The second set of recommendations from JHPS on Radiation Protection Issues after Fukushima Accident

Takatoshi HATTORI*
Advisor for Fukushima issues
Japan Health Physics Society (JHPS)

47th JHPS Annual Meeting, Kamisaibara village culture center
June 19th, 2014

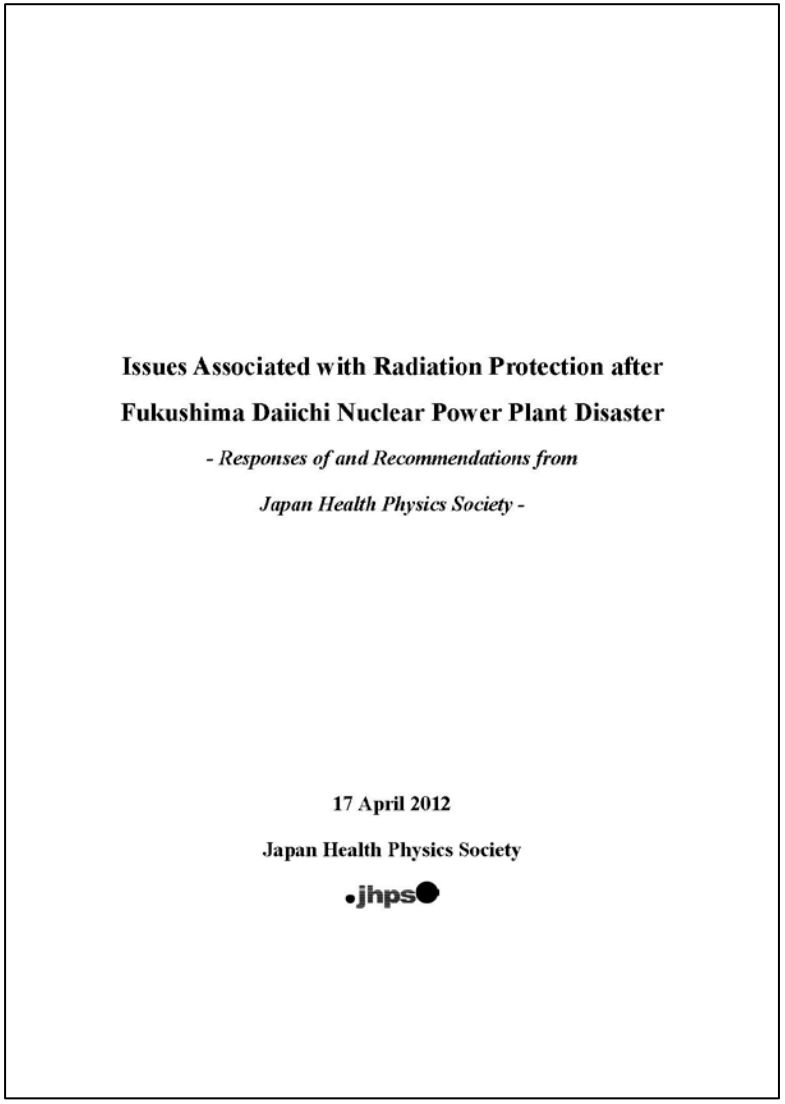
*Central Research Institute of Electric Power Industry

.jhps

JHPS Responses and Recommendations

- 27(31 with overlapping 4) points at issues were pointed out from 11 issues associated with RP after the accident.
- 5 Responses of JHPS were declared.
- 12(16 with overlapping 4) recommendations of JHPS were drawn up taking into consideration
  1) how to improve the current system of RP by overlooking the various opinions on RP in an emergency and
  2) direction towards future goals of the RP system by exploiting the strength of JHPS of having many experts in RP among its members.

This report can be downloaded from the JHPS HP at http://www.jhps.or.jp/en/


Issues Associated with Radiation Protection after
Fukushima Daiichi Nuclear Power Plant Disaster
- Responses of and Recommendations from
Japan Health Physics Society -

17 April 2012

Japan Health Physics Society

.jhps

1st set of Recommendations from JHPS

1. Balance among other emergency criteria
2. Assumption of long-term emergency situation and maintenance of infrastructure including electricity, water, and communications
3. Use of SPEEDI and simulations on the diffusion of radioactive materials in the ocean
4. Communication with residents to designate the deliberate evacuation zones
5. Review of emergency planning zones (EPZs)
6. Category of foods and scope of radioactive nuclides except for key nuclides in regulation of foods and drinks
7. Validity of screening levels for decontamination (100 and 13 kcpm) from the viewpoint of RP
8. Transition of dose limit for emergency workers to 250 mSv and how to control individual dose after shifting back to a normal situation using a dose limit (50mSv/y & 100mSv/5y)
9. Post disaster investigation of thyroid equivalent dose of radioactive iodine by simulating the atmospheric diffusion using SPEEDI and surveys on residents' behavior
10. Balance among provisional criteria for judging the safety of using school yards, forage, cropping soil, fertilizers, bathing areas, etc.
11. Balance among RP measures, inconvenience and heat stroke in relation to systems for temporary entry into restricted zones
12. Management of radioactive wastes such as cesium-containing rubble, sludge, and decontaminated soil

Fundamental policy for the recommendations

- Indicate the direction of evolvement of the radiological protection system in the future

by overseeing various radiological protection measures in emergency situation.

- Share the recommendations with radiological protection experts in the world;

they must be understood by experts in the world from each standpoint and be able to be utilized independently.

IRPA 13 in 2012

S12.1 Japan HPS: Fukushima Issues		
Type:	Symposium	
Date:	Tuesday, May 15, 2012	
Time:	09:00 - 10:30	
Room:	Clyde Auditorium	
Chair:	Toshiso Kosako	
Rapporteur:	Ted Lazo	
09:00	Overview. T Kosako	S12.1.1
09:15	Environmental and Personal Monitoring. T Momose	S12.1.2
09:40	Public Concern Regarding Fukushima Accident - Challenge to RP Community. K Sakai	S12.1.3
09:55	Points at Issue on Radiation Protection following Fukushima Accident. T Hattori	S12.1.4

Issues Associated with Radiation Protection after Fukushima Daiichi Nuclear Power Plant Disaster

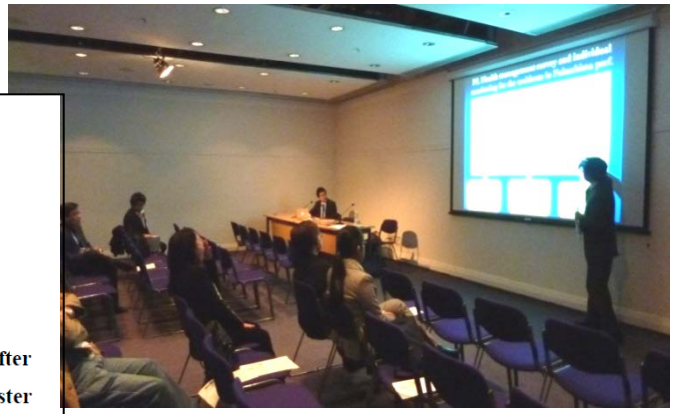
- Responses of and Recommendations from

Japan Health Physics Society -

17 April 2012

Japan Health Physics Society

jhps



AOARP Regional Meeting
(17th May, 2012)

IRPA Bulletin started on March 2014

IRPA Bulletin

March, 2014 — No. 01

Welcome to the IRPA Bulletin

It is a great pleasure to introduce this first issue of the IRPA Bulletin to all 18,000 or so members of the International Radiation Protection Association. IRPA strives to be the international voice of the radiation protection profession. This new quarterly bulletin, although aimed primarily at IRPA members, is an important part of fulfilling this objective.

The renewal of the IRPA Commission on Publications (CoP) has focused on ways to help our members in all 49 Associate Societies learn more about what is going on outside their own countries and regions. Over the last year you may have noticed an overhaul of our website, irpa.net, making it easier and more intuitive to access the information you want. This includes the irpa.net news feed, featured on the front page of the website, and which is more active than ever before. We are also now visible in the social media landscape. You can like IRPA on Facebook, follow IRPA on Twitter, subscribe to the IRPA RSS feed, or register for email updates through irpa.net.

