Response of four Pacific Islands Forum Independent Expert Panel members to the "Note on the dialogue between Japan and the PIF Expert Panel on 1 June -(IAEA Safety Standards relating to justification)" sent by the Government of Japan to the Pacific Islands Forum on 29 June 2023

2023-07-06

With attachment of the 12 June 2023 paper on the concrete option

We appreciate that the Government of Japan has responded to the request of the Pacific Islands Forum on the issue of whether the dumping[1] of ALPS-treated radioactive water in the Pacific Ocean from the Fukushima Daiichi plant is justified, under the guidance of IAEA General Safety Guide No. 8 (GSG-8). This issue was raised by the Expert Panel (and not just the member of the Expert Panel who was designated to speak about it) during the virtual meeting on 31 May/1 June 2023 between TEPCO, the NRA, MoFA, PIF and the PIF-appointed Expert Panel.

It was apparent to the Expert Panel during the 31 May/1 June meeting that the NRA had not considered the specific guidance in GSG-8 that was discussed that day; it was stated that GSG-9 and GSG-10 were the guidance documents that Japan had considered. We appreciate especially that Japan now agrees that GSG-8 justification is relevant guidance as specified in paragraph 8 its letter: "Therefore, with regard to justification of the discharge of ALPS treated water, both GSG-8 and GSG-9 are relevant Safety Guides for a planned discharge of radioactive materials."

I. Standards of science

However, we did not find much of the rest of the letter as responsive as paragraph 8 to our concerns. The letter asserts three times that the environmental analysis and impact assessments done by Japan has been "performed to the highest international standards." We have, over the main conversations and officially in writing, stated that that is not the case. TEPCO's REIA is inadequate, inaccurate, and deficient in addressing numerous concerns.

Protocols for detecting radionuclides in ocean water, sediments and marine life are inadequate, and fall short of assessing sublethal deterministic and stochastic effects of association ionizing radiation on marine life and ecosystems. Specifically, the present experiments being performed by TEPCO do not address the critical and relevant questions of uptake, trophic transfer, and bioaccumulation of radionuclides in appropriate marine indicator species. In the tritiated water exposure experiments, no phytoplankton assays are being performed nor are any studies undertaken for filter feeding organisms. The bottom fish in the assays are being fed commercial fish pellets rather than exposed annelids, crustaceans, molluscs and smaller fish that would take-up, accumulate and trophically transfer radionuclides up the food web. Several offers by the Expert Panel members to design the appropriate experiments and protocols were

[1] The terms "dump" and "dumping" are used in this paper in the technical sense of the title of the 1972 treaty "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter". Japan is a party to the treaty.

rejected by TEPCO (Junichi Matsumoto), which is taken as proof that they are not interested in collecting relevant data that may demonstrate and confirm concerns regarding their present plans.
In addition to tritium and C-14, inadequate data are provided on Sr-90, Cs-137, Co-60, Ru-106 and several other radionuclides of interest. There is no mention of measurable biological effects on DNA (nuclear and mt), RNA, signaling proteins, and telomeres which can all be detected using modern multi-omics technics and may result in the need to re-evaluate accepted standards.
When the Expert Panel pointed out the REIA did not consider organically bound tritium, Japan's response was to include an OBT factor related to drinking water, though somewhat higher at 10%. Our point has been that the oceanic ecosystems need to be assessed in their specificity. For instance, Japan has not considered the issues of exchangeable and non-exchangeable tritium an especially the latter, in the context of ocean ecosystems. The following characteristics of non-exchangeable tritium illustrate the necessity of factoring it in specifically:

> The amount of time that tritium remains incorporated therefore depends on biomolecular turnover: fast in the case of molecules involved in the energy cycle, and slower in the case of structuring molecules or macromolecules such as DNA or energy reserve molecules. *These exchange mechanisms are common to all living organisms, plant and animal alike.*[2]

The entire complex of forms of tritiated water needs to be considered for the ecosystem, not just waved away by doing a drinking water calculation:

> The distribution between tritiated water, exchangeable and non-exchangeable tritium varies according to the respective intake of HTO or OBT, the nature of the organic bonds generating OBT *and the metabolism of each individual species.*[3]

We have also pointed out that the measurements of radioactivity in the tanks also have basic and fundamental deficiencies, like biased and insufficient sampling and bizarre measurements of tellurium-127.

