

Safety Research Activities on Radioactive Waste Management in JNES

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Abstract. Research activities in safety regulation of radioactive waste management are presented. Major activities are as follows.

As for the geological disposal, major research areas are, developing “safety indicators” to judge the adequacy of site investigation results presented by an implementer (NUMO), compiling basic requirements of safety design and safety assessment needed to make a safety review of the license application and developing an independent safety assessment methodology. In proceeding research, JNES, Japan Atomic Energy Agency (JAEA) and the National Institute of Advanced Industrial Science and Technology (AIST) signed an agreement of cooperative study on geological disposal in 2007. One of the ongoing joint studies under this agreement has been aimed at investigating regional-scale hydrogeological modeling using JAEA’s Horonobe Underground Research Center.

In the intermediate depth disposal, JNES conducted example analysis of reference facility and submitted the result to Nuclear Safety Commission of Japan (NSC). JNES is also listing issues to be addressed in the safety review of the license application and tries to make criteria of the review. Furthermore, JNES is developing analysis tool to evaluate long term safety of the facility and conducting an experiment to investigate long term behavior of engineered barrier system.

In the near surface disposal of waste package, it must be confirmed by a regulatory inspector whether each package meets safety requirements. JNES continuously updates the confirmation methodology depending on new processing technologies.

The clearance system was established in 2005. Two stages of regulatory involvement were adapted, 1) approval for measurement and judgment methods developed by the nuclear operator and 2) confirmation of measurement and judgment results based on approved methods. JNES is developing verification methodology for each stage.

As for decommissioning, based on the regulatory needs and a research program, JNES has been continuing research activities from October 2003. This program consists of researches for 1) review process of decommissioning plan of power reactors, 2) review process of decommissioning plan of nuclear fuel cycle facilities, 3) termination of license at the end of decommissioning and 4) Management of decommissioning waste.

1. Introduction

The report titled “An Approach to Establish a Basis for Nuclear Safety”^[1] issued by the Nuclear and Industrial Safety Committee, Advisory Committee on Energy and Natural Resource, showed a philosophy of the nuclear safety regulation, i.e. “the government should gain public trust in that the nuclear safety is ensured through regulatory activities; it will be a mission for the government to explain extensively and let the public understand about that the regulations are appropriately applied and that emergency response system has been secured to respond to inadvertent events, considering concerns about the nuclear safety by the public”. It also presented three principles for the safety

regulation; clear and transparent, effective by reflecting latest technological knowledge, and proactive in responding international trends.

Nuclear and Industrial Safety Agency (NISA) in Ministry of Economy, Trade and Industry (METI) has promoted the regulatory researches in accordance with the basic policy. In October 2009, Radioactive Waste Safety Subcommittee and Decommissioning Safety Subcommittee, which are advisory committees for NISA, published reports about regulatory research needs on radioactive waste management^[2] and decommissioning,^[3] respectively. Based on these needs, JNES published reports about regulatory research plan on radioactive waste management^[4] and decommissioning,^[5] and the subcommittees approved them, respectively. Now, regulatory researches on geological disposal, intermediate depth disposal, near surface disposal, clearance and decommissioning have been performed based on this plan. This paper describes recent regulatory research activities on radioactive waste management in JNES.

2. Radioactive waste management system in Japan

2.1. High level waste (Geological disposal)

JNES as a TSO, JAEA, and AIST, have been developing a safety assessment methodology which is independent of implementer's research. Especially JNES has been expected to unify the regulatory researches for safety conducted by AIST and JAEA as a core institute. And in order to promote the research for safety regulation effectively, these three organizations concluded "The agreement of cooperative research on the safety of the geological disposal of radioactive waste" in October 2007. One of ongoing joint studies under this agreement is a research on the regional scale groundwater flow at Horonobe, where JAEA has been constructing a underground research laboratory (URL). The objective of this joint study is verification of the methodology for the assessment of regional scale ground water flow. Four boreholes are drilled in this research. One is near the URL site, another is in the recharge area, and the others are in the discharge area. AIST conducts an analysis of the isotopes and chemicals in the groundwater obtained in each borehole and the identification of the residence time of each groundwater sample. AIST also conducts an estimation of the hydrological influence of the construction of the URL using a successive monitoring for hydraulic pressure. JAEA makes a hydrogeological model using the parameters obtained from the literature survey and hydrological investigation of each boring, and conducts the assessment of regional scale groundwater flow using the code 3D-SEEP which has been developed by JAEA. Integrated with the results of AIST and JAEA, proper revision or improvement are done to the 3D-SEEP or other steps of the methodology of assessment in order to conduct the cross-check to the result submitted by the implementer. JNES reflects the needs into the research plan, conducts it in corporate with AIST and JAEA, unifies the results and makes a suggestion of better approach. This joint research is scheduled to finish on March 2011.

