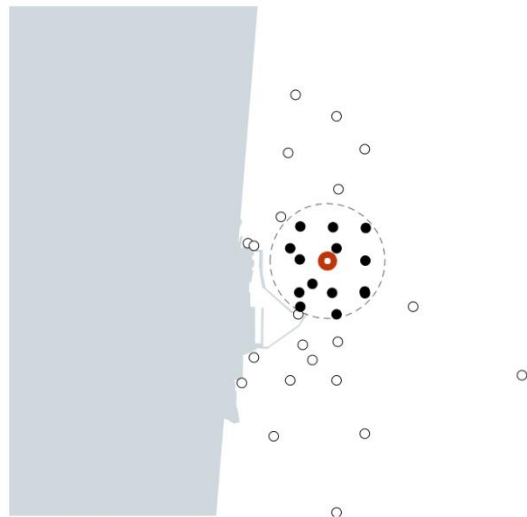
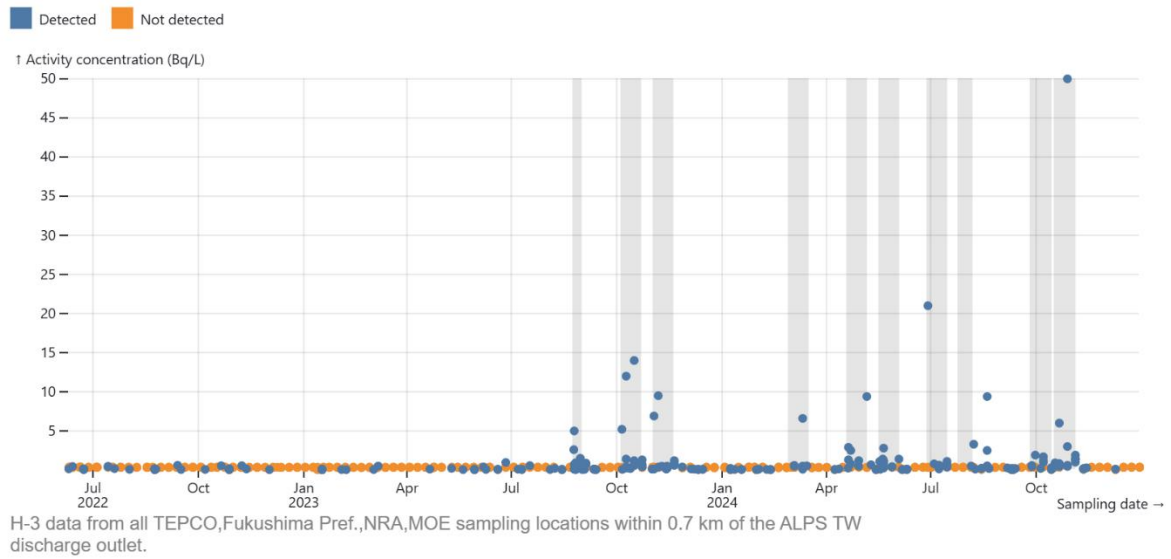


Figure 2: Tritium activity concentrations in seawater as a function of distance from the discharge outlet (darker colours indicate more measurements; regional long-term background indicated by the grey area)



*Figure 3: Tritium activity concentrations in seawater from sampling locations close to the discharge outlet (discharge periods indicated by the grey shading)*

TEPCO also maintains their Overarching Radiation-monitoring data Browsing System (ORBS) that presents comprehensive monitoring data relevant to the ALPS treated water discharges from all agencies contributing to the Comprehensive Radiation Monitoring Plan (CRMP) [4]. The Task Force noted this system and remains impressed by its functionality. ORBS provides users with convenient access to the most current data available for each sampling location regardless of which organisation conducted the monitoring, along with time-series data visualizations covering the previous three-year period. This system represents a significant advancement in data transparency and accessibility.

The Task Force noted that TEPCO's presentation of tritium results in seawater can be enhanced to avoid created confusion by combining data obtained through methods with significantly different detection limits. Given the distinct purposes of the daily quick measurements (detection limit of 10 Bq/L) and the less frequent, more sensitive analyses (detection limits of 0.1 Bq/L (electrolytic method) and 0.4 Bq/L (Distillation method)) conducted weekly or monthly, these results should be presented separately with clear explanations of their respective objectives and limitations. The Task Force further observed that even within the category of sensitive weekly measurements, the varying detection limits between 0.1

and 0.4 Bq/L introduced additional complexity for data interpretation. For presentations to scientific audiences, the Task Force recommended that all monitoring data within the CRMP should consistently include three key parameters: the measured activity concentration, the associated measurement uncertainty, and the method detection limit. The Task Force acknowledged that TEPCO already implements this comprehensive approach for source monitoring results, commended the practice and encouraged for all environmental monitoring presentations.

