The regulatory requirements for safe disposal of radioactive waste

Dr. Ruoh-Tsann Lee

Deputy Director, FCMA, AEC, ROC.

E-mail: rtlee@aec.gov.tw

Dr. Wen-Chuan Chen

Associate Technical Specialist, FCMA, AEC, ROC.

E-mail: wcchen@aec.gov.tw

ABSTRACT

This paper presents the requirements for management of safe disposal of low-level radioactive waste (LLRW). Provisions or the regulations, guidelines and criteria needed in the licensing processes for disposal facility is the responsibility of the regulatory body. These relevant requirements, which set up by Atomic Energy Council, are the important elements in ensuring the safety control during siting, design, construction, operation, closure, and post-closure stages. Besides, a detailed overview of the relationship between the different elements from regulatory body's viewpoint is addresses in this paper.

Keywords: radioactive waste, disposal, regulatory requirement

---

I. INTRODUCTION

Taiwan is a country lack of natural energy resources and currently nuclear energy is one important energy sources contributing up to 23% of total electricity production. Radioactive waste managements arising from nuclear energy applications are now a public concern that must be carefully and credibly resolved. One of the most

challenging tasks is the management of radioactive waste that must be isolated from the human environment for a long period. Final disposal system with multiple barriers design concept, either shallow land disposal or underground tunnel or silo disposal, could be considered as a suitable option for disposing of low level radioactive waste (LLWR) containing short lived radionuclides, which would decay to radiologically insignificant levels within a time period ranging from a few decades, and acceptably low concentrations of long lived radionuclides.

Being a regulatory body for radioactive waste management, the Fuel Cycle and Materials Administration (FCMA) of Atomic Energy Council (AEC) shoulder responsibilities for regulating the safe disposal of radioactive waste. A comprehensive regulatory framework is a prerequisite for implementing disposal program. This paper introduces the regulatory requirements on the LLRW disposal activities throughout all stages of life cycle of a repository, including site selection, disposal system design, construction licensing, site construction, operation, site closure and surveillance, and future uses of the site.

II. REGULATORY FRAMEWORK ON LLRW DISPOSAL

The main legislation regulating LLWR waste disposal activities includes the following Act, Regulations, and Guidance.

(1) **The Nuclear Materials and Radioactive Waste Management Act** (2002) and **Enforcement Rules for the Nuclear Source Materials and Radioactive Waste Management Act** (2003) defines the responsibilities, licensing and enforcement procedures and financial liabilities for nuclear waste management.

(2) **Regulations for the Review and Approval of Applications for Construction License of Radioactive Wastes Treatment, Storage and Final Disposal Facilities** (2004) specifies the qualification requirements and licensing process of LLWR disposal.

(3) **Regulations on Final Disposal of Low Level Waste and Safety Management of the Facilities** (2003) defines the requirements for safe management of LLWR disposal facility and disposal operation.

(4) **Guidance of Safety Analysis Report for a Low Level Waste Disposal Facility** (2004) specifies the information to be supplied in an application for a license to construct and operation a LLWR disposal facility.

（1）REQUIREMENTS ON SITE SELECTION

The site of LLRW disposal facility shall avoid locating in the following areas:

(1) Where in active faulting or other areas to influence the safety of the disposal facilities.

(2) Where the geochemical conditions are unfavorable for effectively suppressing the migration of radioactive nuclides.

(3) Where the surface and underground hydrographic conditions and geology are likely to have negative impacts on the disposal facilities.

(4) Where in the ecological protected areas that are already known or announced by the government.

(5) Where in the areas of known important natural resources or announced by the government as national resources.

(6) Where in the historical protection areas that are known or announced by the government.

(7) Where in the areas of high population density and with development potentials.

（2）REQUIREMENT ON DISPOSAL SYSTEM DESIGN

The LLWR disposal system shall be designed to contain the waste and to provide long term safety. The design of LLWR disposal facility shall ensure the annual effective equivalent dose to general public are not more than 0.25mSv, and shall adopt ALARA principle.

The safety system and components of LLWR disposal facilities shall be designed to permit periodic inspection, testing, and maintenance; to provide adequate protective measures against natural events; to provide emergency capacity; and to provide protection against dynamic effects of equipment failure.

Before the closure of LLWR disposal facilities, the drainage and the cover system shall be designed to prevent the waste from contacting with the standing water or infiltrating water after disposal.

The security and alarm system of LLWR disposal facility shall be designed to protect against inadvertent intrusion.

（3）REQUIREMENTS ON CONSTRUCTION LICENSING

The LLWR disposal facility shall be constructed in accordance with the requirements before a construction license is issued by FCMA.

