

Line-by-line comment on "ICRP PUBLICATION 1XX
Radiological Protection of People and the Environment in the Event of a Large Nuclear Accident
Update of ICRP Publications 109 and 111"

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Following my general comment posted earlier, I comments line-by-line for the draft. My comment is added after (Comment).

MAIN POINTS

Line 39 The principle of optimisation of protection applied with reference levels, considering all impacts (radiological, non-radiological, social, economic, and environmental), is essential to mitigate the consequences during the emergency response and to improve living conditions in affected areas during the recovery process.

(Comment) Listed consequences are mixture of micro (individual level) and macro (aggregated or social) levels, they should be sorted out. Additionally, in the draft body, no literature on thyroid cancer in Fukushima is cited. On the contrary, papers on psychological consequence and lifestyle are cited. Biased citation seems to underestimate the effects of radiation exposure.

Line 44 For protection of responders and the population during the emergency response, the reference level should not generally exceed 100 mSv, while recognising that higher values may be necessary to save lives and for the prevention of catastrophic conditions.

(Comment) It should be explicitly stated that the dose here is effective dose. It is necessary to explain why the reference level for responders who deal with accidents and the general public is the same.

Line 48 For people living in long-term contaminated areas during the recovery process, progressive reduction in exposure will result from continuing optimisation of protection. Reference levels should be selected to support this progressive improvement, taking into account the progress already achieved. Levels should be within or below the Commission's recommended 1–20-mSv band taking into account the actual distribution of doses in the population and the tolerability of risk for the long-lasting existing exposure situations, and would not generally need to exceed 10 mSv per year. The objective of optimisation of protection is a progressive reduction in exposure to levels on the order of 1 mSv per year.

(Comment) In this paragraph, the reference level can be interpreted as 1 -20 mSv, but Table 6.1 defines it as ≤ 10 mSv per year. The reason lowering upper limit is not explained and "tolerability" is not defined. Adding "the order of" to "1 mSv per year" seems to allow higher exposure for the long-term. To avoid ambiguity, changes from previous publication and their reasons must be explained, or the sentence should be simplified as follows.

Levels should be within or below the Commission's recommended 1–10-mSv/year band for the long-lasting existing exposure situations. The objective of optimisation of protection is a progressive reduction in exposure to 1 mSv per year.

Line 57 For protection of the public and the environment during the recovery process, the Commission recommends a 'co-expertise' approach in which authorities, experts, and stakeholders work together to share experience and information in affected communities, with the objective of developing a practical radiological protection culture to enable individuals to make informed decisions about their own lives.

(Comment) I believe that the 'co- expertise' is recommended based on the experiences in ETHOS in Chernobyl and Fukushima. ETHOS was originally performed at Chernobyl, but is not introduced at all in "ANNEX A. CHERNOBYL." For Fukushima, the draft and ANNEX B. FUKUSHIMA quoted Ando (2016, 2018), an individual's subjective assessment, in which authorities unilaterally set standards without considering the opinions of the residents that is far from ICRP's stakeholder participation principle. Although more than 20 Fukushima dialogues have been conducted, the activities of ETHOS in Fukushima are limited to some areas and the number of participants is also limited¹. Moreover, Kimura (2018) criticized ETHOS in Fukushima as "It has

¹ Lochard, J., T. Schneider, R. Ando, O. Niwa, C. Clement, J. F. Lecomte, and J. I. Tada (2019), "An Overview of the Dialogue Meetings Initiated by Icrp in Japan after the Fukushima Accident," *Radioprotection*, 54 (2), 87-101.

helped portray the reduction of government/industry responsibility.” Recommendation should be grounded by quantitative studies by third parties.

Additionally, although Ando (2016, 2018) describes the measurement of dose with a personal dosimeter, in Date City, there was a research ethics problem in which professors published papers analyzing data from a person who does not consent to use the data for research (Miyazaki and Hayano 2017a, b). There is also criticism that (Miyazaki and Hayano 2017b) underestimates the effectiveness of decontamination (Kurokawa and, Tanimoto 2019).

As mentioned in my general comment, these activities originated from the failure of companies responsible for the nuclear accident to take appropriate measures. Because of the premise of accountability and the lack of positive evidence, "co-experts" should be removed and the paragraph should be modified as follows.

Line 57 For protection of the public and the environment during the recovery process, the Commission recommends ~~a ‘co-expertise’ approach in which authorities, experts, and stakeholders work together to share experience and information in affected communities, with the objective of developing a practical radiological protection culture to enable individuals~~ authorities to enable residents or stakeholders to access necessary information and to participate policy making process to make informed decisions about their own lives.

EXECUTIVE SUMMARY

(g) The principle of optimisation of protective actions applied with reference levels aims to
(Comment) It should be clarified optimized for whom: residents or government?

Line 107 (i) For protection of responders and the population during the emergency response, the reference level should not generally exceed 100 mSv,
(Comment) Please clarify dose is “effective dose.” Upper limit for the public should be lower than that for the responders as a profession.

Line 114
(Comment) As pointed out in Line 48, this should be modified accordingly.

Line 125 (l) co-expertise process
(Comment) Changes should be made as described above.

Line 166 (3) Following the Fukushima nuclear accident in March 2011 in Japan, the Commission identified a first series of issues relevant to implementation of the system of radiological protection of people and the environment in the case of a large nuclear accident (ICRP, 2012b). These issues included: difficulties related to the quantification of exposures; interpretation of potential radiation-induced health effects; ad-hoc protection of responders; societal impacts of the evacuation of people; recognising the importance of psychological consequences; and challenges related to the rehabilitation of living conditions in contaminated areas. The present publication is intended to address some of these issues, together with the lessons learned during the decade following the accident.

(Comment) As I explained above, ICRP TG 84 (2012) was written 1 year after the accident. Thus, there is a lack of understanding of the facts in later phase. Please add the facts I listed in the general comment.

1.2. Scope and structure of the publication

Line 194 (6) This publication was to recommend application of the system of radiological protection
(Comment) As mentioned in my general comment, positioning of this publication must be clarified.