### **Visit to FDNPS**

As part of the mission, the Task Force carried out a comprehensive visit to FDNPS, as was conducted in previous years to Japan after the start of ALPS treated water discharge.

During the mission, the Task Force travelled to Fukushima Prefecture to visit the FDNPS. While at the site, the Task Force was provided with an updated overview of the technical status of the ALPS treated water discharges and was able to visit each step of the discharge process.

This included:

- Confirmation/measurement tanks (K4 tank area)
- ALPS treated water transfer facility building
- Seawater pumps and header piping, radiation detectors installed near the seaside pumps and the vertical shaft, and the vertical shaft leading to the discharge tunnel
- Storage Tanks which will be dismantled (J8 and J9 Tanks area)

Most zones related to the discharge of ALPS treated water were visited and important maintenance activities were performed in each zone because at the time of the mission there was no batch discharging ALPS treated water. The members of the Task Force were explained about the functions of the components of the discharge system in each zone. The Task Force saw the related components and systems of the ALPS treated water discharge systems in the field and learned about the details of the functions of each component of the discharge system and the maintenance activities status.

### **Discussions with NRA**

The Task Force reviewed NRA's approach to encourage optimization of protection and safety during future reviews of the authorization and its approach to reviewing and potentially revising discharge limits in response to TEPCO's ongoing optimisation of protection and safety.

The Task Force noted that there have been no changes to the Basic Policy and the associated discharge limit for tritium. NRA reiterated the view that Japan is in a data collection stage regarding the discharge of ALPS treated water into the sea and the environmental monitoring programmes in place.

The Task Force recognised that Japan is gathering important data that could inform the next iteration of optimization, which in turn could inform discussions about the discharge limits. The Task Force reiterated its intention set out in the Comprehensive Report to "review NRA's approach to encourage optimization of protection and safety" and "review NRA's approach to reviewing and potentially revising discharge limits in response to TEPCO's ongoing optimisation of protection and safety" noting that discharge limits should be influenced by the optimization of protection and safety, and not the other way around. However, the Task Force recognizes that measures for protection and safety were established by considering the national prevailing circumstances, the available protection options, and the nature, likelihood, and magnitude of exposures.

This review also included NRA's approach to identify "unusual values" and refine action limits based on incoming environmental monitoring data and other operational experience. NRA said that they have a process for taking actions if there is an anomaly in the monitoring results but that this is not written down.

During previous missions, NRA explained the independent source monitoring that is undertaken to complement the operational safety inspections and more broadly, the regulatory oversight of the discharge activities. It plans to conduct independent monitoring for one batch each year. NRA verifies TEPCO's source monitoring by analysing samples for  $^{14}\text{C}$  and  $^{129}\text{I}$ , as the two major contributors to dose according to TEPCO's REIA and for  $^{60}\text{Co}$ ,  $^{106}\text{Ru}$ ,  $^{125}\text{Sb}$ ,  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$ , as "major" gamma-emitting radionuclides, i.e., those frequently detected in ALPS treated water. The Task Force evaluated this verification approach and found it scientifically justified and appropriate.

During the meeting, NRA presented the results from its most recent independent source monitoring exercise in which samples collected on September 4th, 2024, were analysed. NRA confirmed the specific radionuclides analysed and indicated that TEPCO's analyses results were valid based.

The Task Force recommended that NRA enhance its data presentation practices by implementing clear, direct side-by-side comparisons between its independent measurement results and TEPCO's corresponding measurements. Such improvements would address the broader need for transparent, ongoing verification through readily comparable independent monitoring data.

The Task Force noted information provide by both TEPCO and NRA regarding the addition of  $^{113\text{m}}\text{Cd}$  to the ALPS treated water source term in August 2024, prior to the source monitoring for the eighth batch. This addition's rationale aligned clearly with TEPCO's methodology for determining radionuclides to be included in the source term as described in detail elsewhere [cite Comprehensive Report]. The Task Force was reminded that the source term's highly conservative nature can potentially be misleading, as it includes radionuclides that might theoretically be present in treated water but often remain undetectable even using sophisticated low-level analytical methods. This conservatism creates a potential for misinterpretation when reviewing the REIA as the theoretical presence of certain radionuclides in the source term will not be reflected in actual environmental measurements. NRA acknowledged that TEPCO's addition of  $^{113\text{m}}\text{Cd}$  to the radionuclides to be measured and assessed has no safety impact for environmental assessment.