These new media channels are fantastic for rapid and frequent communication, but focus on relatively short messages. This Bulletin complements our other media tools. It is certainly less frequent, being produced quarterly, but this has the advantage of shining light on a few carefully chosen top stories, and in a bit more depth than a 140 character tweet allows. Another advantage is the potential reach, as the intention is that it be translated into many languages. Although English is the working language of IRPA, it is not the first language for many of our members. Our hope is that this Bulletin will help cross language barriers, even if only in a small way.

How is all of this possible? The answer is simple: we draw on the strength of our volunteer members. Members of the CoP come from Canada, France, Germany, Japan, Korea, UK, and the US. We have a crack team of media reviewers watching Associate Society publications and websites in English, French, German, Japanese, and Korean, and passing on items of broad interest to those who manage irpa.net, our social media, and of course this Bulletin.

Would you like to join the team? We need more media reviewers to cover other languages, and volunteers willing to translate this quarterly bulletin. If you are interested contact me at pub.dir@irpa.net.

Christopher Clement
IRPA Publications Director

This Issue...

Your IRPA CoP

Chair: Christopher Clement
Vice Chair: Bernard LeGuen

Bulletin Editors
Chunsheng Li, Ali Shoushtarian

Associate Societies Liaison
Adelene Gaw

Website Managers
Andy Karam, Chris Malcolmson

Social Media Managers
Sven Nagels, Chris Malcolmson

Media Reviewers
Melanie Rickard
Ralph Thomas
Sven Nagels
Young-Khi Lim
Duncan McClure
Daisuke Sugiyama

International Radiation Protection Association
https://www.facebook.com/IRPA0
https://twitter.com/IRPA
www.irpa.net

http://www.irpa.net/page.asp?id=54592

IRPA Bulletin

March, 2014 — No. 01

Japanese Health Physics Society: Discussion on RP Issues after the Fukushima Accident

Following the publication of a recommendation report on the issues associated with radiation protection in the aftermath of the Fukushima Daiichi nuclear disaster as discussed at IRPA13, Japan Health Physics Society (JHPS) has been further discussing the issues to complete the second set of recommendations in 2014. Any comments and suggestions from radiation protection colleagues in the world to the first set of recommendations are welcomed and appreciated. Please send your comments and suggestions by email to exec.off@jhps.or.jp. The first set of recommendations can be referred and is available at: http://www.jhps.or.jp/en/wp-content/uploads/2011/12/53224f1dbbc1063ffff46bb5cc3fa01c.pdf

IRPA 会報

2014 年 3 月 — 第 1 号

日本保健物理学会：福島事故後の放射線防護の課題に関する議論

IRPA13 で議論された福島第一原子力災害後の放射線防護に関連する課題についての提言文書の発行を受け、日本保健物理学会（JHPS）では、2014 年に第二期提言を完成させるために、さらに議論を行っています。第一期提言に対しての世界中の放射線防護の専門家からコメントや提案をいただけましたら幸いです。コメントや提案は電子メールで exec.off@jhps.or.jp までお送り願います。第一期提言は http://www.jhps.or.jp/en/wp-content/uploads/2011/12/53224f1dbbc1063ffff46bb5cc3fa01c.pdf から入手できます。

AOCRP-4 in 2014

AOARP Special Session (12nd May, 2014)

AOARP Special Session, Kuala Lumpur Room, Level 5, PWTC
"International voice of the radiation protection profession in Asia and Oceania"
Chair:Prof. Toshiso Kosako, Japan
Co-Chair: Dr. Noriah Bt. Mod Ali, Malaysia

President Keynote
Prof. Toshiso Kosako (AOARP, Asian and Oceanic Association for Radiation Protection President)
"Radiation Protection Learned from Fukushima Daiich NPP Accident"

Associate Society Presentations
Dr. Antony M. Hooker (Australian Radiation Protection Society)
"Key Challenges for Present and Future Radiation Protection Agencies – an Australian Perspective"

Dr. Senlin Liu (China Society of Radiation Protection):
"Current Activities on the Enhancement of China Society for Radiation Protection"

Dr. Daisuke Sugiyama (Japan Health Physics Society):
"The Second Set of Recommendations from JHPS on Radiation Protection Issues after Fukushima Accident"

Dr. Kyo-Youn Kim (Korean Association for Radiation Protection):
"Korean Association for Radiation Protection; Current Status and Activities"

Dr. Noriah Bt. Mod Ali (Malaysian Radiation Protection Association):
"Enhancement on Radiation Protection System in Malaysia: Post- Fukuskima Nuclear Accident"

General discussion

Toward the 2nd set of recommendations from JHPS

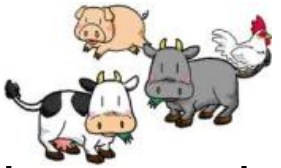
Picking-up of RP issues through overall reviews of 5 reports of investigation committees on the Fukushima nuclear accident

- Investigation Committee on the Accident at Fukushima Nuclear Power Stations of Tokyo Electric Power Company, Interim Report (Dec. 26, 2011)【Governmental Interim Report】
- Same as above, Final Report (Jul. 23, 2012)【Governmental Final report】
- National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission, Official report (Jul. 5, 2012)【National Diet Report】
- Independent Investigation Commission on the Fukushima Nuclear Accident, Research Investigation Report (Feb. 27, 2012)【Nongovernmental Report】(Only in Japanese)
- Tokyo Electric Power Company, Fukushima Nuclear Accident Analysis Report (Jun. 20, 2012)【TEPCO Report】

Categorization for picking-up RP issues (1)

1. Environmental radiation monitoring
   a. Radiation monitoring of land
      i. Monitoring car
      ii. Aircraft monitoring
      iii. Tap water, agricultural and livestock products, and foods
      iv. Woods
      v. Sand from the riverbed and bottom of the lake
   b. Coastal sea area monitoring
      i. Sea water
      ii. Sand from bottom of the sea
      iii. Sea products

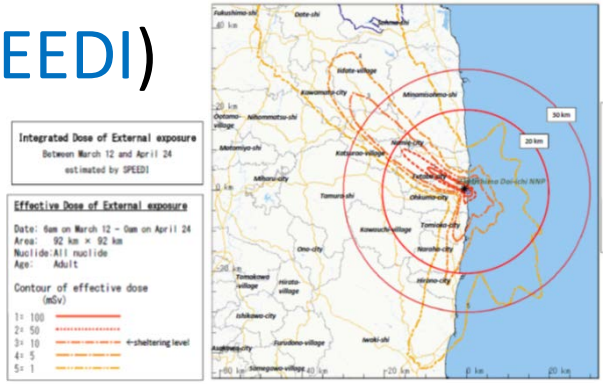




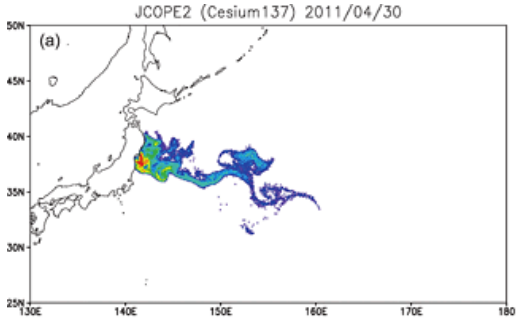



Categorization for picking-up RP issues (2)

2. Prediction of dilution of radioactive materials
   a. System for Prediction of Environmental Emergency Dose Information (SPEEDI)
      i. Utilization of SPEEDI information
      ii. Disclosure of SPEEDI information

