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Study on the Contamination Monitoring System of Large Groups through the Fukushima Daiichi Nuclear Power Plant Accident

Young-Min Lee*, Hyun-Ha Lee
Korea Institute of Nuclear Safety, 62 Gwahak-ro, Yuseong-gu, Daejeon, Korea
** Corresponding author: k722lym@kins.re.kr*

1. Introduction

Nuclear or radiological emergency that radioactive materials can be released into the environment can cause the radiation exposure of the public and environmental contamination. In the case of radioactive materials' release, radiological contamination monitoring is one of the critical components to identify individuals who need medical treatment, prevent cross-contamination, and deal with anxiety and concerns of evacuees.

Affected people have to be monitored and evaluated for the needs of medical treatment, the presence of external and internal contamination, the received dose, and the health risk from exposure and long-term health effects. The International Atomic Energy Agency (IAEA) provides practical guidance on conducting the screening survey for a large number of people in a radiation accident [1]. This guidance intends to give techniques and methods for conducting large-scale monitoring of contaminated people using simple, readily available equipment and improvised techniques. The accidents such as the Chernobyl, Goiania, and Fukushima have shown that it needs preparedness and implementation of the rapid survey and assessing internal contamination in large numbers of individuals.

This study reviewed the contamination monitoring experiences in the Fukushima accident and suggested need points for the effective and practical contamination monitoring system of large groups in a nuclear or radiological emergency.

2. Methods and Results

As a result of the Great East Japan Earthquake that occurred on 11 March 2011 off the northeastern coast of Japan, the Fukushima Daiichi Nuclear Power Plant (FDNPP) was damaged in the electric power supply lines to the site. The large tsunami destroyed the operational and safety infrastructure on the site. The combined effect resulted in the loss of the cooling function at the operating reactors as well as at the spent fuel pools and then FDNPP reported nuclear emergency (inability of water injection of the emergency core cooling system) to national and local governments. At 21:23 on 11 March, the national government issued an evacuation order for an area within a radius of 3 km of the plant and sheltering for an area within a radius of 3 ~ 10 km. As the accident situation worsened, the evacuation area was expanded [2].

2.1 Radiological screening survey in the Fukushima Accident [3]

The screening survey was implemented from 12 March 2011 until 10 February 2012 and divided into four periods. Screening of the first period (12 ~ 20 March) was performed mainly for evacuees at the shelters. In the second period (21 March ~ 9 April), screening was performed including the general public. During the first and second periods, screening was carried out at 200 sites (188 shelters). The third period (10 ~ 24 April) screening was included individuals who had entered the 20 km radius from NPP. Fig 1. shows the number of surveyed people during the four screening periods.

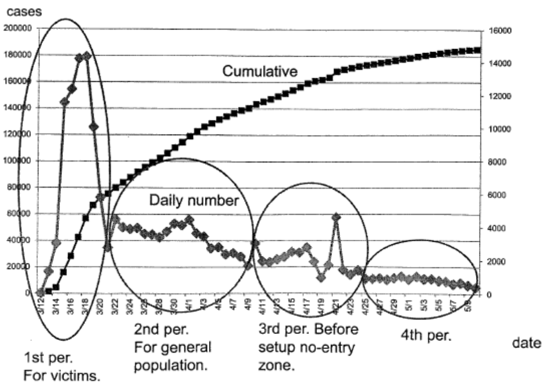

Fig. 1. The number of surveyed people

In the first period, the number of screened exceeded 70,000 and this number shows that most evacuees from the 'Restricted Area' (within a 20km radius from the NPP) were screened. The case of over 100,000 cpm was 104 (0.14 %) and the case of 13,000 ~ 100,000 cpm was 645 (0.88 %).

The survey teams used Geiger-Müller (GM) survey meter (1 cm distance from the body). The body decontamination level was set at 100,000 cpm. For 13,000 to 100,000 cpm, partial decontamination (wiping, dry decontamination) was implemented.

2.2 Preparedness for contamination monitoring in Korea

The purpose of contamination monitoring is to identify affected people who need to have medical attention, to provide medical treatment, to assess the exposure dose, and to follow up on the effects of health. Preparedness for contamination monitoring in Korea focuses on the injured patients and has no detailed contamination monitoring procedure for the evacuees and the public.
If the General Emergency is declared, the residents of Precautionary Action Zone (PAZ) should evacuate into designated shelters. In the case of the release of radioactive material during the evacuation, radioactive contamination monitoring is a critical response activity for the evacuees to screen the affected people and relieve the concerns.

In particular, considering the half-life of radioactive iodine is about 8-day, contamination monitoring of evacuees should complete until 1 week. In the case of the Fukushima accident, Fukushima prefecture dispatched more than 100 monitoring staff per day at 200 sites for 72,660 people from 12 March to 21 March 2011. The number of PAZ residents in the Gori site is approximately 10,000. If this number of residents is considered, the amount of resources required is more than the Fukushima accident case. Local governments have some portal monitors and hand-held devices for contamination monitoring but the instruments and staff are insufficient compared to the number of residents.

2.3 Suggestion

This study suggests designating the community reception center (CRC) and arranging the detailed contamination monitoring procedure.

Most local governments already have plans to shelter populations after the General Emergency is declared but these plans may not be adequate for caring for people in a nuclear or radiological emergency due to potential contamination with the radioactive material.
The monitoring for large groups needs lots of monitoring staff, measuring devices, decontamination tools, supporting resources, etc. So CRC has to be a checkpoint for screening, decontamination, medical triage, registry, and so on. Because it is hard to conduct these response actions at each shelter.

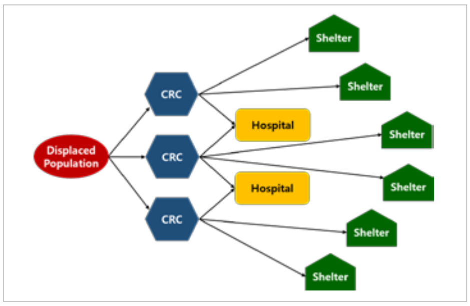

Fig 2. CRC Network [4]

According to the time, the target of contamination monitoring changes and the response performed after the contamination monitoring is as shown in fig. 3. In each response step, appropriate detectors, proper procedure, screening criteria, and trained staff are needed.

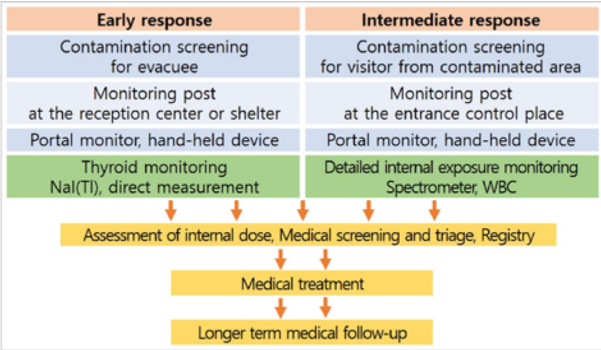

Fig 3. Contamination monitoring and follow-up

3. Conclusion

This study reviewed the contamination monitoring experiences in the Fukushima accident and suggested the CRC as a screening checkpoint and detailed monitoring plan. For effective and practical contamination monitoring, these response actions have to be conducted by the operational intervention levels (OILs) consistently under the national protection strategy for a nuclear or radiological emergency.

ACKNOWLEDGMENTS

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