Line 193 (6) This publication was to recommend application of the system of radiological protection in emergency and existing exposure situations related to radiological accidents, respectively. While Publications 109 and 111 were intended to deal with all exposure situations resulting from a nuclear accident or a radiation emergency, this publication focuses on the protection of people and the environment in the case of a large nuclear accident.

(Comment) In the case of large nuclear accident, the necessity of *permanent relocation* increases. Publication 109 has a separate section: “8.3 permanent relocation”, but the draft does not. Permanent relocation is an important alternative and should be a separate section.

Line 209-211 They underline the role of the ‘co-expertise process’ for the rehabilitation of living conditions of affected people during the recovery process.

(Comment) As mentioned above, 'co-expert process' is not working, this sentence should be deleted.

Line 223 (9) The recommendations given in this publication for the protection of people and the environment during the emergency response and the recovery process of a large nuclear accident supersede all previous recommendations (ICRP, 1984, 1991, 1999, 2009a, b).

(Comment) It says supersede all previous recommendations, but ICRP (2009 a, b), ICRP 111 & 109, deals with situations other than a large nuclear accident and cannot be superseded by the draft.

270 2.2. Consequences of a large nuclear accident

(Comment) This is a new section that Pub 109 & 111 did not have. They are arranged in the following order.

- 2.2.1. Radiation-induced health effects
- 2.2.2. Consequences for fauna and flora
- 2.2.3. Societal consequences
- 2.2.4. Economic consequences
- 2.2.5. Psychological consequences
- 2.2.6. Health impacts of changes in lifestyle

It seems effects of radiation are listed in 2.2.1 and 2.2.2, and non-radiation consequence are listed in other section. Those that are important to humans should be listed first. For each consequence, problems at the individual level and at the national and local government levels are mixed. Taking into account the participation of stakeholders in decision making, the level of impact should be classified as Table 2.

Table 2 Classification of Consequences of a large nuclear accident

	Micro (Individual) level	Macro (country, region) level
Radiation induced Health Effect		
Economic consequences		
Psychological consequences		
Societal consequences		
Health impacts of changes in lifestyle		
Consequences for fauna and flora		

Line 301 Table 2.1. Dose thresholds for selected tissue

(Comment) The relationship between dose here and effective dose used at the reference level should be explained.

Line 324 (22) There is reliable scientific evidence that whole-body exposures on the order of ≥ 100 mSv can increase the probability of cancer occurring in an exposed population.

(Comment) With regard to Fukushima, it was misunderstood that "risk coefficients is insignificant " for doses below 100 mSv is "There is no effect." This paragraph should clearly indicate the adoption of the LNT model that reject threshold. The source of the quotation of "Whole body exposures on the order of ≥ 100 mSv can increase" is ICRP (2007). Since then, there have been a number of papers in which significant coefficients have been obtained with an average exposure of less than 100 mSv (For example, Richardson et al. 2015, Leuraud et al. 2015). In recent survey of epidemiological studies, NCRP (2018) concluded “Most of the larger, stronger studies broadly supported an LNT model. Furthermore, the preponderance of study subjects had cumulative doses < 100 mGy (NCRP 2018, p.6)”. Therefore, it should be rewritten as follows.

(22) There is reliable scientific evidence that even whole-body exposures < 100 mSv can increase the probability of cancer occurring in an exposed population (NCRP 2018, p.6).

Line 315 2.2.1.2. Cancer and heritable diseases

(Comment) No papers are cited in the section, please add the following paragraph after (23).

(23) Regarding the results of thyroid ultrasound examinations in Fukushima, Ohira et al. (2016) and Suzuki et al. (2016) examined regional differences of thyroid cancer detection rate for the 1st round and conclude that there is no significant difference, on the contrary, Tsuda et al. (2016) reported statistically significant regional differences. Kato (2019) related external dose and thyroid cancer detected in the 1st and 2nd round and obtained statistically significant relationship. Health effect of radiation is undetermined in Fukushima.

Line 335 2.2.3. Societal consequences

(Comment) There is a mixture of micro and macro levels, including the possibility of individual migration (Para 26), damage to public goods such as infrastructure (Para 28), loss of confidence in expert and authorities (Para 29), and problems in areas where evacuees can be accepted (Para 30). It should be organized as described above.

It should be noted that the term "a collapse of trust in experts and authorities (Para 29)" has various meanings, and the definition of "trust" should be clarified. If trust is a part of what we call "social capital", it is a macro-level concept. How to measure trust and evaluate consequence of "collapse of trust" is unclear and impractical. It is necessary how to measure and evaluate listed consequences.

Line 393 2.2.4. Economic consequences

(Comment) Only macroscopic effects are described, such as the agricultural sector (31), infrastructure (32), Companies (33), and change in the local demography (34). In Fukushima, the abandonment of agriculture, forestry, and corporate bankruptcies caused unemployment, a decline in personal income, a decline in the value of assets such as houses, and an increase in the cost of living due to the separation of family members. The impact on the individual level should also be described to promote stakeholder participation.

Line 413 2.2.5. Psychological consequences

(36) These studies highlight

(Comment) It says "These studies highlight" but it is not clear which study this sentence refers to. Is it the body of literature summarized at the end of the paragraph? The sentence should be revised as follows. There are other similar expressions in the draft, each sentence should specify the documents on which it is based.

Studies (Bromet, 2011, 2014; Harada, 2015) highlight sociopsychological and psychosomatic disorders associated with the emergency response of the accident and during the recovery process.

In addition, Murakami et al. (2018) found that the "Anxiety about radiation exposure" was lower in thyroid examination participants including family members. Such studies should also be introduced in the draft. Moreover studies have shown that radiation exposure effects on the central nervous system and brain, resulting in cognitive impairment². Psychological effects could attributable due to exposure. These studies should also be surveyed.

Line 434 Sususki, 2015 should be Suzuki.