(1) Consistency with the requirements of the relevant international conventions;

(2) The facility is design to ensure the public health and safety;

(3) The impact to the environment complies with the requirements of relevant laws/statutes and decrees; the technology.

(4) The management and the financial assurance are competent to operate the facility.

FCMA shall announce and display the application for a period of 120 days. After that, a hearing, which is a statutory procedure, shall be held by FCMA.

The applicant shall submit an application form with a safety analysis report (SAR) and a financial guarantee statement to FCMA. The SAR shall include the following contents: General description; Description of site characterization; Design of the facility; Construction of the facility; Operation of the facility; Safety assessment for the facility; organizational planning, administrative management and personnel training plan; radiation protection and environmental radiation monitoring plan; security plan, emergency response plan and fire protection plan; site closure and surveillance plan; and quality assurance plan.

This guidance for SAR application is available for both shallow land disposal and underground tunnel disposal concept. For applicant's convenience, FCMA outlined the key investigation items which are essential for performance assessment, as shown in Table 1.

（4）REQUIREMENTS ON OPERATION

The disposal facility shall be operated in accordance with the conditions of LLRW disposal license so as to maintain safety during the operational period.

Either design amendment or equipment change which involved in the following significant safety items shall be approved by FCMA.

(1) Modification of technical specification;

(2) Newly added safety issues not covered in the SAR;

(3) Change of safety-related equipments that need to amend the SAR and that may lower the original design standard after assessment;

(4) Any other events designated by the competent authorities.

The operator of LLRW disposal facility shall submit regularly to FCMA the reports related to operation, radiation protection, environmental radiation monitoring, irregularity (and/)or emergency event.

The operator of LLRW disposal facilities shall renew the SAR in every 5 years during the operation stage, and submit to FCMA for review and approval

（5）REQUIREMENTS ON SITE CLOSURE AND SURVEILLANCE

For the permanent cease of operation of LLRW disposal facility, the operator shall prepare a decommission plan and shall implement it after been approved by FCMA. For the closure of the LLRW disposal facility, the operator shall prepare the closure plan and the institutional control plan and shall implement it after been approved by FCMA.

The closure plan shall include the following contents: Organization of executor; Procedure of dismantling the facilities on the ground surface and decontamination; Backfill of the excavated areas; Stabilization operations after the site is closed; Long term safety evaluation; Analysis of accidents likely to occur and response plan after closure; Quality assurance program; Other matters designated by FCMA.

The institutional control plan shall include the following contents: Organization of executor; Site security; Environmental radiation monitoring; Quality assurance program; Record and archive management; Other matters designated by the competent authorities.

Once closure of LLWR disposal facility, considerations shall be given to the land reuse after the active institutional controls are removed.

After the LLRW disposal facilities are sealed, the disposal control area shall be observed and monitored for not less than 5 years.

III. DRAFT SITING LAW ON LLRW DISPOSAL FACILITY

Based on the siting experience in the past, local opposition to LLRW disposal program is found to be one of the key obstacles to find a suitability site. To alleviate the public opposition and to win the support of a prospective host community, AEC had submitted a draft law on LLRW site selection to Executive Yuan for review and then for parliament’s approval. This draft law clearly defines the site selection process and responsibilities of relevant organizations, as shown in Figure 1.

This draft law mandates that Ministry of Economic Affairs (MOEA) shall organize a siting committee to select the potential and candidate sites. The whole siting process is expected to be accomplished by 2008. The public acceptance is regarded as the critical factor for successful accomplishment of disposal program. The draft law also requires MOEA should draw up the incentive packages for negotiation with the local county. Also the negotiating process to host county should be proposed in order to enhance public acceptance. During the site selection process, AEC is required to implement on-site inspection during the site investigation stage, review the relevant data, and provide opinions to MOEA over the suitability of the site.

IV. SAFETY REVIEW ON DISPOSAL SYSTEM

As mentioned earlier, shallow land disposal or underground tunnel could be chosen as the concept of LLWR disposal system in this country. The disposal system must ensure protection of any individual living in the surrounding environment of the disposal site.

A series of stages contribute to the disposal system planning and development as illustrated in Figure 2. The aim of this figure is to ensure that a comprehensive and sound basis of decision-making process exist. The safety strategy, which is the approach adopted for achieving safe disposal, should be identified. This includes for overall management of the various activities required for radioactive disposal planning and implementing for siting and design, and for performing the assessment. The information and analysis tool for safety assessment must also be described. These are collectively termed the assessment basis, which contains system concept, models and methods, and scientific data can be obtained from experiment/testing, modeling, and nature analogue.