This is not, in our view science done "to the highest international standards"; far from it.

Without adequate testing of ALPS, including with water from tanks with sludges, and without a sound REIA the Government of Japan cannot assert, as it has done in the letter that "no harm is expected" from the dumping. A statement like that must be based on the best science; Japan has so far failed in that regard. We reject this conclusion because it is not scientifically well founded.

II. Justification

The matter is relevant because it goes directly to the heart of the justification issue. If the science underlying the claim of the expectation of "no harm" is flawed, the claim should be rejected. As a corollary, Japan's claim that the justification requirement has been fulfilled is also scientifically unacceptable.

Your letter appears to assume that justification guidance in GSG-8 is optional. It is not. GSG-8 (like GSG-9 and GSG-10) were written as guidance for the requirements in GSR Part 3. GSG-8 states clearly that

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[2] P. Calmon and J. Garnier-Laplace, Tritium and the Environment. Paris, France : Institut de Radioprotection et de Sûreté Nucléaire, 2010. On the Web at http://www.irsn.fr/EN/Research/publications-documentation/radionuclides-sheets/environment/Documents/Tritium_UK.pdf p. 3, italics added
[3] Ibid., italics added

justification "applies to all situations and also that paragraph 2.11, which you quote, applies to planned activities. The dumping is a planned activity.

The core of the justification argument in the letter is that "decision on justification should be made for the overall decommissioning process of FDNPS." The specific argument is that there is limited room on the site and that dumping will make room for other decommissioning activities to proceed smoothly. We have not agreed with this argument in the past, but are accepting it here for the sake of argument. The issue of room on the site and the emptying of the tanks to make that room will be much better met by the concrete option we first proposed in August 2022. We have more recently published a detailed paper on the topic, which is appended to this response. It would empty the tanks much faster than the thirty years now envisioned for the TEPCO plan, while at the same time avoiding transboundary contamination and the ecological damage that will occur as a result of the decades-long operation.

Japan at first basically ignored the concrete option proposed by the Expert Panel, then incorrectly stated that it had already been considered – it had not. In fact, as we state in our paper on our concrete option, we would also have rejected the option that TEPCO considered in 2016. There have been informal responses, such as the water having too high a salt content or evaporation during concrete making – issues that we believe are either not material or can be overcome. Japan has done no serious analysis and has refused to address the many benefits, including for decommissioning that the Expert Panel concrete option would bring. We stated in August 2022 that this option, among the others, "*may have orders of magnitude lower impact than the proposed course*" (italics in the original) and our subsequent analysis confirms that the doses from tritium with this option would be essentially zero as would the ecological damage. The letter continues the Japanese refusal to address the Expert Panel concrete option seriously by not mentioning it at all.

Besides the issue of the lack of sound scientific basis for a claim that "no harm is expected", we cannot agree with the substance of the claim. Ecological harm is to be expected from such a prolonged campaign to dump hundreds of millions of tons of radioactive water (post dilution) into the ocean. Reputational harm has already occurred. We note that despite the reported offer of 50 billion yen to the Japanese fishing community, they remain opposed to the dumping. This means that for this important cultural and economic community, the dumping is not justified as the harm outweighs the benefit. The salt panic in South Korea has also caused economic and cultural harm. It indicates that TEPCO and the Japanese government are not trusted. Dr. Tatsujiro Suzuki explained why this is so in a 2021 article in the Bulletin of the Atomic Scientists.[4] Thus, it is clear that the claim of no expected harm in the letter has already been proven false by the facts on the ground, if we recall that GSG-8 guidelines include consideration of societal factors.