2.2.6. Health impacts of changes in lifestyle

Line 466 Considering the level of exposure of the affected population, these disorders cannot be considered as direct radiation induced health effects but are linked to a change in lifestyle resulting from the accident

(Comment) The radiation exposure is still being re-estimated. Thyroid cancer is also under discussion as explained above. It is too early to describe these disorders cannot be considered as direct radiation induced health effects and this sentence should be revised as follows.

Line 466 These disorders could be considered as direct radiation induced health effects but are linked to a change in lifestyle resulting from the accident

² CEREBRAD (Cognitive and Cerebrovascular Effects Induced by Low Dose Ionising Radiation)
<https://cordis.europa.eu/project/rcn/100538/reporting/en?rcn=58119>

Line 470 2.3. Principles for protection of people and the environment
Line 474 reasonably achievable

(Comment) The meaning of "reasonable" is unknown. It is written in the past Publication, but it should also be stated in this Publication.

Line 482 (43) For emergency and existing exposure situations, the fundamental protection principles to guide action are the justification of decisions and the optimisation of protection. For implementation of the optimisation principle, the Commission recommends using reference levels to guide decision making concerning protective actions.

(Comment) For whom is this justification? Individual, authority? It should be specified whether it is either one or both. The same goes for Optimization.

Line 490 (45) Once an emergency situation is declared, decisions on protective actions on-site and off-site should be taken promptly during the early phase to be effective. Given the short time to react, these actions should be prepared in advance on the basis of plausible scenarios, and adapted as much as possible to the actual situation.

(Comment) For this purpose, it should be clearly stated that the evacuation plan should be subject to the nuclear power plant operation inspection, and that it should be an effective plan that does not cause death during evacuation that occurred in Fukushima. Thus, the following underlined sentence must be added.

Line 490 (45) Once an emergency situation is declared, decisions on protective actions on-site and off-site should be taken promptly during the early phase to be effective. Given the short time to react, these actions should be prepared in advance on the basis of plausible scenarios, and adapted as much as possible to the actual situation. These actions or emergency evacuation plan should be an effective plan that does not cause death due to evacuation, and the plan must be approved by the regulation authority and it must be also approved by the referendum in surrounding municipalities.

Line 505 protect pets and livestock

(Comment) Consideration of protect pets and livestock is also important, but it should be clearly stated that priority should be given to dealing with vulnerable children and pregnant women. The following sentence should be added after (45).

(45') During and under nuclear disaster, radiation protection measures must be focused radiation sensitive group: children and pregnant women.

Line 519 2.3.1. The justification of protective decisions

(48) The principle of justification states that any decision altering a radiation exposure situation should do more good than harm. It is part of the ethical goal to do good (principle of beneficence) while avoiding doing harm as much as possible (principle of non-maleficence), as stated in Publication 138 (ICRP, 2018).

(Comment) On what criteria do you evaluate good and harm? Publication 138 "Ethical Foundations of the System of Radiological Protection" is cited, but it is an abstract argument and impractical.

Line 530 Decisions should be based on a reasonably conservative approach to consider the inevitable uncertainties concerning the situation on-site as well as off-site, and bearing their potential negative consequences in mind.

(Comment) Specific decision method should be specified.

Line 531 (49) Justification thus goes far beyond the objective of radiological protection, which is to avoid or reduce exposure, as it may also have various health, psychological, societal, economic, environmental, and political consequences. Thus, justification falls under the overall ethical goal of societies, which is to contribute to the health and well-being of individuals and the quality of life of affected communities, with preservation of biodiversity and sustainable development representing an integral part.

(Comment) It seems to be trying to underestimate the effects of radiation by considering effects other than radiation. For the affected people, this would not have happened without the release of radioactive substance from the nuclear power plant. First of all, it must be clarified that the electric power companies responsible for the nuclear accident should fulfill their responsibilities. Thus, the following must be added to after (49).

(49'). The responsibility for a nuclear power plant accident lies with the power company that owns and operates the plant. It is clarified that the electric power company is responsible for the overall response including emergency response to halt progress of the accident, information disclosure, and compensation after the accident.

(50) Responsibility for judging justification usually falls on the authorities to ensure an overall benefit, in the broadest sense, to society, and thus not necessarily to each individual.

(Comment) This description deviates stakeholder participation principle. Although ICRP assumes the authorities has enough knowledge, the authority did not work properly in Fukushima accident. In addition, local governments face a conflict of interest problem, "The prefectural governments were highly dependent upon the subsidies provided by the central government for hosting the NPPs (AMERICAN _ NUCLEAR _ SOCIETY 2012, p.28)." Authority should ensure individuals to judge justification by providing information.

Line 2.3.2. The optimisation of protective actions

Line 624 radiological, socio-economic, and environmental characteristics of the exposure situation, as reflected by the views and concerns of stakeholders, and the ethical values that govern radiological protection (ICRP, 2018).

(Comment) Specific decision making methods should be specified.

Line 679 (66) The optimisation process must recognise that there are inevitable conflicting interests, and seek to reconcile the differences and needs of various groups. For example, producers of goods, services, and food will wish to continue production, but their ability to do so is affected by the willingness of consumers.

(Comment) The electric power company that caused nuclear power accident should be responsible to the decline of sales. This sentence pass on accident caused firm's responsibility for purchasing products to consumers. It should be modified as follows.

(66) The optimisation process must recognise that there are inevitable conflicting interests, and seek to reconcile the differences and needs of various groups. However, the electric power company that caused the nuclear power accident should be responsible to the accident and related damage. For example, the sales decline of products from the affected regions should be compensated by the company.

Line 728 The Commission calls these types of actions 'self-help protective actions', and considers their implementation to be an integral part of the optimisation process that can be very effective and should be supported and encouraged

(Comment) First of all, the responsible electric power company should take appropriate measures, and 'self-help protective actions' should be minimized. The sentence should be modified accordingly.

Line 728 The accident caused power company should responsible for radiation protection of affected people, industries, and environment. It should take every measure to protect them from radiation. 'Self-help protective actions' that also shift responsibility of the company to the affected people and consumers should be minimized.

