Temporary Increase in the Emergency Exposure Dose Limit in Response to the TEPCO Fukushima Daiichi NPP Accident

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1. Introduction

In response to the situation at the TEPCO Fukushima Daiichi Nuclear Power Plant, the government of Japan declared a nuclear emergency on 11 March 2011, and emergency operations were initiated to prevent further expansion of the nuclear disaster. To expedite the operation, the Ministry of Health, Labour and Welfare (MHLW) issued an exemption ordinance to increase radiation exposure dose limits from 100 mSv to 250 mSv during emergency work at the affected plant in unavoidable circumstances. Subsequently, the MHLW succeeded in reducing the emergency dose limit back to the original limit through a phased approach. This paper explains the decision-making process and deliberation on temporarily raising the emergency dose limit and key challenges that require further deliberation to be resolved [1][2].

2. Raising of Emergency Dose Limits

On the afternoon of 14 March 2011, the Prime Minister Office demanded the MHLW to raise the dose limits during the emergency at the affected plant, limits which were kept at 100 mSv since 1998. The MHLW did not have any other options except to raise the emergency exposure dose limit because, under the nuclear emergency declaration, sufficient emergency response actions were needed to prevent the expansion of the nuclear disaster at the affected plant. The MHLW, however, decided to employ 250 mSv as the emergency dose limit. A radiation exposure of 250 mSv is the minimum dose to cause chromosome disorders in lymphocyte cells, an effect that is not clearly defined by the onset of clinical symptoms. Radiation exposure of 500 mSv is the level that causes transient leukopenia as a clinical symptom, and as a result, can reduce resistance to infections [3].

On 15 March 2011, the MHLW promulgated an exemption ordinance and put it into effect on 14 March 2011. Taking advantage of this type of legislation as an "exemption", the MHLW made it clear that the exemption of the increased dose limit exclusively applied to the emergency work occurring at the affected plant and that the exemption would cease to exist once the nuclear emergency is no longer declared.

2.1. Controversy Over the Combined Control of Emergency and Normal Exposure Dose

The MHLW has provided administrative guidance for employers, recommending that the combined dose should not exceed the normal exposure dose limit in the case of workers engaged in normal radiation work. On 1 April 2011, the Nuclear and Industrial Safety Agency (NISA) proposed to the MHLW that the emergency exposure dose should be distinct from the normal exposure dose. The NISA argued that if the emergency work continued, approximately 320 workers would exceed 100 mSv and 1,600 workers would surpass 50 mSv. This could result in a shortage of qualified personnel to perform periodic inspection and maintenance at other NPPs.

The MHLW, however, declined the proposal from the NISA in principle for the following reasons. (a) No sound reasons were provided to distinguish emergency doses from normal doses, even though the health effects from each of them are equal. (b) A long-term shortage of personnel would not occur because qualified technicians and engineers in related industries could be trained and tentatively transferred. The MHLW, however, issued an administrative guidance document on 28 April 2011 allowing ex-emergency workers to exceed the annual dose limit of 50 mSv during normal operations with the presumption that the combined normal and emergency doses would not exceed the 5-year dose limit of 100 mSv because the health risks of radiation exposure would remain within the tolerable risk in the case that the combined dose did not exceed the 5-year dose limit.

3. Reduction of the Emergency Dose Limits

On 29 August 2011, the Minister of the MHLW proposed the following to the Minister for Nuclear Accident Settlement. a) As soon as the nuclear reactors are stabilized, the government should terminate the application of the emergency dose limit because the government should stress balance among the benefit of preventing expansion of the damage and protecting the lives and property, and the health risk of emergency workers. b) Even during emergency work, the government should reduce emergency dose limits as much as possible to adhere to the principle of optimization.

With direct consultation with ministers, they agreed to deliberate on the reduction of the emergency dose limit based on the following principles on 15 September 2011. a) Before the stabilization of the reactors, emergency dose limits for newcomers would be reduced from 250 mSv to 100 mSv. b) Following the stabilization of the reactors, the exemption ordinance enacting the temporary rise in the emergency dose limit to 250 mSv would be abolished. c) In both cases, pay appropriate attention to avoid disturbing the implementation of emergency work.