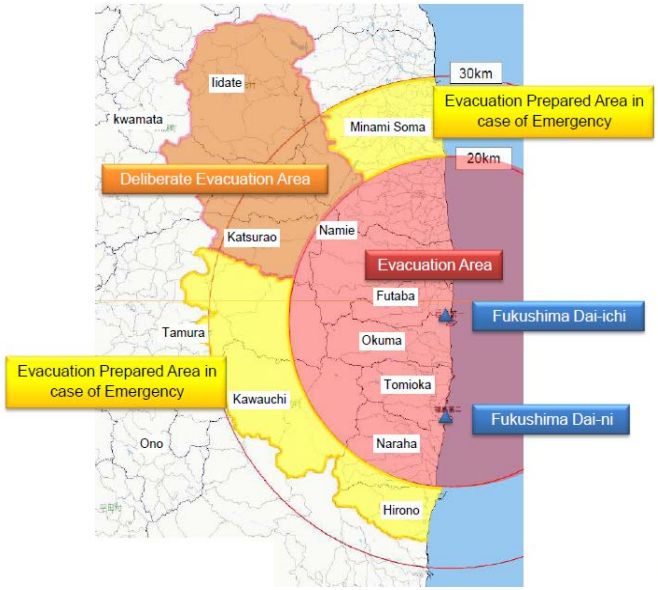


   b. Simulation system on the diffusion of radioactive materials in the ocean



Categorization for picking-up RP issues (3)

3. Evacuation of residents
   a. Criteria and zone of evacuation and stay in-house
   b. Communication of measures of evacuation and stay in-house
   c. Implementation and cancelation of measures of evacuation and stay in-house
   d. Designation of deliberate evacuation zone and specific spots recommended for evacuation



Categorization for picking-up RP issues (4)

4. Radiation exposure
   a. Radiation protection criteria
      i. Criterion for administration of stable iodide 
      ii. Screening level for decontamination 
      iii. Criteria for using school yards, bathing areas, and aggregate, and disaster waste disposal, sewage sludge etc.
      iv. Criteria for foods and drinks 
      v. Criteria for temporary entry into restricted zones 
      vi. Dose criteria for emergency workers 


Categorization for picking-up RP issues (5)

4. Radiation exposure
   b. Radiation exposure of residents
      i. Thyroid equivalent dose assessment by simple measurement

      ii. Internal dose assessment using whole-body counters (WBC)

      iii. External dose assessment using personal dosimeters
      iv. External dose estimation using residents' behavior surveys
   c. Radiation exposure of plant recovery workers
      i. Reservation of dosimeters, WBCs and protective tools, and administration of stable iodide in emergency
      ii. Measurement and assessment of individual dose in emergency

Categorization for picking-up RP issues (6)

5. Risk communication to the public
   a. Understanding of low dose radiation exposure
   b. Mental health care

   c. Communication through mass media and internet

   d. Information delivery to oversea countries

6. Nuclear emergency preparedness
   a. Nuclear emergency preparedness system and responses of relevant organization after accident

   b. Opportunity of revision of nuclear emergency preparedness for complex disaster (earthquake, tsunami and nuclear accident)

Categorization of post-accident radiological protection measures

Timing to implement the radiological protection measures: early stage (up to 1 week post-accident), middle stage (up to 1 month post-accident), later stage (up to 1 year post-accident) or long-term stage (after 1 year post accident).

Residential area: surrounding area / far from the accident site (for public)

Target: public / workers

Workers: plant recovery or rescue/decontamination workers around the accident site

2nd set of Recommendations from JHPS (1)

1. Radiation monitoring on land – unexpected effects on means of transportation and communication
2. Radiation monitoring on land – monitoring posts washed away and communication lines severed
3. Tap water monitoring – communication method with public
4. Shipping restrictions and monitoring of agricultural and livestock products – expansion of contamination due to food chain
5. Shipping restrictions and monitoring of agricultural and livestock products – measurement method for livestock products
6. Food monitoring – regional variations (6-1, 6-2)
7. Monitoring of forests and subsoils of rivers and lakes – lack of understanding of the necessity
8. Monitoring of seawater, subsoils of ocean, and sea products – lack of understanding of the necessity
9. Monitoring of seawater, subsoils of ocean, and sea products – lack of prediction tools (9-1, 9-2)
10. System for Prediction of Environmental Emergency Dose Information (SPEEDI) – underutilization of prediction results (10-1, 10-2, 10-3)
11. Simulation system on the diffusion of radioactive materials in the ocean – lack of prediction tools in the emergency preparedness system (11-1, 11-2, 11-3)

2nd set of Recommendations from JHPS (2)

12. Evacuation of residents and its criterion – extension of order to stay indoors
13. Evacuation of residents and its criterion – instruction of deliberate evacuation
14. Evacuation of residents and its criterion – communication of evacuation instruction
15. Evacuation of residents and its criterion – evacuation beyond a designated zone for emergency preparedness (15-1, 15-2)
16. Evacuation of residents and its criterion – evacuation of socially vulnerable individuals
17. Radiological protection criteria – criteria for administration of stable iodide – confusion regarding administration criteria (17-1, 17-2)
18. Radiological protection criteria – screening level – validity of the level (18-1, 18-2, 18-3)
19. Radiological protection criteria – criteria for contamination of soil (schoolyards and educational facilities, and bathing areas, utilization of crushed stones, and disposal of disaster waste and sewage sludge) – consistency of concepts for derivation of criteria (19-1, 19-2)
20. Radiological protection criteria – criteria for food and beverages – comprehensiveness of food categories
21. Radiological protection criteria – criteria for food and beverages – universal use for various types of accident (21-1, 21-2)
22. Radiological protection criteria – criteria for food and beverages – approach to dose criteria
23. Radiological protection criteria – protective criteria for temporary entry into restricted zones – balance among other risks

2nd set of Recommendations from JHPS (3)

24. Radiological protection criteria – dose criteria for emergency work – dose limit taking life-saving work into account
25. Radiological protection criteria – dose criteria for emergency work – treatment of individual doses received in an emergency situation
26. Radiation exposure of residents – estimation of thyroid equivalent dose of radioactive iodine by simple measurement (26-1, 26-2, 26-3, 26-4)
27. Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – investigation system (27-1, 27-2)
28. Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – measurement method
29. Radiation exposure of residents – external dose assessment using personal dosimeters
30. Radiation exposure of residents – external dose estimation on the basis of behavior survey
31. Radiation exposure of plant recovery workers – network for urgently borrowing alarm pocket dosimeters (APDs)
32. Radiation exposure of plant recovery workers – control of internal exposure in an emergency
33. Radiation exposure of plant recovery workers – control of localized exposure in an emergency
34. Radiation exposure of plant recovery workers – managing access to and from a controlled area in an emergency

2nd set of Recommendations from JHPS (4)

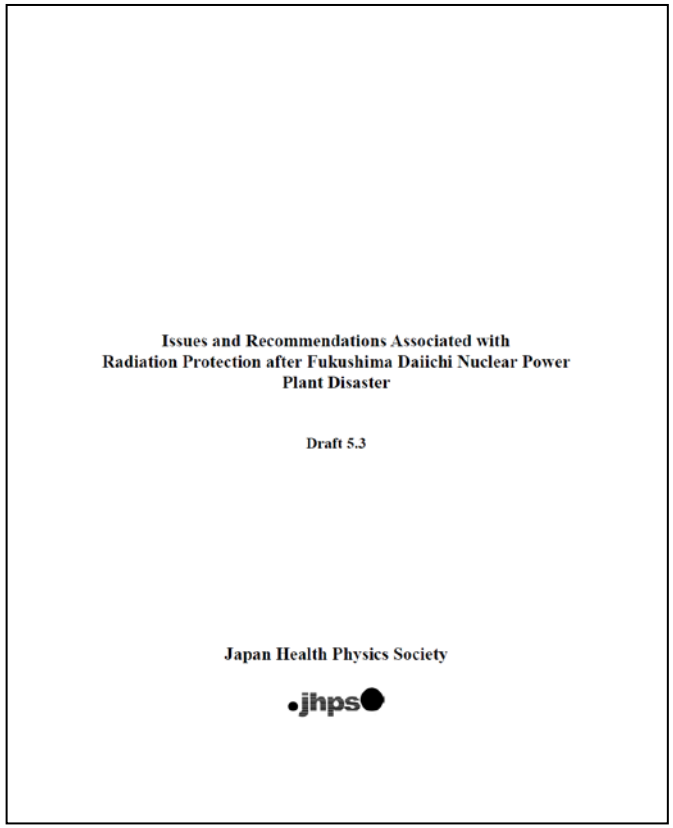
35. Risk communication to the public – spreading understanding of radiation effects (35-1, 35-2, 35-3, 35-4, 35-5)
36. Risk communication to the public – comprehensibility of radiological protection system
37. Risk communication to the public – utilization of mass media
38. Risk communication to the public – response to foreign residents and overseas countries
39. Nuclear emergency preparedness system – preparedness for complex disasters (39-1, 39-2)
40. Nuclear emergency preparedness system – opportunity of revision of nuclear emergency preparedness for complex disasters (earthquake, tsunami, and nuclear accident)

Total 61 recommendations

Concluding remarks

- JHPS has been reviewed how radiological protection measures after an accident should be operated on the basis of concrete facts clearly described in the five investigative reports and voices collected in the JHPS symposia, and elaborated comprehensive reports on the second set of recommendations including the first set of recommendations.
- JHPS hope that this will be of help in developing the scientific fields of health physics and radiological protection utilized by international radiation protection experts as well as those in the JHPS, residents in affected areas and relevant staff in the government, in cooperation with overseas associated societies such as the Asian and Oceanic Association for Radiation Protection (AOARP), the International Radiation Protection Association (IRPA) and the Health Physics Society in the US.