Line 744 (72) A strategy for protective actions should be prepared by authorities as part of national preparedness and planning arrangements.

(Comment) For the preparation process of the strategy, local residents must be involved and the final decision should be made through a referendum. The sentence should be Modified as follows:

(72) A strategy for protective actions should be prepared by authorities and citizens as part of national preparedness and planning arrangements. The preparedness strategy must be supported by a referendum.

Line 788 Fig. 2.3

(Comment) The relationship between this figure and "representative individuals" defined in ICRP103 must be clarified. In the initial stage, the overall dose is high and the 95% tile should not exceed 100 mSv?

Line 797 restricting exposures of the affected population and the emergency responders should generally not exceed 100 mSv. This may be applied for a short period, and should not generally exceed 1 year.

(Comment) As mentioned above, the public including children should have a lower reference level than the responder. Please add the following sentence.

Line 797 restricting exposures of the emergency responders should generally not exceed 100 mSv. The affected population that includes children and pregnant women should generally not exceed 10 mSv. This may be applied for a short period, and should not generally exceed 1 year.

Line 815 should be adjusted. It should be noted that maintaining exposure below or in the range of 100 mSv effective dose is no guarantee of the absence of excess incidence of thyroid cancer in a population when there has been intake of radioiodine. In case of a possible intake of radioiodine, specific protective actions should be implemented (see Section 3.4.1.3).

(Comment) If the 100 mSv dose does not include internal radiation exposure, that fact is clearly stated in the main point.

(79) For the optimisation of protective actions during the recovery process

Line 826 (80) For people living in long-term contaminated areas following the emergency response, the Commission recommends that the reference level should be selected within or below the Commission's recommended 1–20-mSv band taking into account the actual distribution of doses in the population and the tolerability of risk for the long-lasting existing exposure situations, and would not generally need to exceed 10 mSv per year, with the objective to reduce exposure progressively to levels on the order of 1 mSv per year.

(Comment) This sentence should be modified as following to avoid ambiguity.

(80) For people living in long-term contaminated areas following the emergency response, the Commission recommends that the reference level should be selected within or below the Commission's recommended 1–10 mSv band, with the objective to reduce exposure progressively to 1 mSv per year.

Line 861 (82) For protection of the environment in emergency and existing exposure situations, the Commission recommends the use of Derived Consideration Reference Levels (DCRL)

(Comment) Specific values and bands should be exemplified.

3. EMERGENCY RESPONSE

Line 935 (89) During the early phase, the Commission recommends that affected people should be informed by all available channels, including radio, television, text messages, emails, and social media. Information should be spread quickly and continuously regarding: what is known; what is not known; reasons for the urgent protective actions taken; what will be done to provide information updates; where to get more information; and what processes will be used to gather and consider the views of those affected to inform decisions on the termination of urgent protective actions.

(Comment) In Fukushima, TEPCO reported the possibility of a core meltdown to the Nuclear Safety Committee at the beginning of the accident, however, it acknowledged the possibility of a core meltdown on May 15, 2011 for Unit 1 and on May 24 for Units 2 and 3³. The use of radio and television to is important, but it is meaningless if information is not disclosed. As a precondition for using media, it should be clearly stated that all emergency calls from power company should be made public in real time. The sentence must be modified as follows.

(89) During the early phase, the Commission recommends that affected people should be informed by all available channels, including radio, television, text messages, emails, and social media. Critical information, such as emergency calls from the power company should be disclosed real time.

Line 1039 3.2.2.2. Individual monitoring

(101) In the early phase, triage is important to identify people who need care due to their level of exposure (decontamination, medical treatment), and those who only require health surveillance. These decisions will be based on limited monitoring information and will concentrate on the identification of those with an urgent need for treatment. In the first few hours, it will only be possible to perform initial screening measurements using

(Comment) In Fukushima, the criteria for body surface screening have been raised and the results of screening have not been well recorded. Preparedness should also include establishing a measurement regime. To clarify it, the following sentence must be added after paragraph 101.

³福島第一原子力発電所事故に係る通報・報告に関する第三者検証委員会

「検証結果報告書」<http://www.tepcoco.jp/press/release/2016/pdf/160616j0301.pdf>

(101') Initial measurement is important to evaluate possibility of health effect of radiation to the affected people. In this regard, the authority and power company must prepare both measurement devices such as hand-held monitors, portal monitors, and WBC and enough number of trained examinees.

Line 1050 (102) Thyroid dose monitoring in the early phase is important for children and pregnant women.

(Comment) In Chernobyl, measurements were taken on 350,000 people immediately after the accident, but in Japan only 1080 were measured. The cause of the suspension was also unknown. This is clearly stated in ANNEX.

Line 1058 The Commission recommends expressing thyroid exposure in terms of organ dose.

(Comment) Explicit reason. The relationship with effective dose and organ dose must be also explained to avoid confusion.

Line 1065 WBC including babies, provide useful information to mothers for understanding their child's situation, and options for adjusting their diet (Hayano, 2014).

(Comment) In WBC, internal exposure is more easily detected in adults than in children. Hayano (2014) conducted WBC, 2 years after the accident, thus the initial exposure due to iodine was not measured. The preparedness should include early WBC measurement and/or urinal examination after the accident.

Line 1069 (104) Measurement data should be collected centrally and made available as soon as possible to all relevant organisations in charge of management of the emergency response in order to assist them in making protective decisions. For the sake of accountability and transparency, the Commission recommends that this information should also be made available to members of the public, accompanied by clear explanations.

(Comment) However, it is important to observe ethics, such as how to use data collected from individuals. Please add this point after the sentence.

(104) Measurement data should be collected centrally and made available as soon as possible to all relevant organisations in charge of management of the emergency response in order to assist them in making protective decisions. For the sake of accountability and transparency, the Commission recommends that this information should also be made available to members of the public, accompanied by clear explanations. Expert must follow research ethics, collected data from individuals without consent must not be utilized for research.