III. Optimization

The Expert Panel had also raised the issue of optimization, which is part of IAEA requirements and guidance. The ALARA principle, which is not mentioned in the letter, but which the Expert Panel discussed with Japan, requires that reasonable measures be taken to keep exposures as low as reasonably achievable;

[4] Tatsujiro Suzuki, "Why Japan's Plan for Fukushima Water Lacks Public Trust", Bulletin of the Atomic Scientists, 13 May 2021 at https://thebulletin.org/2021/05/whats-wrong-with-japans-anticipated-release-of-fukushimas-wastewater/

optimization also states that "Protection of the environment should also be considered in the process of optimization of protection and safety." (GSG-8, paragraph 2.16) The Expert Panel concrete option would avoid harm to the oceanic environment. However, low the doses may be from the ocean dumping of radioactive water for 30 years (possibly more), the concrete option would have lower doses to the public than the TEPCO plan because tritium beta particles would not penetrate the concrete and not become part of living ecosystems. Thus, the TEPCO plan is also not optimized and does not follow the guidance of GSG-8 or the corresponding requirement in GSR Part 3 either for radiation dose or for the environment.

IV. Protection and Safety of Society

Finally, we were surprised to read this claim in your letter:

> During the dialogue, one PIF expert, referring to paragraph 2.11 of GSG-8, stated that there needs to be benefit to other countries like PICs brought by the discharge of ALPS treated water, because the harm from the discharge is not zero. On this point, the GOJ is of the view that paragraph 2.11 does not require benefit to each individual country within the scope of review. Rather, the question is whether the planned activity will result in benefit to society overall, and whether the benefit will outweigh any harm.[5]

Read literally, Japan is claiming that the entire Pacific region is one society. Societies are defined by common cultures and institutions, including decision-making institutions. Were the entire Pacific region one society, the people of the whole region via their governmental and regulatory institutions, would have decision-making power over the critical and enormous common resource, the Pacific Ocean. But Japan here is claiming that the region is a society as a whole but at the same time reserving to itself alone the right to decide to dump radioactivity into the most critical common resource for a large number of countries. If the Pacific region were a society in the sense of assessing benefits and harms, would not the governments of all the region's countries have the right to assess those benefits and harms and participate in the decision-making about which options are most appropriate. If the all the people in the Pacific region were a society, would there be visa restrictions on the citizens of many of them preventing easy movement in and out of Japan, as is the case for the citizens of Australia and New Zealand but not the case for people of most other countries. If Japan truly believed that to be the case it should open up the decision to all the governments of the region, including PIF members, South Korea, China, and the Philippines. Unless Japan does that, we would consider that each country should be considered as a society responsible for protecting its resources. Japan has not done that. It is clear that by the common definition and usage of the term "society" and the specific circumstances of the decision-making of the present issue, the dumping plan is neither justified nor optimized.

V. Conclusions

We are dismayed that the IAEA has not given due attention to rigorous science and has not fully considered the justification aspect of safety and protection requirements that are the documents it said it would use to evaluate the dumping plan.

5. The Government of Japan should note that the Expert who presented on GSG-8 was doing so on behalf of the whole panel.

The health of ocean life is in decline from a plethora of human-induced disturbances, ranging from pollution and over-exploitation of resources to the impacts of global climate change, and the reduction of pollutants entering the ocean is a key target of ongoing activities and goals undertaken under the present U.N. Ocean Decade.

We hope that Japan, having recognized that GSG-8 is linked to various requirements and that justification is an essential part of the framework, would halt preparations for dumping and consider the options to avoid harming the oceans – they urgently need the world's protection. We urge Japan to include a full consideration of optimization as well. We are ready to collaborate with the Government of Japan, the NRA, and other institutions in such an endeavor.

Signed

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- Dr Ken Buesseler, Senior Scientist and Oceanographer, Woods Hole Oceanographic Institution

ATTACHMENT

PAPER ON THE CONCRETE OPTION

Minimizing Harm: the concrete option for solving the accumulation of radioactively contaminated water at the Fukushima Daiichi Nuclear Power Plant site

