Trends in Domestic Regulations Relating to Radioactive Waste Disposal I

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Recent discussions and future issues at the Nuclear Safety Commission, Radioactive Waste and Decommissioning Special Division

(1)Clearance Level Study

"Clearance level at major nuclear reactor facilities" (March 17, 1999, Nuclear Safety Commission)

"Clearance level at heavy water reactors and fast reactors" (July 16, 2001, Nuclear Safety Commission)

"Clearance level at nuclear fuel using facilities (handling facilities of irradiated fuels and materials)“ (April 24, 2003, Nuclear Safety Commission)

“Concentration of radioactivity not required to be handled as radioactive materials among those generated along with demolition of nuclear reactor facilities and nuclear fuel using facilities" (December 16, 2004, March 17, 2005 partial correction and amendment, Nuclear Safety Commission)

“Clearance level at uranium handling facilities" (October 5, 2009, Nuclear Safety Commission"

Other clearance levels will be studied as needed.

(2) Safety Review Guides Related to Low Level Radioactive Waste Burial Facilities (Study to Establish Safety Review Guide on Sub-surface Disposal)

"Fundamental concept on safety regulation of land disposal for low level radioactive solid waste" (October 24, 1985, Nuclear Safety Commission)

"Fundamental concept of safety review for radioactive waste burial facilities" (March 17, 1988, Nuclear Safety Commission decision, January 7, 1993 (partial revision), March 29, 2001 (partial revision), October 5,2009 (partial revison))

"Common important matters at safety regulation for radioactive waste disposal" (June 10, 2004, Nuclear Safety Commission)

"Upper limit of radioactivity concentration on burial disposal of low level radioactive solid waste" (May 21, 2007, Nuclear Safety Commission)

"Fundamental concept of safety review on low level radioactive waste burial (interim report)" (July 12, 2007, Nuclear Safety Commission)

"Concept on safety review after control period finishing of sub-surface disposal (draft)" under receiving public comments (January 25 to February 25, 2010)

(3) Study of Fundamental Concept of Safety Regulation of Research Institute Waste

"Fundamental concept on safety regulation of near-surface disposal of radioactive solid waste generated at radioactive isotope using facilities" (January, 2004, Nuclear Safety Commission)

"Fundamental concept on safety regulation of near-surface disposal of radioactive solid waste generated at research institutes" (April 20, 2006, Nuclear Safety Commission)

(4) Study of Whole Concept for Security on Decommissioning of Nuclear Facilities

"Fundamental concept of ensuring safety on demolition of nuclear reactor facilities" (December 19, 1985, August 6, 2001, partial revision, Nuclear Safety Commission)

"Radioactivity concentration not required to be handled as radioactive materials among those generated at the demolition of nuclear reactor facilities and nuclear fuel using facilities" (December 16, 2004, March 17, 2005, partial correction and amendment, Nuclear Safety Commission)

"Whole concept of safety regulation system after finishing operation of nuclear facilities" (January 28, 2005, Radioactive Waste, Decommissioning Special Divisions)

(5) Specific Regulation on Treatment and Disposal of Radioactive Waste Including Transuranic Elements (TRU)

The Nuclear Safety Commission report has already reported that radioactive waste, including transuranic elements with low TRU concentration, are suitable for pit and sub-surface disposal and the upper limit of alpha nuclide concentrations, including TRU, in the inventory studying upper concentration limit.

(6) Facilities Site Relieving Criteria

(7) Fundamental Concept of Safety Regulation on Uranium Waste Disposal and Upper Concentration Limit

(8) Ensuring Safety and Safety Regulation of High Level Radioactive Waste Disposal

These items will be studied and reviewed in future.

"Concept on Safety Review After Control Period Finishing of Sub-surface Disposal (Draft)"

（Open to public feedback: January 25 to February 25, 2010)

1.1 Review history

Some low level radioactive waste, when containing radioactive materials with significantly long half-lives, requires a safety assessment after the control period has elapsed. After burial, control for several centuries should be required to monitor the leakage of radioactive materials from burial facilities and limit land utilization. In addition, after the control period has elapsed, complete measures should be applied to avoid exposure-related safety problems, even assuming contact between human and radioactive waste, and an appropriate disposal system should be constructed to sufficiently constrain the transfer of radioactive materials.

The Nuclear Safety Commission began a survey and study in 2001.

"Common important matters at safety regulation for radioactive waste disposal" (June 10, 2004, Nuclear Safety Commission)("Common important matters")

Ensuring safety was studied on burial of radioactive wastes requiring safety assessment after finishing control period. The study revealed that risk-based concept appropriately handling uncertainty with long-term prediction after finishing control period should be applied to the safety regulation.