(105) Medical monitoring programmes that are focused on people affected by a radiation emergency should consider two target groups: people who developed clinical conditions during the emergency; and people known to have been exposed but not showing any symptoms. Follow-up in the first group is aimed at diagnosis and treatment of long-term complications. Conversely, the main purpose of epidemiological follow-up in the second group is the detection of adverse effects or diseases that are potentially related to radiation exposure (e.g. cancer).

(Comment) The word "epidemiological" should be deleted because group is followed not only for the epidemiological study but also for health monitoring. This point should be added to the sentence.

(105) Medical monitoring programmes that are focused on people affected by a radiation emergency should consider two target groups: people who developed clinical conditions during the emergency; and people known to have been exposed but not showing any symptoms. Follow-up in the first group is aimed at diagnosis and treatment of long-term complications. Conversely, the main purpose of follow-up in the second group is the detection of adverse effects or diseases that are potentially related to radiation exposure (e.g. cancer), early detection and treatment.

Line 1115 (108) The justification of decisions that may affect the exposure of emergency responders should be taken in light of the expected benefits in terms of avoidance or reduction of off-site population exposures and contamination of the environment. Overall, these decisions should aim to do more good than harm; in other words, they should ensure that the benefit for the individuals concerned and society as a whole is sufficient to compensate for the harm they cause to the responders.

(Comment) It is difficult to do this in an emergency. Responders should be trained in advance so that they can make decisions in a short period of time it should be a part of preparedness.

(108) The justification of decisions that may affect the exposure of emergency responders should be taken in light of the expected benefits in terms of avoidance or reduction of off-site population exposures and contamination of the environment. Overall, these decisions should aim to do more good than harm; in other words, they should ensure that the benefit for the individuals concerned and society as a whole is sufficient to compensate for the harm they cause to the responders. Potential responders should be trained in advance so that they can make decisions in a short period of time.

Line 1202 management in order to overcome the lack of radiological protection culture

(Comment) The meaning of "radiological protection culture" is unknown. Should be defined here or in glossary.

Line 1204 ensuring that they have decent working and housing conditions. The individual dose of any emergency responder should be monitored and recorded, and each responder should be informed about the exposure received.

(Comment) In Fukushima, nuclear workers dosimeters were covered with lead to lower exposure. It should be clearly stated that the manager is responsible to prevent such a malpractice.

Line 1204 ensuring that they have decent working and housing conditions. The individual dose of any emergency responder should be monitored and recorded, and each responder should be informed about the exposure received. In Fukushima, dosimeters were covered with lead to lower exposure. The managers of responders are responsible to prevent such malpractice.

Line 1249 (119) In Publication 103 (ICRP, 2007, Para. 236), the Commission explained that 'At doses higher than 100 mSv, there is an increased likelihood of deterministic effects and a statistically significant risk of cancer.

(Comment) In LNT model, the risk of cancer increases linearly in all areas. " and a statistically significant risk of cancer " should be removed.

1249 (119) In Publication 103 (ICRP, 2007, Para. 236), the Commission explained that 'At doses higher than 100 mSv, there is an increased likelihood of deterministic effects.

Line 1261 appropriate and sustainable medical surveillance should be provided for responders with exposures >100 mSv during the emergency response.

(Comment) The dose range should not be limited if it is based on LNT. "with exposures >100 mSv during the emergency response." must be removed.

Line 1261 "appropriate and sustainable medical surveillance should be provided for responders."

Line 1276 3.4. Protection of the public and the environment

3.4.1. Protective actions for the early phase

Line 1293 response to emergencies involving natural and man-made hazards. However, evacuation can be inappropriate for certain populations, such as patients in hospitals and nursing homes, as well as elderly people, if it is not well planned (Tanigawa, 2012).

(Comment) If evacuation is not to be conducted hospitals and nursing homes around nuclear power plants should be equipped with preventing the entry of radioactive materials from outside and stockpile at least one week's worth of fuel for electricity generation, water and food. These should also be incorporated into evacuation plans, subject to review by the regulatory committee and subject to a referendum. Add this point to the end of the sentence.

Line 1293 response to emergencies involving natural and man-made hazards. However, evacuation can be inappropriate for certain populations, such as patients in hospitals and nursing homes, as well as elderly people, if it is not well planned (Tanigawa, 2012). Hospitals and nursing homes around nuclear power plants should be equipped with preventing the entry of radioactive materials from outside and stockpile at least one week's worth of fuel for electricity generation, water and food. These should also be incorporated into evacuation plans, subject to review by the regulatory committee and subject to a referendum.

Line 1304 (126) The Commission recommends that those authorities in charge of the emergency response, together with the evacuees and the authorities and professionals of the concerned communities, should be closely involved in the

complex decision-making processes regarding returning to the evacuated area. This should be conducted in a transparent manner.

(Comment) In Fukushima, affected population are not involved in decision process.

Line 1351 problem, especially if large population groups are concerned. Therefore, national authorities should give careful consideration to the most effective way to ensure

(Comment) During emergency situation, national authorities failed to understand situation. Please refer NAIIC (2012).

3.4.2. Protective actions for the intermediate phase

Line 1438 higher values. Higher radiological criteria may also be set to preserve local production, which may be deeply embedded in traditions or which may be essential to the economy of the entire community. Such decisions must be taken in close co-operation with the local stakeholders, as was the case in Norway with reindeer meat produced by the Sami population after the Chernobyl accident (Skuterud et al., 2005).

(Comment) Cited paper (Skuterud et al., 2005) is on the high level of Cs contamination of reindeer in Norway, not on cooperation with local stakeholders. Appropriate references should be cited. Distribution of highly contaminated food should not be allowed for preserve local production. The impact on local economy should first be compensated by the company responsible for the accident. Including producers to decision making also reduces effectiveness because of conflicts of interest. This sentence should be deleted.

