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Risk Management on Radiation under Prolonged Exposure Situation - Focusing on the Tokyo Metropolitan Area in Japan Under the TEPCO Fukushima Dai-ich NPP Accident -

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Abstract : Examples and experiences of risk management on radiation under prolonged exposure situation are shown. The accident of the Fukushima dai-ichi nuclear power plant after the great east Japan earthquake (11 March, 2011) elevates background level of environmental radiation around the east Japan. For example, ambient dose equivalent rate around Tohkatsu area next to Tokyo located about 200 km-south from the plant, is about 0.1-0.6 micro-Sv h^{-1} mainly due to ^{134}Cs and ^{137}Cs falling on the ground soil. This level is about double or up to ten times higher than the genuine natural level around the area. International Commission on Radiological Protection (ICRP) recommends how to face the existing exposure situation; that is the prolonged exposure situation. Referring to ICRP's reports and/or related international/ domestic documents, we have been discussing how to manage this situation and acting to gain safety and relief of public, who have a possibility to be exposed to prolonged lower-dose radiation. Here, we introduce our several experiences on risk management, especially focusing on risk communication, radiation education to public, and stakeholder involvements into decision making in local governments on radiation protection, relating to the accident.

Key words : risk management, risk communication, radiation protection, optimization of protection, prolonged exposure situation, radiation education

1. Introduction

The accident of the Fukushima dai-ichi nuclear power plant of Tokyo Electric Power Cooperation after the great east Japan earthquake (11 March, 2011) elevates background level of environmental radiation around the east Japan. Here we are focusing on the present contamination status and the ambient dose level around the metropolitan area. Under the situation, optimization of protection following the recommendations of the International Commission on Radiological Protection (ICRP) has mainly been discussed; how to apply them to our real site. As one of examples on relating activities, continuous challenge of Tohkatsu area, which consists of six local governments located in the Tokyo metropolitan has been introduced.

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2. Overview of the Environmental Radiation Around the Metropolitan Area in Japan

2.1 Location of the Nuclear Plant

Japan is a country of islands situated east of the Asian continent. Fukushima Prefecture lies between 139 and 141 degrees east longitude and 37 to 38 degrees north latitude - the same latitude as southern Greece and San Francisco, California in the United States. It faces the Pacific Ocean to the east and lies within 200 kilometers of Japan's capital of Tokyo [1]. The Fukushima dai-ichi nuclear power plant is located at the east cost of Fukushima prefecture.

2.2 Fallout and Ground Surface Contamination

The International Atomic Energy Agency (IAEA) has been confirmed that the Nuclear and Industrial Safety Agency (NISA) in Japan has submitted a provisional International Nuclear and Radiological Event Scale

(INES) Level 7 rating for the accident at the nuclear power plant. "An event resulting in an environmental release corresponding to a quantity of radioactivity radiologically equivalent to a release to the atmosphere of more than several tens of thousands of terabequerels of I-131." NISA estimates that the release of radioactive material to the atmosphere is approximately 10% of the Chernobyl accident, which is the only other accident to have an INES Level 7 rating [2]. Radioactive plume from the plant diffused around east side of Japan mainly from March to April in 2011. Especially around the metropolitan area; 8 prefectures of Tokyo, Chiba, Ibaraki, Gunma, Tochigi, Saitama, Kanagawa, Yamanashi; the present status of contamination results from two main fallouts on 15 March and 21 March due to the atmospheric current and rainfall [3].

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan has been monitored environmental radioactivity and radiation in all prefectures in Japan (47 points) since 1963 [4]. In this project, rain and dry fallout have also been estimated monthly. In addition, MEXT in cooperation with United States Department of Energy (US-DOE) started airborne monitoring after the accident in order to understand the effects over a wide area due to radioactive substances, and for the assessment of future doses and of the deposition of radioactive substances in evacuation zones, etc [5]. So far, the monitoring project is still continuing, has not finished. Combining some useful data [6] with the above monitoring results, we have estimated around several tens $kBqm^{-2}$ of ^{134}Cs and ^{137}Cs as the present maximum contamination level of ground surface around the Tokyo metropolitan area.