The 2nd set of recommendations (draft)

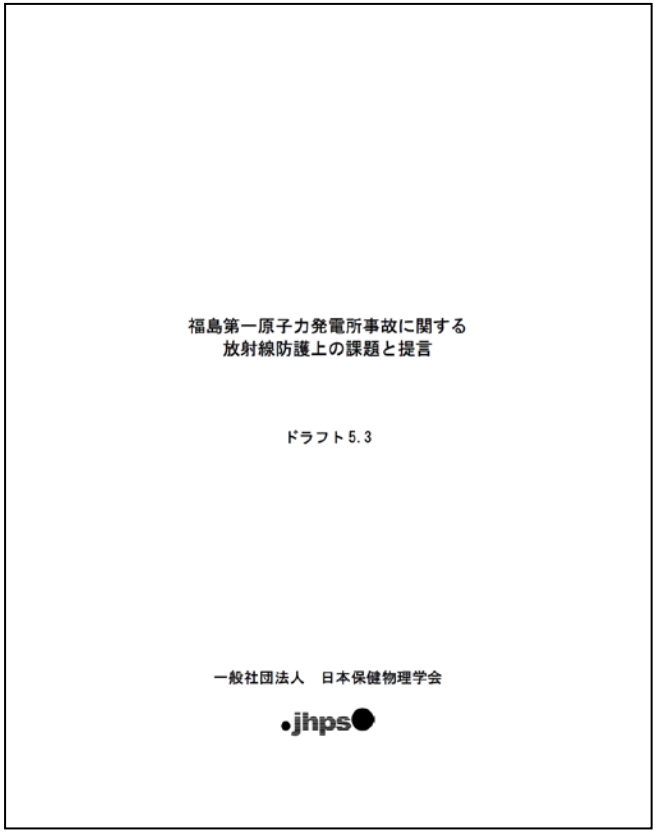


Issues and Recommendations Associated with
Radiation Protection after Fukushima Daiichi Nuclear Power
Plant Disaster

Draft 5.3

Japan Health Physics Society

jhps



福島第一原子力発電所事故に関する
放射線防護上の課題と提言

ドラフト 5.3

一般社団法人　日本保健物理学会

jhps

jhps

Recommendations for protection of the public

Recommendation 1: Radiation monitoring on land

Radiation monitoring on land – unexpected effects on means of transportation and communication

Recommendation 1: Alternative means or cooperative system for land monitoring should be previously prepared assuming that the Off-site Center fails to function, the monitoring car is unable to be utilized or aircraft monitoring cannot be carried out as intended, and so forth.

Issue 1: Radiation monitoring on land could not proceed following the previously determined emergency preparedness plan owing to unexpected effects due to road damage, widespread power failure, fuel shortages in monitoring cars, damage to communications networks, and delay in the preparation of helicopters.

Recommendation 2: Radiation monitoring on land

Radiation monitoring on land – monitoring posts washed away and communication lines severed

Recommendation 2: Monitoring posts should be upgraded so as to ensure high tolerance to earthquakes and tsunami.

Issue 2: Four of the 24 monitoring posts established by Fukushima Prefecture were washed away by the tsunami and another 19 were unable to transmit data owing to severed communication lines, which resulted in 23 monitoring posts being inoperable.

Recommendation 3: Tap water monitoring

Tap water monitoring – communication method with public

Recommendation 3: Risk communication methods should be prepared to inform the public of a restriction period for the intake of drinking water (tap water, river water and well water, etc.) indispensable to keep our lives and the meaning of the regulatory value.

Issue 3: After notification on 23 March 2011 to refrain from providing tap water to infants in the 23 wards of Tokyo and the Tama area, the radioactivity concentration in tap water on 24 March decreased to below the regulation value. For this reason, it was announced that tap water may be used without any concern, including for infants. However, since mineral water could not be obtained in many areas, there were actually severe cases whereby people ultimately had to decide for themselves whether to drink tap water including radioactive materials or to refrain from drinking water and whether or not to continue breast feeding owing to concern of transferring radioactive materials from mother to infant.

Recommendation 4: Shipping restrictions and monitoring of agricultural and livestock products

Shipping restrictions and monitoring of agricultural and livestock products – expansion of contamination due to food chain

Recommendation 4: Methods to predict and restrict the expansion of contamination due to the food chain should be prepared for various agricultural and livestock products in response to the characteristics of the accident.

Issue 4: The Notice on Farming Management was not communicated to grain farmers, who produce rice straw. Furthermore, the information and guidance provided to cattle farmers were inadequate and it was discovered that cattle farmers had fed their cattle rice straw that had been stored outdoors and was most likely contaminated with radioactive material. This led to the detection of radioactive cesium exceeding the temporary regulation value in beef.

Recommendation 5: Shipping restrictions and monitoring of agricultural and livestock products

Shipping restrictions and monitoring of agricultural and livestock products – measurement method for livestock products

Recommendation 5: Methods to measure radioactivity in livestock products in emergency situations should be standardized in collaboration with expert committees and associated societies while verifying their technological validity by comparison with previous findings and conventional technologies.

Issue 5: Beef fed by contaminated rice straw could not be identified by inspection after slaughter.

Recommendation 6: Food monitoring

Food monitoring – regional variations

Recommendation 6-1: Methods to measure radioactivity in foods in emergency situations should be standardized in collaboration with expert committees and associated societies while verifying their technological validity by comparison with previous findings and conventional technologies.

Recommendation 6-2: A cooperative system that will enable us to temporarily lend equipment for measuring radioactivity in foods should be developed after nationwide investigation of the availability of such equipment.

Issue 6: Food monitoring was left to the test plans of the prefectures, so the level of the monitoring varied depending on the prefecture. The monitoring equipment and other infrastructure in the various prefectures were insufficient at the early stage after the disaster. Moreover, there were also local governments that were unenthusiastic about performing monitoring because of their concerns about the harm to their reputation, so the level of monitoring varied depending on the local government.

Recommendation 7: Monitoring of forests and subsoils of rivers and lakes

Monitoring of forests and subsoils of rivers and lakes – lack of understanding of the necessity

Recommendation 7: Monitoring methods should be prepared taking into consideration the behavior and transition of radioactivity in forests and subsoils of rivers and lakes.

Issue 7: The necessity of monitoring forests and subsoils of rivers and lakes was not sufficiently understood.

Recommendation 8: Monitoring of seawater, subsoils of ocean, and sea products

Monitoring of seawater, subsoils of ocean, and sea products – lack of understanding of the necessity

Recommendation 8: Coastal sea area monitoring methods should be prepared taking into consideration the behavior and transition of radioactivity in sea water, subsoils of the ocean and sea products.

Issue 8: Since the necessity of sea area monitoring was not fully understood, the monitoring area was limited to the region within 30km from Fukushima Dai-ichi NPS at the early stage after the accident. Ocean currents formed around this local area were not considered in the monitoring design, which led to missing knowledge on the dynamics of the transition of radioactive materials from the source.