A paper prepared by the Independent Expert Panel to the Pacific Islands Forum

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Abstract: The Tokyo Electric Power Company (TEPCO) proposes to treat 1.3 million cubic meters of accumulated, radioactively contaminated water to greatly reduce concentrations of all radionuclides other than tritium and carbon-14 by using the Advanced Liquid Processing System (ALPS). It proposed to dilute the resultant water so that the tritium concentration would be 1,500 Bq/liter, which is one-seventh drinking water guideline of the World Health Organization for that radionuclide. Japan's Nuclear Regulation Authority and the IAEA have been evaluating the health and environmental impact questions with the presumption that TEPCO's plan could comply with IAEA guidelines and Japan's regulations. However, a presumption that TEPCO's plan would comply in principle with all guidelines does not appear to include the transboundary implications of IAEA's guidance in its General Safety Guide No. 8 (GSG-8) that requires that benefits outweigh the harms for individuals and societies. The Expert Panel of scientists appointed by the Pacific Islands Forum have recommended an option that would avoid transboundary impacts, in conformity with GSG-8. That option is to treat the water in the ALPS system as now proposed by TEPCO and then to use it to make concrete with little potential for human contact, such as the concrete being used on the Fukushima Daiichi site and/or tsunami barriers for coastal protection. This Expert Panel paper is focused on the concrete option; it should be seen in the context of the broader issues with the TEPCO plan that were covered in an overall assessment made by the Expert Panel in August 2022.[1]

Over 1.3 million metric tons of radioactively contaminated water are stored in about 1,000 tanks at the Fukushima Daiichi Nuclear Power Plant Site (hereafter "Fukushima"). The water contains dozens of radionuclides, much of it in high concentrations thousands of times higher than present drinking water standards. These radionuclides include cesium-137, which emits penetrating gamma radiation, and strontium-90, which emits strong beta radiation and concentrates in the bone. The predominant radionuclide, in terms of quantity of radioactivity is tritium – a radioactive isotope of hydrogen; it is in the form of tritiated water, HTO, in which an atom of ordinary hydrogen in water has been replaced by radioactive tritium.

The Tokyo Electric Power Company, (TEPCO) which owns the power plant, has proposed that the water in the tanks be treated through its Advanced Liquid Processing System (ALPS) to greatly reduce the concentrations of all radionuclides except tritium and carbon-14, the latter being present in relatively small amounts. This ALPS-treated radioactive water would then be diluted to reduce tritium concentrations to below the Japanese regulatory standards and released into the Pacific Ocean over a period of roughly thirty years about 1 kilometer off the East Coast of Japan. The dilution factors needed

[1] Expert Panel to the Pacific Islands Forum, "Summary of Information and Data Gathered at Meetings and the Expert Panel's Views of the Scientific Status of the Planned Release of Radioactively Contaminated Cooling Water from the Fukushima Nuclear Power Plant Disaster," 11 August 2022

would depend on the batch of water since tritium concentrations in tanks are from about 100 times to over 1000 times TEPCO's target concentration of 1,500 Bq/L. TEPCO has stated that the dilution factor will be over 100 times but has not provided a more precise estimate of the overall average expected dilution factor.

Since contaminated water is still being generated, this ocean dumping – that is what it would be called if the water were put in a barrel and thrown overboard – of radioactive water would continue for 30 years (possibly more).[2] The water would still contain some strontium-90 and other radionuclides with attendant risks of uptake associated with seafloor sediments at the outfall point, trophic transfer, bioconcentration and propagation through oceanic ecosystems. Besides the radioactivity exposure, which TEPCO estimates will be well below 1 millisievert per year, the dumping would also create reputational damage to the fishing and tourist industries, not only in Japan but across other countries in the Pacific region. In this paper, we explore a specific alternative that would greatly mitigate or avoid numerous environmental, legal and reputational problems. Specifically, we propose that TEPCO:

- Treat the water with the ALPS system, as now proposed, independently confirming concentration levels in every tank;
- Use this water without dilution to make concrete for useful applications that have little potential for public contact.

Treating the water with the ALPS system to the degree now proposed would leave only very small quantities of radionuclides like strontium-90, cobalt-60 and cesium-137, if the ALPS system works smoothly or if the waste is treated multiple times, both contingencies having been mentioned by TEPCO and the IAEA in the context of the TEPCO plan. In effect, the first step in our proposal is the same as that proposed by TEPCO, except that we advocate better testing of the ALPS system in advance and over time to ensure that it is working effectively and continues to do so.

The second step is very different. In the TEPCO plan, dumping the water in the Pacific Ocean would lead to varying degrees of bioaccumulation and bioconcentration of different radionuclides including strontium-90, cesium-137, cobalt-60 and tritium, as well as propagation of radioactive exposure through oceanic food webs. These processes would not occur if the water is used to make concrete.