The Japan Chemical Analysis Center (JCAC) has estimated the vertical distribution of ^{131}I and $^{134}Cs/^{137}Cs$ in soil based on their in-situ measurement in Chiba prefecture. According to the center's report [6], ^{131}I could distribute to deeper position of soil more than 5 cm from the ground surface. When the particle size of soil is larger, $^{134}Cs/^{137}Cs$ could also distribute to deeper position of soil more than 5 cm from the ground surface. $^{134}Cs/^{137}Cs$ are held at the surface position of 2 cm-thickness soil when with surface grass.

2.3 Ambient Dose Equivalent Level

The university of Tokyo has been reporting time-variation of ambient dose equivalent rate monitored in their three campuses (Hongo, Komaba in Tokyo, and Kashiwa in Chiba) located at the metropolitan area [7]. The report started in the morning on 15 March, 2011. As described above, the temporal two main peaks of dose rate have been observed; for example, 0.72 micro Sv hr^{-1} at around 14:30 on 15 March, and 0.80 micro Sv hr^{-1} at around 11:00 on 21 March, 2011, in the Kashiwa campus. Now, the ambient dose equivalent rate around 0.05 to 0.1 micro Sv hr^{-1} in the Hongo/Komaba campus, and around 0.25 micro Sv hr^{-1} in Kashiwa campus are observed. The dose rate in the Kashiwa campus located in Tohkatsu area seems to be double or up to five times higher than the genuine natural level around the area.

3. Challange of Risk Management

3.1 An Activity Toward to Local Forums

The ambient dose equivalent rate around the Tohkatsu area has been elevated after the accident. The Tohkatsu area is located at the position about 200 kilometers-south from the plant. Public strongly requested their local governments to monitor the ambient dose equivalent rate precisely and officially. In addition, a lot of questions, requests of consultation and feeling of fear rushed to the local governments.

Six local governments (Kashiwa, Matsudo, Noda, Nagareyama, Abiko and Kamagaya) in the Tohkatsu area decided to establish a new organization to solve the total situation officially and in cooperation, called as Conference on Radiation Countermeasure in the Tohkatsu area (CRCT). CRCT started its official activity on 8 June, after preparation period of about one month. The chair of the conference is the mayor of the Kashiwa-city. Three specialists of radiation protection, radiation measurement and medical science in the radiation field are also involved in the conference as supporting members for its activity. We think this is the preparation step or the first step toward the real stakeholder engagement and involvements procedure in local governments for the optimization of protection. ICRP Publication 111 recommends; "(71) Authorities should facilitate the setting-up of local forums involving representatives of the affected population and relevant experts (e.g. health, radiation protection, agriculture authorities, etc.). These forums will allow gathering and sharing of information, and favor a common assessment of the effectiveness of strategies driven by the population, and the authorities." [8] CRCT is considered to be an example of simple local forum mentioned by ICRP.

CRCT's activities, new findings and its future scope until now are followings. These are written in its interim report released on 8 July, 2011.

- A standard manual for measurement of the ambient dose equivalent rate in Tohkatsu area has been determined. The manual provides how to measure the ambi-

ent dose equivalent rate and how to select measuring points.

- The 2 kilometers-mesh mapping for the ambient dose equivalent rate in the Tohkatsu area is now continuing.
- 0.08 – 0.65 micro Sv hr^{-1} has been observed so far.
- Real annual ambient dose at every measured point in the Tohkatsu area would be less than 1 mSv hr^{-1}, which is a reference level for school yards determined by MEXT.
- Higher dose prone area comparing surroundings must be found and acknowledged as soon as possible. Higher dose should be reduced quickly, when public would access the position easily and the area is smaller.
- Optimization of protection including dose reduction would be realized according to the actual conditions of each city.

Based on the discussion in CRCT, Kashiwa city, the organizer city of CRCT, has planned the followings, for example.