Recommendation 9: Monitoring of seawater, subsoils of ocean, and sea products

Monitoring of seawater, subsoils of ocean, and sea products – lack of prediction tools

Recommendation 9-1: Methods to predict and restrict the expansion of contamination due to the food chain should be prepared for various sea products in response to the characteristics of the accident.

Recommendation 9-2: A technique for simulating the transition of radioactivity in the ocean should be prepared as a nuclear emergency preparedness measure.

Issue 9: Since the seawater off Fukushima Prefecture travels down to the southern region of the Fukushima Dai-ichi NPS along the coast after the "Oyashio" current meets the "Kuroshio" current, radioactive materials in seawater traveled down to off the coast of Ibaraki Prefecture in the area south of the Fukushima Dai-ichi NPS, which led to the situation that radioactive materials temporarily accumulated in sand eels, forcing fishermen in Ibaraki Prefecture to refrain from fishing. In addition, radioactive materials also accumulated in bottom-dwelling coastal fishes (e.g., flat fish, flounder, etc.). The timing of the accumulation of radioactive materials in medium-sized fish owing to the food chain could not be predicted since the monitoring target at the early stage postaccident was not ocean subsoils but seawater.

Recommendation 10: SPEEDI

System for Prediction of Environmental Emergency Dose Information (SPEEDI) – underutilization of prediction results

Recommendation 10-1: The calculation results obtained from SPEEDI should be promptly disclosed together with their uncertainty in a clearly understandable form so that municipalities and evacuees can actively use the data.

Recommendation 10-2: Usage of SPEEDI in the case that the Emergency Response Support System (ERSS) is unable to be used and a detailed plan for the evacuation of residents in the case that SPEEDI fails to be utilized should be clarified under the framework of nuclear emergency preparedness.

Recommendation 10-3: When the entire range within concentric circles is established as an evacuation area owing to the fast unfolding of events in the present accident, methods to predict areas scarcely affected by the diffusion of radioactive materials and to speedily inform the relevant parties of the predicted information should be determined in combination with monitoring information to continue disaster management, such as life saving activities in evacuation areas, as long as possible.

Issue 10-1: Since the external power supply was lost following the earthquake and the Government's dedicated line for sending data became unavailable, the release of source information from the Emergency Response Support System (ERSS) on which SPEEDI calculations are based was not carried out. For this reason, the Nuclear Safety Technology Center provided the predicted results of their unit release rate calculation based on “the Environmental Radiation Monitoring Guidelines”, to the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Emergency Response Center (ERC), the Nuclear Safety Commission (NSC), the Off-site Center, the Fukushima Prefectural Office, and the Japan Atomic Energy Agency (JAEA) in response to the directive from MEXT on 11 March 2011. However, these predicted results were neither utilized to discuss practical evacuation measures nor disclosed to the public, since the calculations based on an assumed unit release rate did not show any actual radiation dose levels.

Recommendation 10: SPEEDI

System for Prediction of Environmental Emergency Dose Information (SPEEDI) – underutilization of prediction results

Issue 10-2: On the night of 12 March, NSC made one request for a SPEEDI calculation to the Nuclear Safety Technology Center. The NSC received the calculation results and shared them with its members, members of its technical advisory body in an emergency, and some staff members of the NSC Secretariat. The NSC, however, believed that the calculation results should only be utilized for internal discussion. As a result, the calculation results were not shared with any other organizations.

Issue 10-3: Meanwhile between 11 and 15 March, the Nuclear and Industrial Safety Agency (NISA) conducted SPEEDI calculations by entering various assumptions of release source information in order to grasp the dispersion trend of radioactive materials. The obtained predicted results were shared with various functional teams within the MEXT-ERC. A few results were provided to the Prime Minister's Office and the Off-site Center. However, NISA sent the Prime Minister's Office the SPEEDI predictions with an accompanying message that NISA believed the SPEEDI predictions to be of low reliability because the calculations were based on assumed release source information. Cabinet Secretariat staff treated them as reference information and did not report them to the Prime Minister

Recommendation 11: Simulation system on the diffusion of radioactive materials in the ocean

Simulation system on the diffusion of radioactive materials in the ocean – lack of prediction tools in the emergency preparedness system

Recommendation 11-1: Methods to utilize simulation results of the diffusion of radioactive materials in the ocean should be determined under the framework of nuclear emergency preparedness.

Recommendation 11-2: The calculation results obtained from the simulation system for diffusion in the ocean should be promptly disclosed together with their uncertainty in a clearly understandable form so that municipalities and evacuees can actively use the data.

Recommendation 11-3: A system to estimate the medium- to long-term effects of ocean contamination on sea products should be established.

Issue 11: No simulation system for the diffusion of radioactive materials in the ocean has been established in the nuclear emergency preparedness system, since people do not live on sea area, unlike on land.

Recommendation 12: Evacuation of residents and its criterion

Evacuation of residents and its criterion – extension of order to stay indoors

Recommendation 12: The adoption of both short-term and long-term criteria in a stepwise manner should be examined by considering the balance between emergency measures that may be effective both temporarily and over the long term, and the maintenance of infrastructure required to ensure the secure everyday life of the general public.

Issue 12: The results of radiation monitoring and SPEEDI retrospective estimation showed there were areas with high radiation doses even more than 20km from the Fukushima Dai-ichi NPS. The distribution of essential items was disrupted in stay-indoors evacuation zones and it was difficult for residents to conduct their daily lives. In the Nuclear Emergency Guidelines, the enforcement of a stay-indoors evacuation for a long period of time was not assumed.

Recommendation 13: Evacuation of residents and its criterion

Evacuation of residents and its criterion – instruction of deliberate evacuation

Recommendation 13: Since the deliberate evacuation zones, which were proposed after the disaster for the first time, were areas in which evacuation was recommended on the basis of the annual individual dose rather than on the need for emergency evacuation, thorough discussions should be held with municipalities to determine suitable evacuation zones and the period of evacuation.

Issue 13: On 11 April 2013, Chief Cabinet Secretary Edano announced a fundamental concept of how deliberate evacuation zones should be established. Subsequently, the government issued early advice to the affected municipalities and then, on 22 April, the Nuclear Emergency Response Headquarters (NERHQ) established deliberate evacuation zones and provided those municipalities with a directive to inform residents in the zones to be prepared to evacuate after a period of approximately one month.

Recommendation 14: Evacuation of residents and its criterion

Evacuation of residents and its criterion – communication of evacuation instruction

Recommendation 14: Measures, such as an order of evacuation, in the case that the Off-site Center, where the Local Nuclear Emergency Response Headquarters (NERHQ) is located, fails to function should be previously established including, for instance, where the Local Headquarters should be replaced to.

Issue 14: The Emergency Preparedness Guide prescribes that the head of the local headquarters shall communicate an evacuation order to each municipality, including cities, towns, and villages. Most of the municipalities actually learned of the evacuation instructions through the mass media including TV. Some of them learned through verbal announcements from police vehicles, including police patrol cars.

Recommendation 15: Evacuation of residents and its criterion

Evacuation of residents and its criterion – evacuation beyond a designated zone for emergency preparedness

Recommendation 15-1: Emergency planning zones (EPZs) that are designated for emergency preparedness within a radius of 8-10 km from nuclear power plants and related disaster management measures should be reviewed through full discussions with municipalities with consideration of the post disaster spread of contamination to a large area, as observed in this disaster.

Recommendation 15-2: The evacuation route and the destination should be previously identified together with a method for the supply of food and drinks on the basis of the nuclear accident size considered.

Issue 15: Each of the municipalities located within a 10km radius (equivalent to the Emergency Planning Zone, or EPZ) of a power plant is expected to possess regional disaster prevention plans and evacuation plans. Each municipality is, as a rule, primarily responsible for formulating evacuation plans and implementing these plans, but in the event of evacuation over a wider area (across municipalities), Fukushima Prefecture bears the responsibility of formulating an evacuation plan. However, in reality, the only evacuation cases in which Fukushima Prefecture took the lead in coordinating shelters across municipalities were for Futaba Town and Okuma Town, when an evacuation instruction was issued for areas lying within a 10km radius.