The potential for radiation exposure to the public would also be essentially eliminated. Tritium decays by emitting relatively low-energy beta particles with an average energy of 5.7 kilo-electron volts (range 0 to 18.6 keV). The stopping distance of the tritium beta particles in concrete is only a few microns at most. Essentially no beta particles would exit the concrete. If someone came close to the structure, their clothes would stop any particles that exited. Tritium beta particles can be stopped by a sheet of paper. That is why its principal risks arise when it is inside the body and becomes part of our cells, potentially disrupting their metabolism, among other things. This is a critical difference between putting radioactive treated water into the ocean and making concrete with it.

It is also important to note that water binds chemically with the cement. Thus, even the disintegration of the concrete over the decades, should that occur, will not result in public radiation exposure from

[2] "Dumping" is the formal term to describe such an activity as evidenced by the title of the 1972 treaty to prevent ocean pollution: "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter".

tritium. The short stopping distance means that tritium's beta particles would still be stopped within the concrete.

The half-life of tritium is 12.3 years. Almost the entire tritium radioactivity (about 97%) in the ALPS-treated water would have decayed away in about 60 years – which may well be the duration of discharges of ALPS treated water given the generation of additional groundwater fed cooling waters until the molten fuel has been removed from the stricken reactors. While TEPCO claims that the water discharges would last for thirty years, it is noteworthy that there is still some residual fuel debris in the Three Mile Island Unit 2 reactor. Its decommissioning is not expected to be complete until 2037, 58 years after the 1979 partial meltdown.[3] The accident at Fukushima was much more severe, involving multiple meltdowns, explosions, and reactor vessel damage.

The risk would also be reduced by the much shorter time frame in which the accumulated water could be dealt with if the concrete option is adopted. Japan uses about 40 million tons of cement a year, according to the Japanese Cement Association. Assuming that use patterns are similar to those in the United States, about a third of this may be used for making concrete with low potential for human contact. Some or much of the ALPS treated water could actually be used for concrete needed at the Fukushima Daiichi site – for barrier walls, containers, stabilizing piles of radioactive soil and the like.

At the low end, about 0.4 liters of water are mixed with a kilogram of cement. Thus, the accumulated water could be consumed in just about 8% of the cement used in Japan in a single year. Assuming that a much smaller fraction of concrete were made with it – on the order of 1% or 2% each year – the stored water would be consumed in less than a decade. After that, only the water generated by cooling in real time would be used. Thus, the risks from earthquakes damaging tanks and spilling their contents into the Pacific Ocean, would be much reduced.

We first proposed the concrete option for evaluation by TEPCO in its August 2022 assessment of the TEPCO proposal and the various scientific and technical issues associated with it prepared for the Pacific Islands Forum, made available to TEPCO and other Japanese authorities as well as the International Atomic Energy Agency (IAEA). We noted that this option, among others, *"may have orders of magnitude lower impact than the proposed course"* (italics in the original).[4] Transboundary impacts would be essentially avoided. Despite that, the option has not been taken seriously, much less officially evaluated.

During the April 13, 2023 meeting with the Expert Panel, TEPCO took the position that it had already considered the concrete option in 2016 and rejected it in favor of ALPS treatment and release of the radioactively contaminated water[5] into the Pacific Ocean. The Expert Panel has reviewed the TEPCO

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[3] U.S. Nuclear Regulatory Commission, Three Miles Island Unit 2 – Site Status Summary, at https://www.nrc.gov/info-finder/decommissioning/power-reactor/three-mile-island-unit-2.html viewed on 2023-05-16

[4] Expert Panel paper prepared for the Pacific Islands Forum, August 11, 2022, op cit.

[5] TEPCO has insisted that the post-treatment water be called "ALPS treated water" without the use of the phrase "radioactively contaminated." However, it is a simple fact that the water to be released will have radioactive tritium, carbon-14 as well as small amounts of other radionuclides. It is, objectively speaking radioactive water. This scientific fact could, with apologies to Shakespeare's Romeo and Juliet, be stated as: "radioactive water by any other name would be just as radioactive".

concrete proposal; it is fundamentally different in a number of ways and in its implications for impact on the environment.