To judge the investigation results in siting process meets requirements of the Designated Radioactive Waste Final Disposal Act, the report^[2] requires to prepare "indicators" of the judgment and also requires to prepare the basic concept of the safety assessment which is necessary to develop a safety review plan. JNES conducts to make these "indicators" with the support of AIST and JAEA. The report^[2] shows the principle that NISA may incorporate the results of the researches other than ones conducted for safety regulation to the basis of safety regulation. In accordance with this principle, JNES, at first, designs the system for the adaptation of the results of the researches used for the regulation for the safety, for example how to collect researches, what to contain the attached information assuring the quality of the research, how to do the quality assurance, how to store and revise the knowledge for the regulation, and so on. After that JNES will make up the system and take existing knowledge in the safety regulation. And JNES will examine technical reports or the "Safety Case" published by the implementer in the site selection process in order to grasp the level of the knowledge for safety regulation with AIST and JAEA. The results of this examination and the current status of the research for safety regulation will be published as "Regulatory Research Report for the safety of the geological disposal."

2.2. Intermediate level waste (Intermediate depth disposal)

Radioactive waste produced from NPPs or reprocessing plant including long lived radionuclides, e.g. channel boxes, shrouds, control rods and core internals, will be disposed of at an intermediate depth disposal (“Yoyu-shindo Syobun” in Japanese) repository in Japan.

NSC has discussed the safety regulation and the safety review for the intermediate depth disposal over a 4 year period. NSC published a report “*Guides for the Safety Assessment of Sub-Surface Disposal after the Termination of the Institutional Control Period*.”^[6] For publishing this report, JNES conducted an example safety analysis of an assumed facility and supported writing the report. One feature of this report is that it is based on risk-informed approach. It means “*to determine whether risk is substantially reduced to a tolerable level, i.e., a level of potential risk, with due consideration to the likelihood of scenarios set for safety assessment.*”^[7] On the basis of this concept, scenarios for safety assessment are classified into four types of categories and “standards (dose value)” are determined for each Scenario. “Likely scenarios” adopted 10μSv/y, “Less-likely Scenarios” adopted 300μSv/y, “Rare Natural Event Scenarios” adopted 10m-100mSv/y, “Inadvertent Human Intrusion Scenarios” adopted 1m-10mSv/y for residents and 10m-100mSv/y for intruders.

JNES continues the activities as follows as TSO.

- a) Technical support of safety review:
JNES is also listing issues to be addressed in the safety review of the license application and tries to make specific criteria of the technical review.
- b) Experiment:
JNES is conducting experiments to investigate long term behavior of engineered barrier system. The experiment for the verification of gas migration in the engineered barriers is adopted by engineered scale (1/5 scale) model and is focused on the restoration and gas migration behaviors in less permeable layer with rectangular geometry. IRSN, French technical support organization, and JNES are planning to exchange the technical information on the topics of gas migration.
- c) Safety analysis
JNES is developing an analysis tool to evaluate long term safety of the facility, e.g., groundwater flow analysis, radionuclide migration analysis, gas migration analysis, database of dose evaluation, and radioactivity evaluation code for the activated metal waste.
- d) Preparation of manuals for inspection
NISA and JNES will inspect the facility and the waste packages on the stage of construction and operation. JNES is preparing the formulation of manuals for inspection of the facility and inspection of the waste packages.

2.3. Low level waste and very low level waste (Near surface disposal)

Low level radioactive wastes generated by the operation of NPPs are solidified in drums and disposed of at the Low-Level Radioactive Waste Disposal Center of Japan Nuclear Fuel Limited (JNFL) in Rokkasho-mura. These waste packages are classified into homogeneous and uniform solidified wastes and container-filled and solidified wastes depending on the difference of wastes contained in the drums and solidification methods.

The safety requirements that these waste packages must meet are stipulated in the Law^[8] and the related ministerial ordinances.^{[9][10]} The safety verification of waste packages, whose objective is to confirm that each package meets the prescribed safety requirements, is carried out before being carried into the disposal center of JNFL.