Recommendation 16: Evacuation of residents

Evacuation of residents and its criterion – evacuation of socially vulnerable individuals

Recommendation 16: For the evacuation of socially vulnerable individuals such as people in medical institutions, homes for the aged and welfare facilities, and developmentally disabled individuals, an emergency evacuation strategy including methods of communication by satellite phone should be provided in the nuclear emergency preparedness plan that is independent of the endeavor of the individuals or the facilities.

Issue 16: People who had difficulty evacuating, such as hospitalized patients, were left behind in the area within a radius of 20km from the nuclear plant, which had been designated as an evacuation zone. In the situation where communication was limited and sufficient information could not be obtained, the evacuation of hospitalized patients was extremely difficult, resulting in many cases of aggravated medical conditions or death.

Recommendation 17: Radiological protection criteria

Radiological protection criteria – criteria for administration of stable iodide – confusion regarding administration criteria

Recommendation 17-1: The emergency measures of evacuation and stay indoors, distribution of stable iodide, and regulation of the ingestion of foods and drinks should be comprehensively examined to ensure consistency in their principles.

Recommendation 17-2: The concept of criteria for administration of stable iodine should be clarified, taking into consideration that there may only be insufficient radiation monitoring data available in an emergency without SPEEDI information.

Issue 17: Local governments were able to obtain a sufficient amount of stable iodine tablets, but instructions to take the stable iodine tablets were not given because there was no information on predicted radiation dose by SPEEDI. On the other hand, new criteria for the administration of stable iodine were provided by the NSC on the basis of a screening level. This advice, however, did not reach Fukushima Prefecture and the cities, towns, and villages concerned. There was no opportunity to take iodine tablets except for some residents who were given instructions at a local government's own discretion.

Recommendation 18 : Radiological protection criteria

Radiological protection criteria – screening level – validity of the level

Recommendation 18-1: The validity of the screening criteria for decontamination in an emergency in terms of their effectiveness for radiation protection should be verified in accordance with the principles of other emergency measures by considering problems that may arise in relation to the radiation measurement.

Recommendation 18-2: According to the stage postaccident (early, middle, later and long-term), when the environmental contamination level reduces, a lower value of the screening level for decontamination should be selected in a stepwise manner in accordance with the reduction of the surrounding environmental contamination level. Also, the concrete process for selecting the screening level should be previously determined.

Recommendation 18-3: Since there are many valuable items in broadly contaminated areas, which could be recycled or reused in normal circumstances, the screening level for recycling should be set in addition to that for decontamination. Moreover, in the case that objects for reuse or recycling are restricted, the process used for setting the screening level should be previously determined because the screening level in the restricted areas can be relaxed in accordance with environmental contamination level.

Issue 18: The screening level was raised in accordance with the present situation using different levels from those that had been previously established.

Recommendation 19: Radiological protection criteria

Radiological protection criteria – criteria for contamination of soil (schoolyards and educational facilities, and bathing areas, utilization of crushed stones, and disposal of disaster waste and sewage sludge) – consistency of concepts for derivation of criteria

Recommendation 19-1: Reference levels should be determined on the basis of the overall policy by considering the radiation sensitivity of children and the balance among reference levels, and, if necessary, stepwise reference levels should be adopted. Also, with the cooperation of experts who can support residents' viewpoints, the active cooperation and understanding of stakeholders including residents should be obtained to determine the reference levels, which should not be described as permissible levels because they do not indicate a threshold between safe and hazardous levels.

Recommendation 19-2: The reference levels for radioactive waste should be set to below those for broad contamination in the overall plan of environmental restoration with the active cooperation and understanding of stakeholders including residents and the cooperation of experts who can support residents' viewpoints. Also, radioactive waste should be managed so that the assessed individual dose becomes lower than the determined reference levels and disposed of in a planned manner so that the assessed individual dose satisfies a target dose of 1 mSv/y or lower.

Issue 19: It has become difficult to explain the consistency among all the criteria since each criterion was determined using a different concept.

Recommendation 20: Radiological protection criteria

Radiological protection criteria – criteria for food and beverages – comprehensiveness of food categories

Recommendation 20: Categories of foods and their restriction values should be reviewed by considering statistical results on their annual amount of ingestion and by monitoring of radiation levels in foods and following an optimization principle in which social and economic factors are taken into account.

Issue 20: Since in the provisional regulatory values (by 31 March 2012) for radioactive materials contained in foods, the restriction values for radioactive iodine in fish and foods not to consumed directly, e.g., tea leaves, were not specified, much confusion occurred.

Recommendation 21: Radiological protection criteria

Radiological protection criteria – criteria for food and beverages – universal use for various types of accident

Recommendation 21-1: The emergency measures of evacuation and stay indoors, distribution of stable iodide, and regulation of the ingestion of foods and drinks should be comprehensively examined to ensure consistency in their principles.

Recommendation 21-2: The adoption of both short-term and long-term criteria in a stepwise manner should be examined by considering the balance between emergency measures that may be effective both temporarily and over the long term and the maintenance of infrastructure required to ensure the secure everyday life of the general public.

Issue 21: Since the new regulatory value for food and beverages enforced on 1 April 2012 was derived for only radioactive cesium on the basis of 1mSy/y as an internal exposure dose and can be applied to the current situation after the present accident, it cannot be universally used as a criterion for emergency preparedness where various types of accident should be considered.

Recommendation 22: Radiological protection criteria

Radiological protection criteria – criteria for food and beverages – approach to dose criteria

Recommendation 22: The individual dose criteria used as references to derive the restriction values of radioactive materials in foods should be determined after full discussion with stakeholders associated with the production, distribution, and consumption of foods.

Issue 22: In the derivation of the new regulatory value for food and beverages enforced on 1 April 2012, 1mSv was adopted as a dose criterion, strictly shifting from 5mSv; nevertheless, the estimated dose due to intake of contaminated foods was sufficiently low and was determined without full discussion with stakeholders associated with the production, distribution, and consumption of foods.

Recommendation 23: Radiological protection criteria

Radiological protection criteria – protective criteria for temporary entry into restricted zones – balance among other risks

Recommendation 23: Flexible systems that will allow people of different ages including the elderly to temporarily enter restricted zones for various purposes should be developed by considering the balance of radiation protection measures with other risks and inconvenience, rather than uniformly imposing the wearing of a protective suit and limiting the entry time.

Issue 23: Irrespective of the ambient dose level in the residence, the maximum time spent at home during temporary entry was limited to 2 h, and the total time taken for the round trip from the relay point to each home was limited to 5 h.

Recommendation 26: Radiation exposure of residents

Radiation exposure of residents – estimation of thyroid equivalent dose of radioactive iodine by simple measurement

Recommendation 26-1: The thyroid equivalent dose for the internal exposure to radioactive iodine should be calculated on the basis of the results of simulating the atmospheric diffusion of the radioactive plume using SPEEDI, food inspections, and surveys on residents' behavior. Also, the calculation results along with their uncertainty should be disclosed..

Recommendation 26-2: The standardization of methods of evaluating the thyroid equivalent dose of radioactive iodine by simple measurement should be examined in collaboration with expert committees and associated societies while verifying their technological validity by comparison with previous findings and conventional technologies.

Recommendation 26-3: The thyroid equivalent dose assessment carried out by other researchers and methods to estimate the thyroid equivalent dose of 1,080 children using simple measurements should be investigated and the results should be reflected in the discussion of the uncertainty of the thyroid equivalent dose of residents.

Recommendation 26-4: Emergency environmental monitoring guidelines should be verified including dose assessment postaccident. A system that can be operated with good understanding of the guidelines should be established developing human resources. Moreover, a mechanism to enable the system to be maintained over a long time should also be established.

Issue 26: Screening tests for thyroid gland exposure levels on 1,080 infants and children were carried out in Iwaki City, Kawamata-machi, and Iitate-mura from 26 March to 30 March 2011; however, this involved low-precision tests and no further tests of the thyroid gland exposure levels of the children were carried out.