The concrete option evaluated by TEPCO in 2016 has the following features:

- It would significantly increase the volume of waste;
- The water in the tanks would not be treated. As a result, the full complement of radionuclides in the tanks would be solidified. As the Expert Panel has repeatedly noted, and as one of our members detailed in an article published in Science in 2020, some tanks contain very high concentrations of strontium-90 and cesium-137.[6]
- Failing to treat the water to remove almost all of the radionuclides other than tritium and carbon-14 would make it more risky for workers to make the concrete and for the public over the decades that the concrete might deteriorate. The radiation emanating from the concrete would no longer be essentially completely stopped by the concrete itself.
- The TEPCO option was to bury the concrete either above or below the ground water table. This kind of processing and disposal is called grouting. While there is no exact parallel to the Fukushima Daiichi situation, disposal of radioactive waste with high concentrations of radionuclides in soil by grouting has not had good success in the United States.[7]

We would therefore agree with the TEPCO rejection of the option of mixing untreated tank water with a cementitious material and disposing of it underground. The Expert Panel proposal is fundamentally different and deserves an official assessment by TEPCO on its own merits.

In the months since we proposed the concrete option, we have also examined the matter of the compliance of the TEPCO proposal with IAEA public safety and environmental protection guidelines. TEPCO and the IAEA have claimed that even though Japan's Nuclear Regulation Authority has given the go-ahead to build the tunnel in preparation for the release of the radioactive water, no such release would actually occur until the IAEA guidelines were met. However, it appears that the TEPCO plan would violate certain IAEA guidelines even if its criteria for safety of the water for release were fully met.

Specifically, we have examined IAEA's General Safety Guide No. GSG-8, entitled *Radiation Protection of the Public and the Environment*.[8] The provisions at issue are also contained in Publication 124 of the International Commission on Radiological Protection.[9]

GSG-8 advises that planned actions that would create radioactive impacts should first of all be justified and, if they are, then they should be optimized. These terms have very explicit meanings in GSG-8. Justification, as per paragraph 2.11, means that the "benefits to individuals and to society" should "outweigh the harm (including radiation determent)".[10] Countries other than Japan will not experience

[6] Ken O. Buesseler, "Opening the Floodgates at Fukushima: Tritium is not the only radioisotope of concern for stored contaminated water," *Science*, 2020 http://science.sciencemag.org/content/369/6504/621

[7] Brice Smith, What the DOE knows and does not know about grout," Institute for Energy and Environmental Research, 2004 at http://ieer.org/wp/wp-content/uploads/2004/10/grout.pdf

[8] IAEA, Radiation Protection of the Public and the Environment, General Safety Guide NO. 8 (GSG-8), International Atomic Energy Agency, 2018 at https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1781_web.pdf

[9] International Commission on Radiological Protection, Protection of the Environment Under Different Exposure Situations, ICRP Publication No. 124, 2014, at http://journals.sagepub.com/doi/pdf/10.1177/ANIB_43_1

[10] GSG-8, 2018, op. cit.

any benefits from the proposed releases of ALPS treated radioactive water. *Given zero benefits, any harm will necessarily outweigh the benefits, even if the harm is small*. It appears to us therefore that, for the societies in the Pacific region, the justification requirement of GSG-8 has not been met.

Neither the first IAEA report, based on its first visit in February 2022,[11] nor the most recent (visit of January 2023)[12], refer to GSG-8 or the justification principle in it. Yet, the IAEA itself has explicitly included GSG-8 as one of the "relevant standards for radioactive discharges to apply to this [Fukushima] review."[13]

The IAEA appears to have endorsed the idea of release of ALPS-treated radioactive water to the Pacific Ocean even before it conducted any missions to Japan specific to the issue. At the announcement of the agreement by the IAEA to review the releases of water in April 2021 – several months before its first mission to Japan, the Director General of the IAEA had expressed a clear, positive opinion on the TEPCO plan saying that it was "both technically feasible and in line with international practice, even though the large amount of water makes it a unique and complex case."[14] Director General Grossi made no reference to the transboundary aspects of justification. The only justification he offered is that it is common practice done under "strict safety and environmental standards." In effect, the practices of states with nuclear power plants to impact countries without them via routine discharges of radioactive water to the oceans were used to endorse an admittedly complex and unique TEPCO proposal.[15] The simple fact is that when there is harm to countries that do not dump radioactive wastewater to the oceans, GSG-8 indicates that there is no justification for imposing such harm on them even if it is small.