"Fundamental concept of safety review on low level radioactive waste burial (interim report)" (July 12, 2007, Nuclear Safety Commission) (“interim report")

For low level radioactive wastes burial including disposal below the generally used depth for radioactive wastes ("sub-surface disposal"), a fundamental concept was developed for safety regulation on the basis of the risk-based concept.

"Safety regulation on the basis of risk-based concept" involves classifying the safety assessment scenario by properly considering the potential occurrence by reflecting on the uncertainty of long-term predictions in the post-control period safety assessment and comparing it with the corresponding "target". It is, therefore, particularly important in the risk-based concept to specify the scenario for the safety assessment.

In the interim report, referring to the dose rate/probability resolving approach, the scenario was divided into three groups of a fundamental scenario, a variation scenario, and an artificial rare phenomenon scenario, to which a "target" dose was attached for individual judgment. The fundamental scenario is defined as one that can be “easily generated as a normal scenario", while the variation scenario is “rarely possible to generate but takes variable factors significant for safety assessments into account", and the artificial rare phenomenon scenario is "a natural or incidental artificial phenomenon extremely unlikely to occur." The resultant dose "target" values from the assessment result for each scenario were determined as 10 μ Sv/y, 300 μ Sv/y, 10 mSv/y to 100mSv/y, respectively.

In October 2007, the radioactive waste and decommissioning special division established the second class waste burial subcommittee to promote a survey and review on the revision of the present safety review guide based on the interim report. The division also surveyed and reviewed a scenario establishing the concept of the long-term safety assessment among requirements to be included in the present safety review guide for low level radioactive solid waste as specified in the interim report and summarized as a draft report delivered for public feedback.

“Present safety review guide”:

"Fundamental concept of safety review for radioactive waste burial facilities" (March 17, 1988, Nuclear Safety Commission decision, January 7, 1993 (partial revision), March 29, 2001 (partial revision), October 5, 2009 (partial revision))

1.2 Studying Scope

* Waste appropriate for sub-surface disposal among radioactive waste generated from nuclear facilities
* The main focus will be the concept of a safety assessment after the control period has elapsed.

* It is important to consider uncertainty on properties when specifying disposal system conditions in future.
* The scenario should be specified considering phenomena responsible for plate movement and climate change, changes in living zone conditions, the facility environment and artificial barriers. The formalization concept was employed for the human lifestyle mode in the living zone.

* The artificial rare phenomenon in the interim report was divided into the artificial phenomenon scenario and the rare phenomenon to study based on four division scenarios.

Fundamental scenario:

This scenario is defined as very frequently generated as a normal scenario and should involve consideration, based on past and present conditions, of the disposal system, property of an exposure path and the predicted sequence of changes which are credibly considered likely to occur in future. This scenario is to be applied in the basic design and policy of the disposal system to ensure resultant doses can be reasonably minimized as far as possible.

Variation scenario:

The scenario is far less likely to be generated but takes variable factors significant to safety assessments into consideration, as well as the area of integral variation subject to various changes other than those specified in the fundamental scenario as well as the disposal system and exposure path. This scenario is applied to ensure that the disposal system design can respond to various uncertainties. This means that the scenario is also used to confirm sufficient reasonability not exceeding a dose rate recently internationally agreed as a "target" for judgment on the long-term safety of radioactive waste disposal, even when considering such variation factors.

Rare phenomenon scenario:

The scenario is extremely unlikely to occur naturally and is applied to confirm whether the design of the disposal system can effectively alleviate the expected phenomenon from a radiation protection perspective. This means the scenario is applied to confirm that no special radiation protection measures are required for uncertainty, even taking very unlikely scenarios into account.

Artificial phenomenon scenario:

The scenario assumes damage to burial facilities due to human activity not taking the existence of radioactive waste disposal facilities into consideration. Similar to the rare phenomenon scenario, this one is applied to confirm whether the design of the disposal system can effectively alleviate the expected phenomenon from a radiation protection perspective. For this reason, the scenario is applied to confirm that no special measures for radiation protection are required, considering persistent uncertainty regarding disposal system design and approaches such as report conservation.