~~Line 1438 higher values. Higher radiological criteria may also be set to preserve local production, which may be deeply embedded in traditions or which may be essential to the economy of the entire community. Such decisions must be taken in close co-operation with the local stakeholders, as was the case in Norway with reindeer meat produced by the Sami population after the Chernobyl accident (Skuterud et al., 2005).~~

3.4.2.4. Decontamination of the environment

Line 1477 outweigh the intended benefits. Therefore, development of the decontamination strategy should be carried out in close consultation with the affected population

(Comment) In Fukushima, affected population are not involved in decision process.

Line 1480 (147) As mentioned above (see Section 2.2.4), the economic activities of different companies are affected by a nuclear accident. During the intermediate phase, companies located in the vicinity of the damaged nuclear installation may need to establish

(Comment) Compensation from responsible company of the accident must be clarified.

Line 1562 Environmental monitoring data coupled with realistic modelling can be used to predict future exposure to adults and children who intend to return to the affected area.

(Comment) The model could be Miyazaki and Hayano (2017b)'s that attached "Express of Concern." The paper is under concern in both research ethics and analysis. The modeling method is unreliable (Kurokawa and Tanimoto 2019). More over Hamaoka(2019) reanalyzed Naito et al.(2017)'s data that compared airborne dose and individual dosimeter dose and found that among 142 participants, there were *negative* correlation between hourly ambient dose and hourly individual level dose for 26 participants. There should be serious measurement error problem, be prudent to cite these researches. This sentence should be deleted.

~~Line 1562 Environmental monitoring data coupled with realistic modelling can be used to predict future exposure to adults and children who intend to return to the affected area.~~

Line 1569 addressing the health and well-being needs of the evacuees, should be available before their return. With this in place, individuals have a basic right to decide whether or not to return.

(Comment) Although, individuals have a basic right to decide whether or not to return, it cannot be exercised without economic backup. The responsible company of the accident must compensate sufficiently.

Line 1605 The decision on permanent relocation should be taken by the authorities on a case-by-case

(Comment) “permanent relocation” is an important protection measure, a section “permanent relocation” should be added as Pub. 111 has.

Line 1640 4. RECOVERY PROCESS

Line 1753 conditions and those of their communities. Similarly, selecting a value that is too low can impair the societal conditions and economic activities of the areas, and be counterproductive.

(Comment) What does "too low" mean? From the perspective of the disaster-affected people, it is natural for them to want to return to the original state.

Line 1785 4.3.1.1. Decontamination including waste management

Line 1811 consequences of protective actions such as food bans and restrictions can include a build up of organic waste that is difficult to dispose of safely, from a biological perspective, regardless of the radiological hazard posed.

(Comment) Disposal of food at risk is a lower priority than the increased risk associated with its ingestion. This sentence should be deleted.

4.3.1.5. Health surveillance

Line 1930 In this regard, a long-term thyroid health monitoring programme should only be conducted for those individuals exposed in utero or during childhood or adolescence with 100–500 mGy absorbed dose to the thyroid.

(Comment) This sentence cites Togawa et al. (2018) that summarize IARC report (IARC 2018). Since there are different expressions from the original, the original should be cited. "First, the Expert Group recommendations against populating thyroid screening after a nuclear accident, and second, it recommendations that consideration be given to offering a long-term thyroid monitoring program for higher-risk individuals (ie, because exposed in utero or during childhood or adolescence to a thyroid dose of $\geq 100 - 500$ mGy) after a nuclear accident."

However, the IARC (2018) report stresses that "Lastly, the Expert Group would like to stress that this report is not an evaluation of the thyroid health monitoring activities that were implemented after the past nuclear accidents, and does not include any recommendations related to thyroid health monitoring activities currently in progress, in particular the Fukushima Health Management Survey. (IARC 2018, p.16)", thus its recommendation should not be included in this draft. This sentence should be deleted.

Line 1930 ~~In this regard, a long-term thyroid health monitoring programme should only be conducted for those individuals exposed in utero or during childhood or adolescence with 100–500 mGy absorbed dose to the thyroid.~~

Line 1940 4.3.2. The co-expertise process

(Comment) As mentioned above, “co-expertise process” is not empirically validated, thus this section must be deleted.

Line 2001 4.3.2.2. Radiological protection culture

(Comment) The term “Radiological protection culture” has already been used several times, but it is not defined. The term “culture” came into use after the Chernobyl accident to indicate there were no problems with the nuclear facilities, but it is thought that there were human problems such as operation and maintenance. The use of the term “culture” here is probably intended to exempt the responsible company from liability. I partly agree with the idea of encouraging the self-help of disaster victims, but we should not exempt those responsible for the accident from responsibility. This section should be deleted.

Line 2040 5. EMERGENCY AND RECOVERY PREPAREDNESS

Line 2053 (219) Planning for the emergency response needs to involve the responsibilities of

(Comment) As mentioned above, the inclusion of evacuation plans in the regulation review and referendum should be added at the end of the paragraph.

6. CONCLUSIONS

Line 2086 legitimate fear of all those affected regarding the deleterious health effects of radiation exposure,

(Comment) Explain what “illegitimate fear” is. There should be no such thing, so the adjective “legitimate” should be deleted.

Line 2086 ~~legitimate~~ fear of all those affected regarding the deleterious health effects of radiation exposure,

Line 2095 reduce the risk of cancer and hereditary effects in the future to as low as reasonably achievable

(Comment) Clarify reasonable for whom?

Line 2102 the recovery process can also be a source of negative consequences and additional complexity.

(Comment) Please give example of “negative consequences.”

Line 2104 developed taking into account the experience gained from previous nuclear accidents, and the most advanced scientific knowledge on the health effects of radiation and the general

(Comment) The draft focused only the issues in the early stages of the accident. Also, as noted above, this draft is based on the 2007 recommendation and it disregards recent studies that detected significant effects below 100 mSv, thus the draft does not take into account the most advanced scientific knowledge on the health effects. If published with this content, it has been modified as follows to clarify these. It should not be left as it is and should be revised by understanding the issues in the middle and long term after the Fukushima accident and by incorporating recent knowledge on radiation epidemiology.