Recommendation 27: Radiation exposure of residents

Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – investigation system

Recommendation 27-1: A cooperative system that enables the temporary lending of WBCs and dispatch staff for measurements to the affected area should be developed after nationwide investigation of the availability of such equipment and training of the staff. Also, a system that enables the investigation of internal exposure using WBCs should be established, led by the national or prefectural government immediately after an accident.

Recommendation 27-2: It is necessary to consider methods of maintaining the large number of WBCs after the accident and to make a Q&A booklet or manual instructions to enhance the understanding of how the monitoring results of WBCs should be explained to the public.

Issue 27: As part of the Fukushima Prefecture Health Management Survey started in June 2011, individual doses for external exposure were investigated as the External Dose Estimation based on the behavior records in the Basic Survey. However, investigation of the dose for internal exposure using the WBC was not carried out in the Basic Survey. For this reason, the WBC measurement results are individually kept in each municipality or hospital since these data are a form of personal information that is unavailable for use for other objectives without permission. The WBC measurement for internal exposure was not addressed in the nuclear emergency preparedness plan, which was a main cause of the delay in conducting the WBC measurement.

Recommendation 28: Radiation exposure of residents

Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – measurement method

Recommendation 28: The standardization of radiation-related emergency methods of evaluating the internal dose using WBCs and the bioassay method should be examined in collaboration with expert committees and associated societies while verifying their technological validity by comparison with previous findings and conventional technologies.

Issue 28: Since individual dose assessment for internal exposure using the WBC highly collected the needs of residents, the WBCs were individually set up by municipalities, hospitals, and nongovernmental organizations, in addition to direct management by the Fukushima prefectural government. Therefore, the dose assessment was carried out by non-unified methods without standardization. Although it is important, when using a great number of WBCs as a monitoring tool, to ensure the traceability from the viewpoint of maintaining the reliability of the measurements, there are no standards for WBCs. Also, there are no manuals to effectively explain the WBC monitoring results to the public.

Recommendation 29: Radiation exposure of residents

Radiation exposure of residents – external dose assessment using personal dosimeters

Recommendation 29: A cooperative system that enables the temporary lending of personal dosimeters to the affected area should be developed. Also, a system that enables the investigation of external exposure using personal dosimeters should be established, led by the national or prefectural government immediately after an accident.

Issue 29: Since dose assessment was carried out by each municipality by lending personal dosimeters in response to the needs of residents, individual dose data for external exposure are kept in the respective municipality because these data are a form of personal information that is unavailable for use for other objectives without permission.

Recommendation 30: Radiation exposure of residents

Radiation exposure of residents – external dose estimation on the basis of behavior survey

Recommendation 30: Knowledge and skill regarding the external dose assessment system developed in the implementation of the the Basic Survey of the Fukushima Prefecture Health Management Survey (the External Dose Estimation), the format of the inquiry form and relevant activities for improving the recovery ratio should be shared. Also, a system that enables us the survey to be started immediately after an accident should be established.

Issue 30: As part of the Fukushima Prefecture Health Management Survey started in June 2011, the individual dose for external exposure was investigated as the External Dose Estimation, using the behavior records obtained via sets of inquiry forms in the Basic Survey. However, the recovery ratio of inquiry forms was only 18% in December 2011. (As of 31 January 2013, the recovery ratio for the whole area of the prefecture was 23.2% and that for the preceding investigation area, Yamakiya district of Kawamata Town, Namie Town, and Iitate Village was 56.7%).

Recommendation 35 : Risk communication to the public

Risk communication to the public – spreading understanding of radiation effects

Recommendation 35-1: Activities to improve nationwide knowledge of the long-term effects of radiation should be started, taking into consideration not only areas relevant to the nuclear emergency and education in schools but also all generations of Japanese people. Moreover, by considering the risks and benefits of not only radiation but also all other applications of science and technology, opportunities should be provided to discuss and understand concepts without taking alternative ways to whether they are safe or dangerous.

Recommendation 35-2: Human resources such as spokespersons for radiation protection who can provide easy-to-understand explanations should be developed as part of a long-term strategy. Also, the ability to explain radiation effects in a face-to-face manner in an emergency should be ensured by developing the communication skills of people in municipal government to explain the risk posed by radiation to local residents.

Recommendation 35-3: Effective methods for communication with the public, for instance, small-size dialogue meetings in the surrounding area and large-size dialogue meetings in remote areas using large facilities in a major town, should be established taking into consideration that there will be a large number of people to communicate with in remote areas where the environmental contamination level is relatively low and the size of the area is large, compared with the surrounding area near the accident site where the environmental contamination level is relatively high.

Recommendation 35 : Risk communication to the public

Risk communication to the public – spread of understanding of radiation effects

Recommendation 35-4: Systems to dispatch risk commnunication experts who fully understand the newest data and changes in the values of criteria with time should be prepared taking into consideration that in the early stage postaccident, there were a lot of simple questions regarding radiation and its effects, and the themes of the questions changed in various ways with the passing of the stages postaccident (early, middle, later and long-term), such as suspicion about governmental announcements, the implications of various standards or measurement results, greater understanding of measured results and suggestions for minimizing risk in daily life. In addition, systems to share both successful and unsuccessful experiences should be prepared.

Recommendation 35-5: As an appropriate public relations measure, unclear expressions such as those in which the intended meaning is unclear should be avoided. In particular, for the explanations of radiation exposure, risk communication systems supported by experts should be established together with consistent explanations of low-dose radiation effects in an easy-to-understand manner.

Issue 35: The Government often explained, "It does not have immediate effects on health", concerning the influence of radiation on the human body. This expression may be interpreted by some people as "it is unnecessary to be anxious about the impact of radiation on human health," while it may be interpreted by other people as "it does not immediately affect human health, however, some effects on human health will appear in the longer term." However, it was not necessarily clear what the intended meaning of the expression was, and there was no detailed explanation. Moreover, anxiety regarding unknown nuclear disasters and dissatisfaction about the explanation from the government were broadly shared. One of the reasons for this is that we have neglected to endeavor to improve public understanding of radiation and have never trained radiological protection experts for risk communication in the municipal government in the nuclear emergency preparedness plan.

Recommendation 36 : Risk communication to the public

Risk communication to the public – comprehensibility of radiological protection system

Recommendation 36: Discussions should be started towards the reestablishment of simple systems for protecting the public from radiation exposure, which will require high accountability to the public, both under normal conditions and in emergencies (including emergency and existing exposure situations), reconsidering the concept of radiation risk.

Issue 36: Residents who had to live in an environment contaminated by radioactive material after the accident sought information about the level of radioactivity that would serve as a basis for making decisions. Mothers, in particular, sought accurate information about the extent of contamination in the food and beverages they were giving their children, and about the radiation dose from the environment and its potential effects on their health. However, the information that was made available to the residents was not satisfactory.

Recommendation 37 : Risk communication to the public

Risk communication to the public – utilization of mass media

Recommendation 37: A system that enables the timely provision of information obtained by accurately collecting information required by people through the bidirectional interactive exchanges of information using social media in an emergency and utilizing both social media and mass media should be established.

Issue 37: The government rapidly responded to online risk communication by consolidating the relevant information onto its homepage and opening an official twitter account of the Cabinet. However, it used only one way communication such as mass media and could not provide appropriate timely information or gain the public's confidence, since the information was not obtained through bidirectional exchanges utilizing the characteristics of social media.

Recommendation 38 : Risk communication to the public

Risk communication to the public – response to foreign residents and overseas countries

Recommendation 38: Taking into consideration the effects on neighboring countries in an emergency and ensuring the safety of foreign residents, a system that enables the timely provision of information to foreign countries and residents should be developed while clarifying the decision-making process for the order to evacuate and discharge to the ocean. Moreover, the authorized discharge of water contaminated with low-level radioactive materials to the ocean in a controlled situation should be decided with sufficient involvement and understanding of stakeholders concerned with the fishing industry, with the cooperation of experts who can support the viewpoint of the industry.

Issue 38-1: Although the discharge of the less contaminated water into the sea conducted on 4 April 2011 did not fall within the scope requiring notification prescribed in the United Nations Convention on the Law of the Sea, the notification stating that the discharge would begin was sent the day of discharge after it had already started and countries around Japan were not informed of the discharge in advance.