NRA provided an update on the marine environmental monitoring being conducted close to the FDNPS as part of CRMP, specifically designed to assess ALPS treated water discharges. Multiple organizations are involved in this coordinated effort: NRA, Ministry of Environment (MOE), Fukushima Prefecture (FP) government and TEPCO monitor tritium in seawater while the Fisheries Agency of Japan (FAJ) is monitors fishery products.

NRA explained that for seawater monitoring follows a dual-method approach that balances timely reporting with analytical precision. This strategy addresses both the need for rapid public information and the requirement for precise low-level measurements. The first approach involves "quick" analyses performed by MOE, FP, and TEPCO with a target detection limit of 10 Bq/L, enabling prompt reporting. The second approach consists of more sensitive analyses with target detection limits between 0.1 and 0.4 Bq/L (varying based on distance from the discharge point), conducted by NRA, MOE, FP, and TEPCO. These more sensitive analyses require longer processing times but provide greater analytical precision. NRA specifically conducts monthly tritium monitoring at four designated locations within three kilometres of the FDNPS site.

The Task Force considered the results of environmental monitoring so far available. It concluded that the tritium activity concentrations that have been measured in seawater from some sampling locations close to the ALPS treated water discharge point are at generally expected levels and consistent with experience at other nuclear facilities. The Task Force noted that while remaining well below the investigation level and the discharge suspension level, elevated levels of tritium in seawater relative to the long-term background were reported within a 10 km, and most notably a 3 km vicinity of the ALPS treated water discharge outlet, during and immediately after discharges of ALPS treated water. A similar



pattern can be observed for tritium in fish monitored close to the discharge outlet. This interpretation was consistent with the information provided by TEPCO as described above.

The Task Force made several observations regarding the reporting of tritium activity concentration in fish. It noted that FAJ publishes its results as "tritium" in Bq/kg, which FAJ later clarified refers to tissue-free water tritium (TFWT) measured in Bq/kg fresh weight. The rationale aims to make results more accessible to fishermen and consumers. The Task Force expressed some concern that labelling results simply as "tritium" creates ambiguity since both TFWT and organically bound tritium (OBT) are monitored within the CRMP and are distinguished as separate measurements by other monitoring organizations like MOE. Furthermore, the Task Force pointed out that Bq/L is the standard unit for TFWT, noting that MOE reports its results in both Bq/L and Bq/kg fresh weight, presumably to maximize utility. The Task Force also observed that detection limits for TFWT are specified in Bq/L in the CRMP. Overall, the Task Force concluded there is potential for harmonization and simplification regarding these reporting practices. The Task Force also noted that despite OBT being reported in Bq/kg fresh weight, the standard unit for in Japan and internationally, detection limits for OBT are defined in Bq/L in the CRMP. The Task Force recommended that for future revisions of the CRMP it could be considered whether maintaining this definition in Bq/L is optimal for consistency and clarity.

NRA explained that, in addition, tritium and other nuclides including  $^{14}\text{C}$ ,  $^{129}\text{I}$  and gamma-emitters are also monitored regularly in seawater, marine sediment and marine biota by NRA, MOE, FAJ, Fukushima Prefecture, and TEPCO.

The Task Force noted that several new and updated information systems are maintained for the purpose of sharing the results of marine environmental monitoring data related to the discharge of ALPS treated water. To a certain extent the Task Force's recommendation to develop a collection of all the monitoring data into a single website and to share it in an easily accessible format has been addressed. However, there are now so many information systems available, all containing similar but not identical data (for instance, as not all information systems contain data from certain data providers and the different systems may have different update frequencies), that the Task Force believes that there is still a need for a single, clearly identified portal for the most up to date monitoring data.

NRA presented plans for a new comprehensive system that would address the Task Force's recommendation from the previous mission that a comprehensive website containing all the monitoring and analysis results would be beneficial for the public and help to streamline the access and consumption of relevant data. The Task Force welcomed this initiative but expressed some concern about the proposed timeline, with completion not expected until April 2027.

NRA reiterated the importance of the IAEA's ongoing verification of Japan's marine monitoring data. In January 2024, the IAEA published the results of two interlaboratory comparisons (ILC) for corroboration of ALPS-related monitoring: a second ILC based on samples of ALPS treated water and a first ILC based on environmental samples. Follow up ILCs for corroboration of both source and environmental monitoring are currently in progress and will continue to be carried out on an annual basis.