Line 2104 developed taking into account the experience gained from previous nuclear accidents; especially emergency situation in Fukushima, and scientific knowledge on the health effects of radiation and the general before 2007.

2117 Table 6.1.

(Comment) As mentioned above, the reason why Public and Respondents are the same reference level in emergency exposure situations should be explained. Changes in the reference level from Pub 103, 109, and 111 and its expression should be explained. Change should be minimum without reason, for example, “<100mSv” should be expressed as “1-100mSv” as in the previous publications.

In Table 6.1, for Public under Existing exposure situation, “The long-term goal is to reduce exposures to the order of 1mSv per year”, meaning of “order” must be clarified. According to my Japanese English experience, “order” is equivalent with the number of digits, digit 1 includes 0-9. “Order” must be removed as previous publication.

The evidence supporting LNT has become more robust (NCRP 2018). The reference level for the Public under emergency situation and existing exposure should be lowered to 1-20 mSv and 1-5mSv/y, respectively.

2125 “section 2.3.3.3” should be “section 2.3.3.”

Line 2119 Previously, the Commission recommended the selection of reference levels in the band of 1–20 and 20–100 mSv or mSv per year for existing and emergency exposure situations, respectively

(Comment) Should be “20-100 mSv and 1-20 mSv per year for emergency exposure and existing situations, respectively” in the order of the columns in the table.

Line 2119-2122

(Comment) Foot note is important. Move them to the body (Para 226). Reasons for change from the previous publication must be explained.

Line 2130 (227) Finally, the Commission emphasises the crucial importance of involving stakeholders in implementation of the optimisation process. Experience from Chernobyl and Fukushima has shown that radiological protection experts and professionals engaged in the emergency response and recovery process should, beyond mastering the scientific basis of radiological protection and its practical implementation,

(Comment) In Fukushima, experts gave incorrect information, such as the nuclear reactors would not explode, radiation exposure 100 mSv or less, 100 μ Sv/h or less would have no effect on health. First of all, the draft should be modified as follows.

(227) Finally, the Commission emphasises the crucial importance of involving stakeholders in implementation of the optimisation process. Experience from Chernobyl and Fukushima where experts gave serious incorrect information, such as the nuclear reactors would not explode, radiation exposure 100 mSv or less or 100 µSv/h or less would have no effect on health deteriorated trust in experts. Radiological protection experts and professionals engaged in the emergency response and recovery process ~~should~~ must master the scientific basis of radiological protection such as LNT, ~~beyond mastering the scientific basis of radiological protection and its practical implementation,~~

Line 2138 Experts and professionals should also share the information they possess

(Comment) "Experts and professionals should also share the information they possess" is typical paternalism, thus inconsistent with "co-expertise" which was emphasized in the draft. In the case of Fukushima, many Experts and professionals lacked basic knowledge, such as denying LNT. Experts and professionals should learn humbly.

ANNEX A&B.

(Comment) After ANNEX A and B, compare Chernobyl and Fukushima in terms of radiation protection measures and policy (Yoshida 2015).

ANNEX A. CHERNOBY

(Comment) Historical origin is important to understand the nature of self-help activity. Please include the following paragraphs in ICRP Publication 111 (ICRP 2009b)" ANNEX A. HISTORICAL EXPERIENCE OF LONG-TERM CONTAMINATED AREAS"

"(A 38) During the mid 1990s, the continuous degradation of the economic situation due to both the collapse of the Soviet Union and the financial burden of the rehabilitation programmes pushed the inhabitants of the areas to restart private production and to rely ever more on wild products to ensure their daily subsistence. In the absence of individual knowledge and adequate means to control the radiological quality of foodstuffs at the local level, the effect of this change was inevitably a significant increase in the level of exposure within the population, and particularly among children because of the importance of dairy products in their diet. This put strong pressure on the authorities and experts, and contributed to aggravate further the loss of confidence of the population in their ability to manage the situation.(ICRP 2009b)"

"(A 39) Faced with this difficult situation, the authorities tested new approaches, such as the ETHOS Project in the late 1990s and the CORE Programme in the early 2000s in Belarus, with the aim of involving the population directly in the management of the radiological situation. (ICRP 2009b)"

(A 32) There was no early notification of the public about the actual radiological situation following the Chernobyl accident. On the contrary, the results of measurements of exposure rate, deposition density of various radionuclides, etc. were classified

(Comment) "On the contrary" should be "Moreover"

(A 32) There was no early notification of the public about the actual radiological situation following the Chernobyl accident. Moreover, ~~On the contrary,~~ the results of measurements of exposure rate, deposition density of various radionuclides, etc. were classified

ANNEX B. FUKUSHIMA

(Comment) Please add section "Preparedness" and describe how Japanese government prepared for the Fukushima accident. Lack of preparedness is well described in NAIIC (2012).

Line 2902 Fukushima Daiichi nuclear power plant, owned by Tokyo Electric Power Company (TEPCO),

(Comment) owned and operated by Tokyo Electric Power Company (TEPCO),

Line 2909 the increased temperature of each reactor led to melting of the nuclear fuel and a series of explosions in the reactor buildings of Units 1, 3, and 4. As a result of these explosions, a large quantity of radioactive material was released into the atmosphere, and was deposited on land and in the ocean.

(Comment) Please specify sequence of radioactive leakage.

Line 3042 From the results for 1080 children under 15 years of age, no age, no children exceeded the screening level of 0.2 $\mu\text{Sv h}^{-1}$, which corresponds to a thyroid dose of 100 mSv for 1-year-old infants (NERHQ, 2011a).

(Comment) Please compare with Chernobyl.

Line 3042 From the results for 1080 children under 15 years of age, no age, no children exceeded the screening level of 0.2 $\mu\text{Sv h}^{-1}$, which corresponds to a thyroid dose of 100 mSv for 1-year-old infants (NERHQ, 2011a). In Chernobyl, screening was conducted for 350,000 children after the accident. Compared with Chernobyl, lack of preparedness of Japanese government and power company is evident.