Issue 38-2: The U.S. Nuclear Regulatory Commission (NRC) had been seeking detailed information regarding the status of the Fukushima Dai-ichi NPS from the Japanese government since 12 March 2011. However, the Japanese government was incapable of providing such information to the U.S. in a manner satisfactory to the U.S. side, because Japanese government had not been able to acquire sufficient information on the nuclear power plant itself and officials of NISA and other government staff familiar with the situation at the nuclear plant were preoccupied with their work of dealing with the plant's situation. For this reason, the NRC decided to issue evacuation advice as a safety measure, and on 17 March (Japan time) advised U.S. citizens in Japan to evacuate to outside of a 50-mile (about 80km) radius of the Fukushima Dai-ichi NPS. This led to confusion because this radius for evacuation was significantly larger than the 20km radius of the Japanese evacuation area.

Recommendation 39 : Nuclear emergency preparedness system

Nuclear emergency preparedness system – preparedness for complex disasters

Recommendation 39-1: Nuclear emergency preparedness should be reconsidered considering the voices of relevant municipalities including countermeasures prepared for an accident scenario where events unfold quickly and a complex disaster involving earthquakes and tsunamis occurring simultaneously with a nuclear disaster.

Recommendation 39-2: Expert groups who can respond to unanticipated accidental events should be developed by daily training incorporating up-to-date technical knowledge.

Issue 39: Serious confusion occurred in the relevant organization owing to insufficient preparedness for an accident scenario where events unfold quickly and for facing a complex disaster involving earthquakes and tsunamis occurring simultaneously with a nuclear disaster..

Recommendation 40: Nuclear emergency preparedness

Nuclear emergency preparedness system – opportunity of revision of nuclear emergency preparedness for complex disasters (earthquake, tsunami, and nuclear accident)

Recommendation 40: Nuclear emergency preparedness should involve a system that is regularly and rapidly updated according to new knowledge, technology and suggestions and so on. Also, natural features should be established to prevent the inflexibility and obsolescence of countermeasures.

Issue 40: Although problems of emergency preparedness assuming the possible occurrence of a nuclear emergency coupled with a complex disaster were pointed out, no measures were taken against them.

Recommendations for protection of workers

Recommendation 18 : Radiological protection criteria

Radiological protection criteria – screening level – validity of the level

Recommendation 18-1: The validity of the screening criteria for decontamination in an emergency in terms of their effectiveness for radiation protection should be verified in accordance with the principles of other emergency measures by considering problems that may arise in relation to the radiation measurement.

Issue 18: The screening level was raised in accordance with the present situation using different levels from those that had been previously established.

Recommendation 24 : Radiological protection criteria

Radiological protection criteria – dose criteria for emergency work – dose limit taking life-saving work into account

Recommendation 24: New dose limits for emergency workers to take into account the need for emergency medical care should be examined while clarifying the decision-making process and considering the fact that the adopted dose limit for emergency workers is 250 mSv, which is lower than the internationally recommended value, and that the current dose limit for radiation workers under normal situations is determined on the basis of a lifetime individual dose of 1,000 mSv.

Issue 24: In the second interim report on the incorporation of the 2007 Recommendations of the ICRP into domestic systems, the Basic Committee of the Radiation Council proposed to match the dose limits to internationally recommended values, taking into consideration that opportunities to participate in international activities were increasing for domestic workers, because the current restriction criteria in Japan (dose limit, 100 mSv) interfered with emergency medical care and other essential operations. On the other hand, in response to the present accident, 250mSv was adopted as a dose limit for emergency workers. This value is lower than the internationally approved principles and the recommended value of the 2007 Recommendations of ICRP (emergency medical care, no restriction; other emergency rescue operations, 1,000 or 500 mSv; other rescue operations, 100 mSv).

Recommendation 25 : Radiological protection criteria

Radiological protection criteria – dose criteria for emergency work – treatment of individual doses received in an emergency situation

Recommendation 25: The individual dose in an emergency should be controlled independently of the compliance with the dose limits for radiation workers under normal conditions (50 mSv per year and 100 mSv over five years) to control radiation exposure.

Issue 25: In the second interim report on the incorporation of the 2007 Recommendations of the ICRP into domestic systems, it was indicated that emergency work doses will be treated separately from normal work doses. However, the Ministry of Health, Labor and Welfare (MHLW) issued an official notice stating that when managing dose limits during normal work, if a worker has a history of engaging in emergency work, the doses received during such work should be included and the limit of 100mSv/5 years should be applied.

Recommendation 31 : Radiation exposure of plant recovery workers

Radiation exposure of plant recovery workers – network for urgently borrowing alarm pocket dosimeters (APDs)

Recommendation 31: An emergency procedure for borrowing APDs, whole body counters (WBCs) and protective tools for internal exposure from other nuclear power stations should be developed for plant recovery workers. Also, systems to ensure the availability of sufficient numbers of personal dosimeters and protective tools for internal exposure should be established for rescue or decontamination workers.

Issue 31: Although many APDs were provided as aid supplies from other NPSs, these APDs were simply stored and remained unused owing to a lack of communication. There were not enough APDs and by 15 March, not every worker was able to wear an APD, which led to the decision that only the leaders of each operational group would wear APDs on behalf of the entire group.

Recommendation 32 : Radiation exposure of plant recovery workers

Radiation exposure of plant recovery workers – control of internal exposure in an emergency

Recommendation 32: The performances and the methods of using protective tools for internal exposure, appropriate methods for eating, drinking and excretion in the case of a long-term emergency situation, protective measures to prevent the reduction of airtightness of seismic isolation buildings used in an emergency and a method for the administration of stable iodine should be trained and practiced in a practical manner for both the plant recovery and rescue/decontamination workers.

Issue 32-1: The individual doses of 6 workers exceeded 250mSv, which was the dose limit for emergency workers temporarily prescribed after the accident.

Issue 32-2: The doses of two female employees significantly exceeded the 5mSv three-month upper limit for female radiation workers, although they took appropriate radiological protection measures such as wearing full-face masks with charcoal filters whilst working in the field, since the double-entry doors to the Seismic Isolation Building were not airtight and the doors to the Seismic Isolation Building were bent and twisted by the hydrogen explosions in Units 1 and 3.

Issue 32-3: 178 workers showed thyroid gland equivalent doses of over 100mSv, and 25 workers under the age of 40 did not take iodine tablets.

Recommendation 33 : Radiation exposure of plant recovery workers

Radiation exposure of plant recovery workers – control of localized exposure in an emergency

Recommendation 33: Protective measures against the localized exposure of radiation should be previously trained and practiced in a practical manner for plant recovery workers, assuming a sudden change in the working environment such as an explosion and leakage of contaminated water in an emergency.

Issue 33: On 24 March, two of three workers who were installing electric cables under the surface of the basement floor of the Unit 3 turbine building were exposed to high radiation doses while working immersed in contaminated water, because they were wearing low quarter shoes. Although it was made clear, after getting cleaned up and having a checkup and getting tested to measure internal radiation doses, that neither worker suffered radiation heat burns on their feet, there had been a possibility of suffering from radiation heat burns due to continuous localized exposure.

Recommendation 34 : Radiation exposure of plant recovery workers

Radiation exposure of plant recovery workers – managing access to and from a controlled area in an emergency

Recommendation 34: Practical methods regarding the management of individual doses and education before registration as a radiation worker in the case of an emergency situation postaccident, where it is difficult to precisely implement protective measures for radiation control, should be established for the plant recovery workers.

Issue 34-1: After the nuclear accident, access to and from the controlled area of the management system was initially impossible for calculating the radiation dose of individual radiation workers. It was then decided to manually calculate the radiation dose of individual radiation workers using APDs. (On 14 April, five simplified instruments were installed in the Seismic Isolation Building for gaining access to and from the controlled area management system. At the same time, a radiation work permit with bar code patterns was introduced so that the names and radiation doses of individual workers could be automatically recorded).

Issue 34-2: From the date of the nuclear accident to 10 May, radiation workers were allowed to carry out their duties after receiving a brief 30-minute explanation about how to protect themselves from radiation and how to wear protective equipment.