3.1. First Phase of the Dose Limit Reduction

At the end of September 2011, the monthly average exposure doses observed during the months from March to August 2011 showed a consistent decrease. Thus, the MHLW recognized that it was reasonable to estimate that

newcomers' exposure would not exceed 100 mSv even if they were exposed to the maximum exposure dose in August, 18.3 mSv, for six months. However, TEPCO emphasized the possibility that newcomers' exposure may exceed 100 mSv in cases where they were needed to engage in troubleshooting tasks. The MHLW, therefore, decided to apply 250 mSv emergency dose limits exceptionally to newcomers responding to a loss or serious malfunction in a) the cooling systems of the nuclear reactors and b) the confinement and enclosure of radioactive substances, and enforced the amendment of the exemption ordinance on 1 November 2011.

3.2. Second Phase of Dose Limit Reduction (Abolishment of the Exemption Ordinance)

In October 2011, TEPCO submitted reports which requested the following three points to the MHLW: 1) Re-establish emergency dose exemption of 250 mSv in the case where serious problems arise following the completion of stabilization of the reactors. 2) Apply an emergency dose limit of 100 mSv during work related to nuclear reactor cooling and the confinement and enclosure of radioactive substances after the stabilization of the reactors. 3) Provide necessary transitional measures for workers who were exposed to more than 100 mSv.

The MHLW agreed to the first and second request and, as a response to the third, attempted to provide transitional measures that would apply the 250 mSv dose limit exclusively to shift supervisors for a few months to secure sufficient time to transfer knowledge and expertise to new supervisors. TEPCO, however, insisted that a few months was insufficient time to train suitable replacement operators for shift supervisors. The MHLW, therefore, suggested TEPCO exclude the inside of the Seismic Isolated Building from its radiation control areas so that shift supervisors exposed to more than 100 mSv can stay and direct emergency operations in the building.

Based on the agreement, the MHLW enforced the abolishment of the exemption ordinance on 16 December 2011, the day of the declaration that stability of the reactors was achieved. Successively, the inside of the Seismic Isolated Building was excluded from the radiation control areas and approximately 50 shift supervisors who were exposed to more than 100 mSv were able to stay in the building at the end of April 2012.

4. Discussion

In the accident, the increase and subsequent reduction in the emergency dose limit was initiated at the political level. To avoid intervention, the government needs a pre-defined protocol for the process and conditions to apply or amend emergency dose limits.

Regarding standard setting of emergency dose limits, considering external exposures, the dose limit of 250 mSv was sufficient to implement the necessary emergency operations in response to the large-scale nuclear accident involving four nuclear reactors.

In the process of application of the dose limits, the application of a high-level emergency dose limit to all workers without any exception was unavoidable in the early stage of the accident. However, after the chaotic situations were resolved, based on the principle of optimization, the government should have established plural emergency dose limits and applied them to specific works based on the urgency of the work and the ambient dose rate at the work site.

5. Conclusion

Lessons learned from this experience tell us that the government should:

a) Prior to the accident, have decided on a protocol to set emergency dose limits, such as post-accident amendment of the limits in accordance with the accident situation.
b) In the light of the principle of optimization, have established plural emergency dose limits and applied them to specific works based on the urgency of the work and the ambient dose rate at the work site.
c) Designate conditions to apply emergency dose limits. The conditions should be clear and objective because the government will have to make a quick decision based on insufficient information.
d) As soon as the situations allows, terminate the application of or reduce emergency dose limits using a phased approach, and to this end, designate the conditions and standards at which to terminate or reduce the limits prior to the accident such as (a) accumulated and expected exposure dose and (b) the degree of urgency of the emergency operations.
e) Create a procedure for radiation control of workers who are exposed to more than the 100 mSv 5-year dose limit during emergency work to keep lifetime exposure below 1 Sv.

References

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