Line 3061 (B 20) As part of the preliminary survey of the Fukushima Health Management Survey, internal exposure was measured by whole-body counting

(Comment) FHMS started in August 2011⁴, please clarify short lived nuclides, such as ¹³¹I, ¹³⁴I are not be detected by WBC.

Line 3179 Fig. B.3.

(Comment) Not referred in the draft. It must be deleted.

Line 3300 Naito, W., Uesaka, M., Kurosawa, T., et al., 2017. Measuring and assessing individual

(Comment) Not referred in the draft. It must be deleted. Hamaoka(2019) reanalyzed Naito et al.(2017)'s data and found that among 142 participants, there were *negative* correlation between hourly ambient dose and hourly individual level dose for 26 participants. There should be serious measurement error problem, be prudent to cite these researches.

Line 3024 B.4.5. The ICRP Dialogue Initiative in Fukushima

Line 3229 B.4.6. The co-expertise process and self-help protective actions

(Comment) As mentioned above the process should not be recommended.

Line 3244 B.4.7. Health surveillance

Line 3251 (B 42) The first and second rounds of the thyroid ultrasound examinations were completed in March 2014 and 2016, respectively. Children will continue to have ultrasound examinations biennially until they reach 20 years of age, and every 5 years thereafter. Childhood thyroid cancer cases found in Fukushima Prefecture are unlikely to be the result of radiation exposure after the accident. The comprehensive medical check-ups started in July 2011. The survey of pregnant women and nursing mothers involved a questionnaire, sent out to all mothers who were given a maternal and child health handbook between 1 August 2010 and 31 July 2011. This survey is updated every year to take account of new data, particularly on pregnancy and births. The mental health and lifestyle survey were conducted twice, in January 2012 and January 2013, with questionnaires covering physiological and mental 3260 conditions, lifestyle changes, experiences of the earthquake and tsunami, and radiation-3261 related issues to provide adequate mental care and lifestyle support for evacuees (FMU, 2016).

(Comment) The source of the third sentence "Childhood thyroid cancer cases found in Fukushima Prefecture are unlikely to be the result of radiation exposure after the accident. "is not indicated. I believe (FMU, 2016) at the end of the paragraph is a source.

At the reference as shown below, URL is listed for FMU 2016, however the link was broken as of 2019/9/18.

Line 3274 FMU, 2016. Report of the Fukushima Health Management Survey, Fukushima Medical University, revised version (April 25, 2016), http://fmu-global.jp/wp-3275/content/uploads/bnr_report_h26_e1.png.

According to the archived data at archive.org, it was an icon for the report not the report itself as its file extension ".png" indicates. Updated version of the report (FMU 2018) describes "Summary of the Results of Initial Screening" that is to say, results of the 2nd round is not reported. Moreover, although the report states "Accordingly it can be concluded that thyroid cancers found thus far through the Thyroid Ultrasound Examination program cannot be attributed to radiation discharged due to the accident.", it concludes "However unlikely, the possibility of the radiation effects cannot be completely denied at this point in time." This paragraph should be corrected.

The ground for denying the effects of radiation is the "There are no significant regional differences in detection rates". For the first round, FMU researchers reported no regional differences in thyroid cancer detection rates (Suzuki et al. 2016; Ohira et al. 2016). However, these 59 municipalities are classified into 4 or 3 regions, and there is criticism that both municipalities with high and low radiation exposure are in the same region (Hamaoka 2016, 2017). On the other hand, Tsuda et al. (2016) found significant differences between regions. Although

⁴ <https://www.pref.fukushima.lg.jp/site/portal/ps-wbc-kensa-kekka.html>

these papers did not utilize exposure level as regressor, Kato (2019) showed a positive and significant correlation between external exposure in the Fukushima basic survey and sum of the first and second round thyroid cancer incidence. Yamamoto et al. (2019) obtained similar results. Hamaoka (2013,2015) found positive correlation between WHO/UNSCEAR estimated thyroid dose and detection rate of thyroid nodule. Akiba et al. (2017) focused on nodule and found that the percentage was higher in the evacuation area than in the non-evacuation area. Thus, no conclusion has been reached as to whether exposure had any effect. Since it is also important to raise the number of thyroid cancers, Line 3251 (B 42) should be modified as follows:

Line 3251 (B 42) The first and second rounds of the thyroid ultrasound examinations were completed in March 2014 and 2016. Children will continue to have ultrasound examinations biennially until they reach 20 years of age, and every 5 years thereafter. For the 1st and 2nd round, 116 and 71 thyroid cancers include suspicious cases were detected among 300,473 and 270,540, respectively. For the 1st round results some academic papers reported insignificant differences among regions (Suzuki et al. 2016; Ohira et al. 2016) and others reported statistically significant difference among regions (Tsuda et al. 2016). However, 59 municipalities are classified into 4, 3, and 9 regions, and there is criticism that both municipalities with high and low radiation exposure are grouped in the same region (Hamaoka 2016, 2017). These papers do not utilize dose information. Kato (2019) related external dose and thyroid cancer detected in the 1st and the second round and detected positive and significant correlation. Yamamoto et al. (2019) obtained similar results. Thyroid nodule is a preliminary stage of thyroid cancer and radiation cause thyroid nodule. Hamaoka (2013, 2015) found positive and significant correlation between WHO estimated thyroid dose and incidents of thyroid nodule in the first round. Akiba et al.(2017) examined relative risk of thyroid nodule between non-evacuated and evacuated area. For the 1st round, relative risk was insignificant, on the contrary, statistically significant higher risk was detected for the evacuated area in the 2nd stage. It is too early to conclude relationship between radiation and thyroid cancer detected in Fukushima.

GLOSSARY

(Comment) Please Add the following terms.

ALARA

LNT

Tolerability

(Comment) Please add "COI" section for the members including financial relationship and participation to stakeholder activity, such as government committee.

Reference

(Comment) Please add URL if available.

Reference

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