- Kashiwa city distributes an electric personal dose meter to every nursery school, kindergarten, elementary school and junior high school to check the real daily dose in each school. They prepare about 160 dose meters. A selected representative person in each school wears the dose meter every day. A person in charge of each school checks the indicated value at the end of the day, and reports the daily value to the city. The city reports the results in its web-site.
- The city prepares several simple survey meters of GM-tube type counter. In parallel with official 2 kilometers-meth monitoring based on CRCT, the city investigates ambient dose distribution in all nursery schools, kindergartens, elementary schools in detail. When they find the position whose dose is exceeding 1 micro Sv hr^{-1}, they would start to try reducing the dose.
- The city prepares an instrument to check the contaminated level of food and drink in detail. They report their own data to the citizens in addition to the data shown by Chiba prefecture.
- Small consultation meetings or small opinion exchanging meetings in nursery schools and kinder gardens are held mainly to share feeling and related information with parents.

3.2 Grass-root Risk Communication

Risk communication is one of the most important components of risk management. Basic radiation education, exchanging information on the real status of environmental radiation level or food contamination, and showing how to reduce the surrounding dose, and so on, are the first step toward the risk communication. Small consultation meeting or small opinion exchanging meeting in nursery school and kindergarten is one of opportunities to realize the process. Here again the activity of Kashiwa city is introduced as an example.

Fig. 1. An example of a small consultation meeting in a nursery school in the Tohkatsu area.

Several radiation specialists have been cooperating with the meeting as a consultant. According to our experiences of several meetings, symposium type or big forum type does not satisfy parents who feel strong anxious about elevated environmental radiation level or contaminated food in their daily life, especially for their children's health. There is a wide range of variation in their concern. It is important for local governments and specialists to listen or respond each concern and opinion one by one, and by face to face. This is the grass-root risk communication. Two or three specialists are waiting for parents in a nursery school (or a kindergarten, etc.,) who come to the school to meet their children when taking them home. Each specialty is different among the specialists. Parents can select the best specialist to ask and exchange their own concern directly, anytime if necessary. This style small consulting meeting shows and receives the best reputation by parents and school staffs according our experiences.

Main keywords of question from parents in nursery school at the stage of the 6-month post-accident are;

- current status of radioactive plume from the nuclear plant
- risk of internal exposure, comparing to external one
- current status of contamination of food and drink
- effect of low-dose exposure on human body
- high sensitivity of children to radiation exposure
- how to reduce the environmental dose, and
- provisional dose/activity criteria, or reference levels.

The meeting will continue to hold until requests or

needs from parents stop. It means more and more specialists, lecturers, or consultants are needed as soon as possible and also in the next generation. ICRP Publication 111 recommends; "(62) The dissemination of a 'practical radiological protection culture' within all segments of the population, and especially within professionals in charge of public health and education, is also an important element of the strategy."[8]

3.3 Future Scope

Through the process of optimization of protection, we must decide some procedures, countermeasures, or dose criteria fitting to the real status in risk management. ICRP Publication 103 recommends; "(224) Societal values usually influence the final decision on the level of radiological protection. Therefore, while this report should be seen as providing decision-aiding recommendations mainly based on scientific considerations on radiological protection, the Commission's advice will be expected to serve as an input to a final (usually wider) decision-making process, which may include other societal concerns and ethical aspects, as well as considerations of transparency. This decision-making process may often include the participation of relevant stakeholders rather than radiological protection specialists alone." [9] For example, the independent CRCT is not sufficient in this sense even for the activities of local governments. However, CRCT could be more effective after the trial of combination with small forum, small consultation meeting, or small opinion exchanging meeting. This total system could become the local forum mentioned by ICRP to realize ideal optimization in the next step.

4. CONCLUSION

We have introduced our several experiences on risk management, especially focusing on risk communication, radiation education to public, and preliminary stakeholder involvements into decision making in local governments on radiation protection, relating to the accident. This is based on the status at the stage of the 6-month post-accident. This is one example in the metropolitan area. Risk management discussion, risk communication contents, or reference levels are also to be dramatically changing as time goes on, of course. This activity and trial are very continuing. Our Japanese experiences, and timely and appropriate related information should open to the world. This long-term activity in the future must be succeeded by all our knowledge, techniques and cooperation.

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