The Task Force again noted the importance of the IAEA's ongoing corroboration activities in providing an independent verification of the accuracy and reliability of the data reported by TEPCO and the Government of Japan. The ILCs and the onsite monitoring continue to provide the robust, independent corroboration of TEPCO's source monitoring, and the Government of Japan's marine environmental monitoring required for the IAEA review of the ALPS discharges, as requested at an early stage by the IAEA's ALPS Task Force. This corroboration is a key component of the IAEA's review of the safety aspects of the ALPS treated water discharges. The Task Force noted that laboratories are selected to participate in ILCs purely on technical factors, namely sufficient laboratory analytical capability and demonstrable measurement quality over an extended period.

## CONCLUSIONS AND OUTCOMES

During the mission, the Task Force received full cooperation from counterparts in TEPCO, METI and NRA and noted their commitment to providing the Task Force with comprehensive update information related to the discharge.

The Task Force did not identify anything that is inconsistent with the requirements in the relevant international safety standards. Therefore, the IAEA can reaffirm the fundamental conclusions of its safety review as outlined in the 4 July 2023 Comprehensive Report.

As part of its discussions during this mission, the Task Force identified several conclusions and outcomes that are summarized below:

The Task Force highlighted that NRA has continued with the comprehensive inspection plan including its onsite presence regarding the safety oversight of the discharge of ALPS treated water. Based on its observations at the site of FDNPS, the Task Force confirmed that the equipment and facilities continue to operate in accordance with the Implementation Plan and the relevant international safety standards.

The Task Force emphasized the importance of the IAEA's corroboration and the IAEA onsite independent tests and analysis, providing a comprehensive, transparent and independent verification of data quality and activity concentration measurements reported by TEPCO and the Government of Japan, to help build confidence.

The Task Force welcomed that TEPCO has presented the Radiological Environmental Impact Assessment (REIA) undertaken one year after the commencement of discharge (operation stage), using a source term that is equivalent to the discharge of ALPS treated water into the sea during the first year of operation. The results of the REIA show that the predicted activity concentrations in marine foods and the annual committed effective doses are very low, as was the case in the REIA undertaken before the start of operation. The Task Force indicated its full support for periodic reviews of the REIA in the future.

The Task Force suggested that TEPCO is gathering important data that could inform any further iteration of optimizing protection and safety. This includes information that allows TEPCO to test assumptions made in the REIA, but not only that. Through complex work on the discharge plan, TEPCO is continuing to build an understanding of the relationship between the discharge rate and the decommissioning of FDNPS. The Task Force highlighted the significance of this information, noting that the discharge limit is the key parameter to consider when comparing options for optimizing protection and safety as well as the national prevailing circumstances related to the discharge.

The Task Force reiterated its intention set out in the Comprehensive Report to "review NRA's approach to reviewing and potentially revising discharge limits in response to TEPCO's ongoing optimisation of protection and safety," noting that discharge limits should be influenced by the optimization of protection and safety, while understanding the situation surrounding ALPS treated water discharge in Japan. TEPCO and METI stated that they need to build a track record of safe discharges before discussing the review of the national requirement of annual amount of tritium discharged.

The Task Force continues to acknowledge the significant efforts with respect to monitoring made by the Japanese authorities -- including NRA, MOE, FAJ, Fukushima Prefecture and TEPCO -- contributing to marine environmental monitoring related to the ALPS treated water discharges, noting both the comprehensiveness of the programme and the professionalism demonstrated in its implementation.

The Task Force concluded that the current TEPCO's presentation of tritium monitoring data in seawater needs to be enhanced to avoid unnecessary confusion from the combination of results from analytical methods with significantly different detection capabilities. To improve clarity and transparency, monitoring results from rapid measurements (detection limit 10 Bq/L) and more sensitive analyses (detection limits 0.1 Bq/L (electrolytic method) and 0.4 Bq/L (Distillation method)) should be presented separately with appropriate explanations of their distinct purposes and limitations.

The variation in detection limits, even within the more sensitive analysis, further complicates the presentation of results. When communicating results to scientific audiences, all monitoring data should consistently include measurement uncertainty values and method detection limits alongside activity concentrations. The Task Force acknowledges that TEPCO has already implemented this approach for source monitoring results, which represents a positive practice that should be extended to all environmental monitoring data presented by both TEPCO and Government of Japan organizations.

The Task Force noted that the tritium activity concentrations measured in seawater from the sampling locations are at generally expected levels consistent with the results of TEPCO's dispersion modelling presented during the mission. This provides further confidence in the REIA as the same modelling techniques were used to simulate future seawater activity concentrations for this assessment. The Task Force encouraged TEPCO to publish this work more widely.