Since the establishment of JNES in October 2003, the safety verification of waste packages has been assigned to JNES by law. JNES has carried out not only safety verification of waste packages as an inspection institute, but also evaluating the competence of technical requirement for new waste packages and examining the continuous use of scaling factor and average radioactivity concentration (hereinafter referred to as “SF”).

JNES deliberates adequacy of continuous use of the SF, or a new method for verifying waste packages, based on data submitted by JNFL. Result of consideration is finalized in consideration of the opinion from advisory panel, and publicly opened as JNES-SS reports.

JNES established the rule of continuous use of the SF on container-filled and solidified wastes in 2004, since then, JNES has published 19 JNES-SS reports about new verification method of waste packages, or new rule on continuous use of the SF. All of these reports have been used as standards of safety verification of waste package. In the future, JNES will continue deliberation about verification method on the new waste package, and JNES will be planning to review the rule of continuous use of the SF on container-filled and solidified wastes. Furthermore, The Japan Atomic Power Corporation Ltd. (JAPC) is planning to construct a new near surface repository to dispose of very low level radioactive waste generated by the decommissioning of the Tokai NPP. JNES is preparing a verification procedure of the waste package and the radioactive waste disposal facility.

2.4. Clearance system

A clearance system was established in December 2005 and has been applied since then for reuse or disposing of extremely low-level wastes as industrial wastes. The clearance system has been applied to metal waste generated associated with the decommissioning of the Tokai NPP of JAPC. JNES supports NISA technically in permission by confirming of the validity of the operator’s radioactivity concentration measurement method. Additionally, JNES confirms that the operator performs methods of measurements using authorized method. Up to now, about 400 tons of carbon steel has been cleared and released.

In the reports,^{[2][4]} regulatory research plan consists of researches for 1) Development of verification methods of large size metal waste/structural concrete and concrete debris, 2) Establishment of criteria for clearance and confirmation method of waste from uranium fabrication facilities, 3) Preparation of contingency response procedure.

For the item 1, it would be difficult to measure large size metal waste such as turbine rotors and structural concrete as a solid unit by dedicated device with limited area for measurement. For the measurement of those wastes, a general type radiation survey meters or an in-situ Ge detector may be used. And, since the concrete has a relatively high background radiation from natural radionuclides such as ⁴⁰K with the same activity level as the clearance level radioactivity, the background activity from natural radionuclides needs to be correctly evaluated to estimate activity concentration of radionuclides for the clearance. Criteria to determine the validity of the activity concentration measurement method should be established considering the operators plan.

For the item 2, because the clearance level for uranium was shown by NSC in October 2009^[11], NISA has been set working group to establish the clearance system for radioactive waste from nuclear fuel fabrication facility. JNES reported the results of examination about clearance measurement of uranium and of researches about uranium clearance system in foreign countries.

For the item 3, with a perspective of settling the clearance system, a contingency response procedure should be prepared, including a response system to take measures in case of contingencies such as strayed radiation source might be found in the cleared object. JNES set the in-situ measuring method that judges whether to exceed the clearance level easily on the site.

2.5. Decommissioning of nuclear power plant

In Japan, 4 nuclear power stations are under decommissioning and some nuclear fuel cycle facilities are expected to be decommissioned in the near future. On the other hand, the safety regulation of decommissioning of nuclear facilities was changed by amending law in 2005. An approval system after review process of decommissioning plan was adopted and applied to the power stations above.

As for decommissioning, based on the needs in terms of regulation, JNES has been continuing research activities from October 2003, when JNES has been established. Considering the “Prioritized Nuclear Safety Research Plan (August 2009)” of the NSC^[12] and the situation of operators facilities, needs and plan of regulatory research were established in November 2009.^{[2][4]}

This plan consists of researches for 1) review process of decommissioning plan of power reactors, 2) review process of decommissioning plan of nuclear fuel cycle facilities, 3) termination of license at the end of decommissioning and 4) Management of decommissioning waste.

For the item 1, JNES studied safety assessment methods of dismantling, e.g. obtaining data and analysis of behavior of dust diffusion and risk assessment during decommissioning, which are useful findings for the review process. For the item 2, safety requirements for the decommissioning of nuclear fuel cycle facilities were compiled, which will be used in the future review. For the item 3, measuring method, release procedure and analysis code for the site release were studied for the establishment of the license termination process in the future.

3. Conclusion and future work

Major recent activities of regulatory researches on radioactive waste management carried out by JNES were described here. There is an urgent need to develop regulations on radioactive waste management in Japan. Based on this need, JNES has organized Radioactive Waste Management and Transport Division in 2009, and addresses actively for the early development of regulations.

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