2 Condition setting of long-term variation phenomenon on geological environment

2.1 Fundamental concept at setting
2.2 Setting of phenomenon caused by plate movement
2.3 Setting of phenomenon caused by climate change
2.4 Setting of phenomenon caused by both plate movement and climate change

3. Environmental changes in human living zones in future

3.1 Fundamental concept at setting
3.2 Major constituting element in the living zone and modeling
3.3 Formation of the exposure path by natural and artificial processes
3.4 Necessary data for living zone assessment

4. Condition setting of burial facilities

4.1 Basic formation of burial facilities
4.2 Fundamental concept at setting
4.3 Artificial barrier function and characteristics
4.4 Studying items at condition setting
4.5 Condition setting method

5. Fundamental scenario setting, 6. Variation scenario setting

5(6).1 Safety assessment concept for fundamental (variation) scenarios
5(6).2 Setting of fundamental (variation) groundwater scenarios
Setting concept, transient period, period expecting multiple barrier function, period mainly expecting natural barrier function, period expecting burial facilities nearing the land surface
5(6).3 Expectation of fundamental (variation) gas transfer scenario
Setting concept, transient period, period expecting multiple barrier function, period mainly expecting natural barrier function, period expecting burial facilities nearing the land surface
5(6).4 Setting of fundamental (variation) land utilization system
5(6).4.1 Setting concept
5(6).4.2 Present land utilization
5(6).4.3 Land utilization available alongside sea level variation
5(6).4.4 Land utilization from re-deposition at a site downstream of burial facilities
5(6).4.5 Land utilization for shallow burial facilities

7. Setting of rare phenomenon scenario

7.1 Safety assessment concept of the rare phenomenon scenario
7.2 Setting of rare phenomenon scenario
1) Influence assessment of mechanical destruction due to earthquake and fault activity
2) Influence assessment of mechanical destruction and thermal, chemical deterioration due to volcanic igneous activity

8. Setting of artificial phenomenon scenario

8.1 Safety assessment concept of the artificial phenomenon scenario
8.2 Setting of boring scenario
Direct boring core observation scenario, transfer path short-circuit scenario, ground water intake scenario at boring hole around burial facilities
8.3 Setting of tunnel excavation scenario
Excavation scenario near burial facilities, excavation scenario of burial facilities penetrating tunnel
8.4 Setting of a land utilization scenario for full-scale development

9. Concept on finishing control period

Based on the contents in the "common important matters report" and “interim report", the control period is to be studied reflecting recommendations by international organizations and the resultant review trend by the Japan radiation review committee.

1) For the long-term safety assessment of radioactive waste disposal, the recent international concept whereby judging criteria should be based on ensuring dose restraint values less than 300 μ Sv/y or risk restraint values of 10^{-5}/y. The Japan radiation review committee also accepts a similar concept.

2) Each country refers to such international concept to define its individual criteria. In Japan, the long-term scenario should be assessed for several tens to several hundred millennia for the safety assessment referring to the country-specific concepts. With the considerable resultant uncertainty in mind, it is reasonable to define the risk less than 10^{-6}/year after the control period has elapsed.

3) Employing the criterion of 10^{-6}/y is important from the perspective of clarification that significant concentrations of radioactive materials, if left, can be controlled to a level not requiring any regulation.

4) It is basically difficult to quantify the potential occurrence of long-term scenarios. Therefore, a safety judgment in comparison with a corresponding "target" value is reasonable when an objective value is used. Consequently, the dose/probability decomposition approach should be applied.

5) Artificial phenomena are typically handled separately to natural process phenomena in international organizations and overseas. Unlike in the “interim report", this scenario has been discussed as opposed to the rare phenomenon scenario.

6) The “goal" in the interim report should be referred to, but after issuing the interim report, the ICRP recommendation 2007 is referenced to study the "goal" for artificial phenomenon and rare phenomenon scenarios.

7) Substantial reasons not to require any regulations after the control period has elapsed, or explanation based on division assessments in each scenario to reduce the risk concerned to less than 10^{-6}/y can be summarized as follows:

a) Applicants should clarify the scientific probability for the basic design and its policy toward the disposal system, in a safety assessment based on the fundamental scenario, whereby the risk can be reduced to less than 10^{-6}/y or where the resultant impact can be lowered under 10 μ Sv/y.
b) Applicants should demonstrate that influence can be reduced to less than 300 μ Sv/y through a safety assessment for variation scenario, considering the uncertainty involved in setting the latter.
c) Applicants should have the courage to conduct safety assessments for rare phenomenon scenario to be considered, in order to clarify that their influence does not exceed basically 10mSv/y and remains less than a maximum of 100mSv/y, eliminating the need for special measures on radiation protection on such occasions.

d) Applicants should formalize the scenario for artificial phenomena and demonstrate that the influence on peripheral individuals does not exceed the range 1 to 10mSv/y, and the particular personal impact on those approached does not basically exceed 10mSv/y, with 100mSv/y the maximum.
(The lower limit of 1mSv/y for the influence on peripheral people represents a level used to judge whether a reducing measure to minimize the influence of artificial phenomenon as far as possible is previously applied. The upper limit of 10mSv/y is a level to judge the adequacy of the applied burial project plan, even considering the uncertainty on formalization.)

e) Summarizing the above classification assessment results, the planned burial project can be judged on the basis of the scientific scope to transfer the duration of the control period without any regulation.