The Task Force encouraged Japan to continue analysing all monitoring results as they become available to track consistency with projections from the REIA and to identify any developing trends.

Regarding NRA's arrangements for independent verification of this source monitoring, while these were also found to be fit-for-purpose and in line with relevant international safety standards, the Task Force recommended that NRA enhance its data presentation by providing clearer visualization of its independent monitoring data and implementing direct side-by-side comparisons with TEPCO's operator measurements. This would further strengthen transparency and facilitate easier verification of the independent oversight process. The Task Force also stressed the importance of NRA publishing its independent environmental monitoring in a format that is easy to understand and also its comparison with the monitoring data from the licensee and other organizations. These data also need to be clearly separated for the independent measurements being made by IAEA.

The Task Force suggested establishing a single portal for the most up to date monitoring data by the Government of Japan, while they recognized that to a certain extent their recommendation has been addressed. While acknowledging that this is not directly required by relevant international safety standards, this important data should be shared as effectively and as widely as possible, in an easily accessible format with the relevant supporting information not least to promote transparency and to support the involvement of interested parties.

The Task Force again noted the importance of the IAEA's ongoing corroboration activities in providing an independent verification of the accuracy and reliability of the data reported by TEPCO and the Government of Japan.

The Task Force will continue to review the activities of TEPCO and NRA to assess whether they are consistent with the relevant international safety standards. During this mission, the Task Force proposed that the next review mission taking place in the first half of 2025 would focus on the ALPS monitoring programme and its results. The Task Force may also conduct additional ad hoc missions or technical reviews depending on the operational situation of the discharge of ALPS treated water or if key technical documents such as the Implementation Plan or REIA were to change significantly.

## REFERENCES

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### ANNEX III. MISSION AGENDA

Date	Time			Location	Activities
9 December	10:00	~	10:30	MOFA (Tokyo)	Opening Remarks (media present)
	11:00	~	12:30	METI (Tokyo)	IAEA, METI and TEPCO Meeting <ul style="list-style-type: none"> <li>• Overview of the 10 discharges (discharge amount, monitoring results, source term changing (adding Cd-113m ), facility inspection results)</li> <li>• Reference information (incident information)</li> </ul>
	13:30	~	17:00		<ul style="list-style-type: none"> <li>• Presentation of self-evaluation according to the related IAEA standards</li> <li>• Response to IAEA's finding at previous review mission (Frequency distribution of (personal) dose equivalent and revision of REIA)  <ul style="list-style-type: none"> <li>※ Will explain these points on 12th Dec.</li> </ul> </li> <li>• Briefing on the conditions on site, for the site visit on 11 Dec.</li> </ul>
10 December	09:00	~	15:00	NRA (Tokyo)	IAEA and NRA Meeting <ul style="list-style-type: none"> <li>• NRA's updates from the previous mission</li> <li>• Regulatory compliance status with IAEA safety standards during the discharge of the ALPS treated water</li> <li>• Updates of Sea Area Monitoring regarding ALPS treated water</li> </ul>
	15:30	~	22:00	-	Travel from Tokyo to the hotel in Fukushima (Iwaki Washington Hotel), via Naraha-town
	09:00	~	09:50	-	Travel from the hotel in Fukushima (Iwaki Washington Hotel) to TEPCO Decommissioning Archive Center
11 December	10:00	~	15:00	FDNPS (Fukushima)	Site visit to FDNPS <ol style="list-style-type: none"> <li>1) K4 tank area (10 min)</li> <li>2) Transfer facility building (15 min)</li> <li>3) Observation platform, Green Deck, by unit 5 and 6 (20 min)</li> <li>4) Discharge vertical shaft (20 min)</li> <li>5) J8 and J9 tank area (5 min)</li> </ol>

Date	Time			Location	Activities
	15:00	~	19:30	-	Travel from TEPCO Decommissioning Archive Center to the hotel in Tokyo
12 December	10:00	~	11:00	METI (Tokyo)	IAEA, METI and TEPCO Meeting • Findings of previous review mission (Frequency distribution of (personal) of dose equivalent)  Briefing on ORP corroboration actions (Mr. R. Cruz Suárez) - Update ORP corroboration to the Task Force
	11:00	~	12:30	METI	IAEA, METI and TEPCO Meeting • Findings of previous review mission (Revision of REIA (review of results of dispersion simulation at sea) )
	13:30	~	15:00		
	15:00	~	17:00	METI	Task Force inner meeting

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