The operator responsible for radioactive waste disposal program has to take measures for ensuring the disposal facility meets the requirements described above during the pre-operational, operational, and closure phases. The adequacy and reliability for assessment parameters and models used should be confirmed by carrying out the sensitivity and uncertainty studies. Each component of the barrier system and the most critical parameters shall be evaluated and indicated by the sensitivity analysis. The results from the uncertainty analysis must show the critical radionuclides delivering maximum dose in most scenarios.

From a regulator’s view point that the siting studies should have been conducted as early as possible, thereby realistic and reliable data can be obtained and used as a

basis for regulator to discuss with applicant and to evaluate the feasibility of the site. At the mean time, applicant can gain more credibility by using these data to prepare the Safety Analysis Report required by the regulation.

However, taking Taiwan's local conditions into account, we like to emphasize that some critical issues regarding the performance of the disposal system need to be fully addressed by applicant.

(1) designing engineering barriers capable of contributing to waste isolation by restricting water percolation and water ingression near disposal areas;

(2) evaluation of materials and construction methods for each component of engineered barriers (such as concrete, buffer, backfill, seals, etc.,) including an sound estimation of their longevity or endurance;

(3) results from the performance assessment are encouraged to be judged by international peer reviews in order to build scientific and public confidence.

V. CONCLUDING REMARKS

The development of an acceptable LLRW disposal facility is an iterative process, which involves many different activities, such as system design, research, safety assessment, construction, operation, and closure and monitoring, etc. This paper illustrates the requirements may interact with the design studies and other activities in all stages of disposal system development. The draft siting law and disposal system planning and development stages described in this paper could be considered as the regulatory basis for the development of LLRW disposal facility.

In final, we like to emphasize that the goal of the siting planning and development is to identify a licensable site with host community support. To improve the chances of political acceptance, the applicant should organize a comprehensive nation-wide public acceptance program as early as possible. The prospects for community support will be enhanced if a tailor-made compensation and incentive package is negotiated and accepted by the host community.

Table 1. Key investigation items defined in the guidance of SAR

classification	investigation items
meteorology	wind, temperature, humidity, precipitation, typhoon
geology	stratigraphy, tectonics,
earthquake	active fault, seismic activity
surface water	surface water resource, water quality, surface water hydrogeology
groundwater	groundwater quality, groundwater hydrogeology
geochemistry	inorganic constituents, organic compound content, Eh-pH, distribution coefficient, retardation factor, ion exchange capacity, solubility, chemical form and valence of radionuclides.
geotechnical	strength, deformation and permeability parameters of surrounding soil and rock