Optimization is the next major issue, if actions are justified. GSG-8, ICRP-124, and other official publications provide explicit guidance that keeping radiation exposures "as low as reasonably achievable" is a part of the optimization process.[16] The IAEA has discussed optimization as part of its Task Force evaluations but only in the context of release of radioactive water to the Pacific Ocean. [17] The IAEA has made specific reference to the principle of keeping doses "as low as reasonably achievable" (known by its acronym as the ALARA principle) but only in reference to keeping doses low in the context of the TEPCO plan.

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[11] IAEA Review of Safety Related Aspects of Handling ALPS-Treated Water at TEPCO's Fukushima Daiichi Nuclear Power Station -- Report 1: Review Mission to TEPCO and METI (February 2022), IAEA, 2022, p. 35

[12] IAEA Review of Safety Related Aspects of Handling ALPS-Treated Water at TEPCO's Fukushima Daiichi Nuclear Power Station -- Report 5: Review Mission to NRA (January 2023), IAEA, 2023.

[13] "Overview of the IAEA", International Atomic Energy Agency, February 2023, Slide 48.

[14] IAEA video, "Statement by IAEA Director General on Fukushima Water Disposal," 13 April 2021, at https://www.iaea.org/newscenter/multimedia/videos/statement-by-iaea-director-general-on-fukushima-water-disposal

[15] The first IAEA visit on the water issue occurred in September 2021, almost five months after Director General Grossi's April 2021 statement. See IAEA Press Release, IAEA Team Visits Japan to Begin Implementing Project to Monitor and Review Water Release at Fukushima Daiichi, 6 September 2021 at https://www.iaea.org/newscenter/pressreleases/iaea-team-visits-japan-to-begin-implementing-project-to-monitor-and-review-water-release-at-fukushima-daiichi

[16] GSG-8, paragraph 2.16, p. 7 and ICRP 124, p. 20

[17] IAEA Review of Safety Related Aspects of Handling ALPS-Treated Water at TEPCO's Fukushima Daiichi Nuclear Power Station -- Report 1: Review Mission to TEPCO and METI (February 2022), IAEA, 2022, p. 35

A variety of national and international guidance and regulatory documents provide insight into the interpretation of the phrase "as low as reasonably achievable". Even if the public doses from the proposed TEPCO action were to be very small, they will be higher than those from our specific concrete-making proposal. Demonstrating that the optimization goal has been achieved requires all reasonable alternatives be examined. For instance, the U.S. Nuclear Regulatory Commission has a poster which explains the ALARA principle as follows:

> ALARA is the principle of reducing exposures to radiation when it is reasonable or practical to do so—that is, reducing radiation exposures to As Low As Reasonably Achievable, or ALARA.
>
> • ALARA evaluations usually address two aspects of what actions are reasonable: (1) typical good practices that are done to reduce exposures and (2) *comparison of costs and benefits of alternative actions.*[18]

In summary, treating the water and making concrete with low potential for human contact is a feasible and reasonable option that would essentially eliminate transboundary harm, have essentially zero doses; it could reduce earthquake risk by being completed decades before the action proposed by TEPCO. Yet none of the parties – TEPCO, the NRA, or the IAEA – have addressed the comparative costs and benefits or even accepted the need to evaluate this option as part of the optimization process.

In addition, In addition while the IAEA and TEPCO have repeatedly stated that they will fulfill their respective roles and ensure the release of ALPS-treated radioactive water to the Pacific Ocean over decades will be "safe" and in conformity with IAEA safety and environmental guides, the term has been construed narrowly , without due consideration of the justification and optimization requirements of GSG-8 in regard to the people and societies in the Pacific region. The fact that other countries with nuclear power have been releasing radioactively contaminated water into the seas without due regard to GSG-8's transboundary implications for countries without nuclear power cannot negate that fact.

We urge the NRA and the IAEA to include consideration of the transboundary implications of GSG-8 and the comparative implications of the concrete option as outlined here versus the dumping action proposed by TEPCO.

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[18] U.S. Nuclear Regulatory Commission, *Poster Title: ALARA Evaluation*, 16 September 2009, at https://www.nrc.gov/docs/ML0925/ML092530539.pdf , italics added.