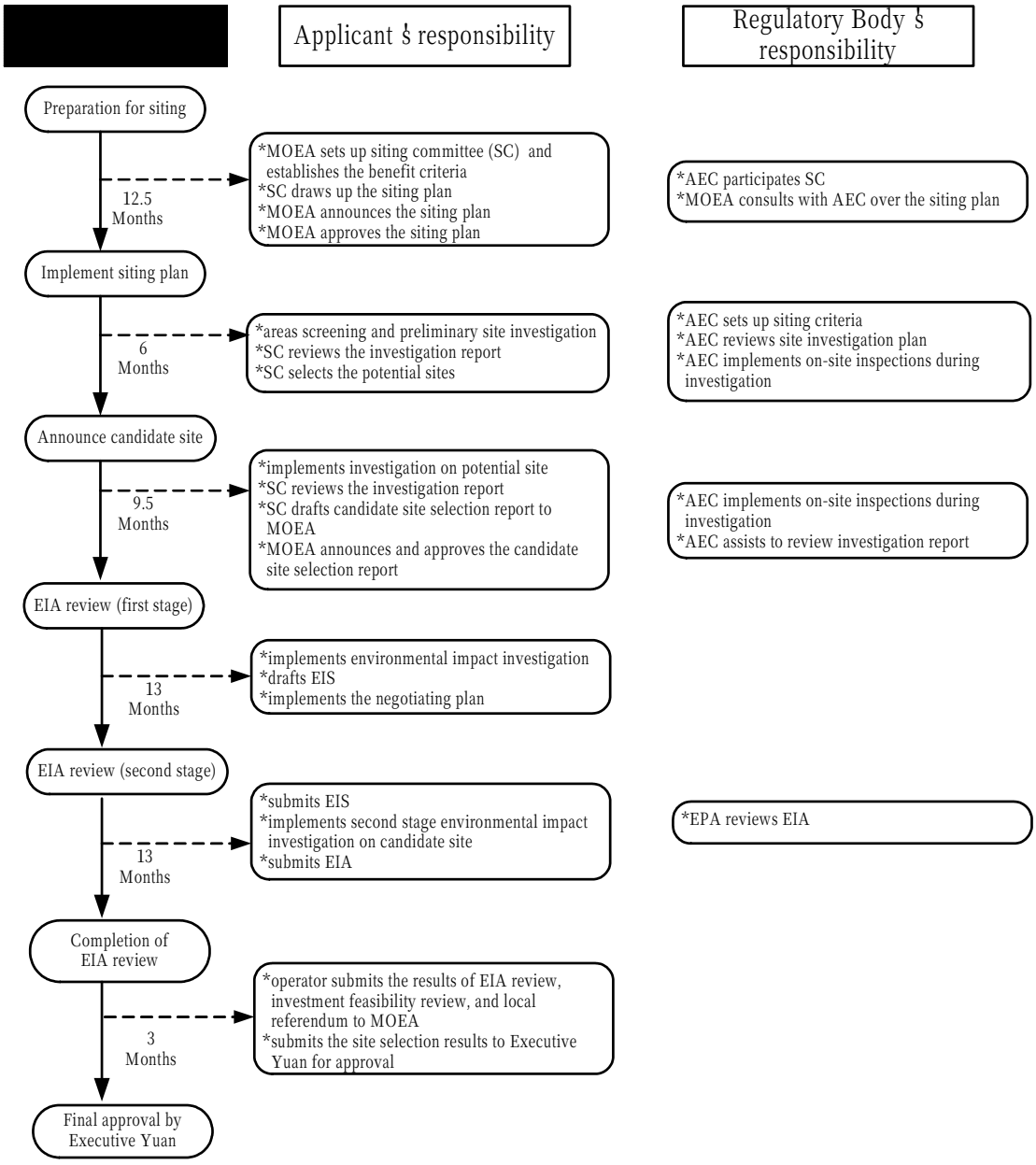

Figure 1. Key elements in the draft Siting Law

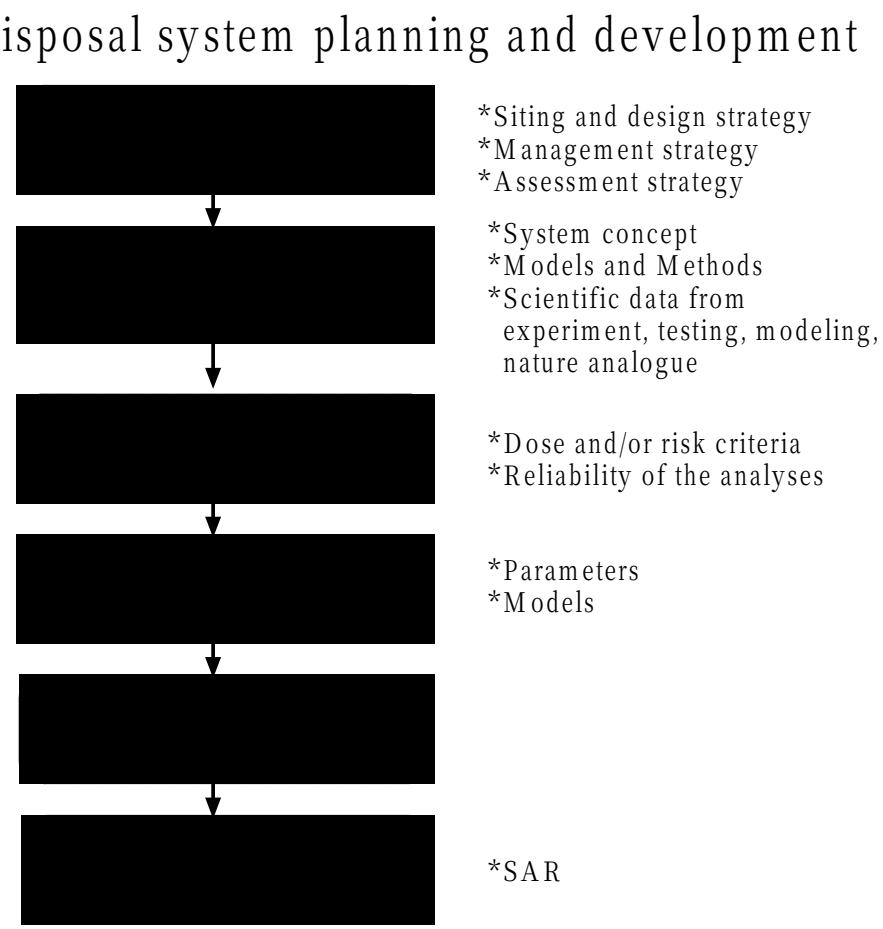

Figure 2. An overview of disposal system planning and development