3.2 Radioactive Waste Management (RWM) in China

The nuclear industry in China was started from the early year of 1950s. The radioactive waste were generated in the nuclear techniques application include research reactor, research, isotope, etc. Some of the radioactive wastes are not properly characterized at the earlier years for the reason of techniques and understanding of radioactive waste management. However, most of the wastes were properly stored safely.

There are four nuclear power stations now under construction. Two nuclear power stations are under operation. The waste generated from the nuclear stations are now stored in site. The low and mediate level radioactive waste will be sent to the near surface repositories. The high level wastes are considered to be sent to geological repository.

Most of the standards are interpreted from IAEA standards. Since China have plan on nuclear power, we pay much attention on the radioactive waste disposal. We have two constructed repositories and some candidate sites.

3.2.1 RWM Policy

The RWM policy in China is as follows:

- The RWM should guarantee that no burden leaving to the next generation.
- The RWM must follow: minimization producing, classification collection, purification, volume deduction, strict package, safety transportation, in-situ storage, centralized disposal, controlled release, enhanced monitoring.
- All facilities or practice must ensure the relative radioactive waste management facilities being designed, constructed and operated at the same time with the main facilities or practice.
- The RWM must aim at safety and disposal.
- The liquid radioactive waste generated at nuclear power plant should be immobilized (solidified) at the earlier time.
- The operator of the waste disposal must keep relative independent from the producer of radioactive waste. The waste disposal service is non-gratuitous.
- The regional disposal sites disposal low and intermediate level radioactive waste. There are two regional disposal sites have been built.
- For the high level radioactive waste including spent fuel, the policy is temporarily stored with care, while those liquid radioactive waste be solidified. The deep geological disposal is adopted at dozens of years later.

3.2.2 RWM Practices

3.2.2.1 Legislative Framework/Body

- NNSA is an administrative agency in SEPA in government reform program in 1998. NNSA is renamed Department of Nuclear Safety and Radiation Environment Management, SEPA.
- The provincial environment protection agencies are responsible for radiation environment management in provinces level.

- New NNSA/SEPA is responsible for both nuclear safety and radiation safety, the functions and duties on radiation safety are:
  - To enact policies, regulations, standards and technical guides
  - To perform surveillance and inspection on radioactive waste management; investigate and approve the disposal of liquid, gaseous and solid radioactive wastes; supervise and monitor the releases of wastes; handle accidents involving contamination of the environment jointly with other departments.
  - To be responsible for nationwide radiation environment monitoring and to compile national radiation environment quality report every year
  - To review and approve the radiation environment impact report of the installations
  - Issue the license
  - The Environmental Protection Act 1989, a general piece of empowering legislation, which includes "radiation pollution" among other things; the Regulation on Surveillance and Control of Civilian Nuclear Installations 1986; the Regulation on Radiation Protection for Radioisotope and Irradiation Apparatus 1989; the Regulation on the Control of Nuclear Accident for Nuclear Power 1993; the Regulation on Environmental Protection for Engineering Project 1999. These regulations are very important for SEPA enacting their role in environmental protection.
- China Atomic Energy Agency (CAEA) is responsible for:
  - Development of policies concerning the peaceful uses of nuclear energy
  - Development of industrial standards for the peaceful uses of nuclear energy
  - Control of nuclear materials
  - Acting as the lead body for nuclear accident response, in particular for organizing the State Committee of Nuclear Accident Coordination
  - Reviewing and approving the nuclear energy development project
  - Reviewing and approving the R&D project

3.2.2.2 Regulatory Framework

ACT.

This is made by the People's Congress and issued over the signature of the President

Regulations.

The State Council is responsible for the promulgation of regulations, which are issued over the signature of the Prime Minister.

Rules, Codes, Standards, and Guides.

The responsible authority of the State Council promulgates the rules, while the responsible department of the State Council issues the standards and guides.

3.2.2.3 Responsibility of License Holder

- Compile and submit license applying documents
- Submit Safety Analysis Report and Environment Impact Report

- Monitor and control the radioactive waste release, and submit the monitoring report to the competent authorities
- Compile and carry out the RWM system operation and maintenance rules, training
- Compile quality assurance program and set up quality assurance system
- Report the operation status to relative departments
- Compile and carry out emergency plan
- Make and keep the files of the waste
- Submit the other documents that the regulatory departments asked for

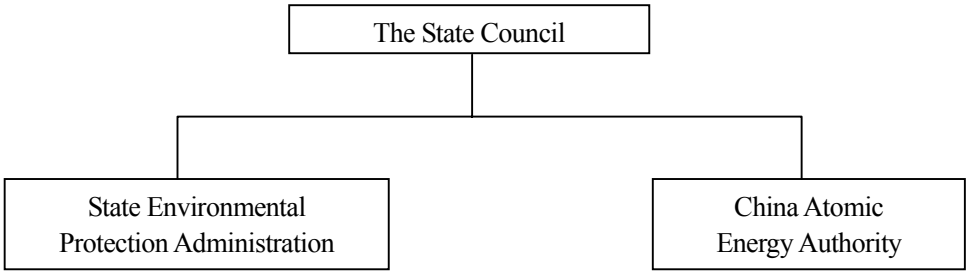

Figure 3.2-1 Principle Government Agencies Involved in RWM in China

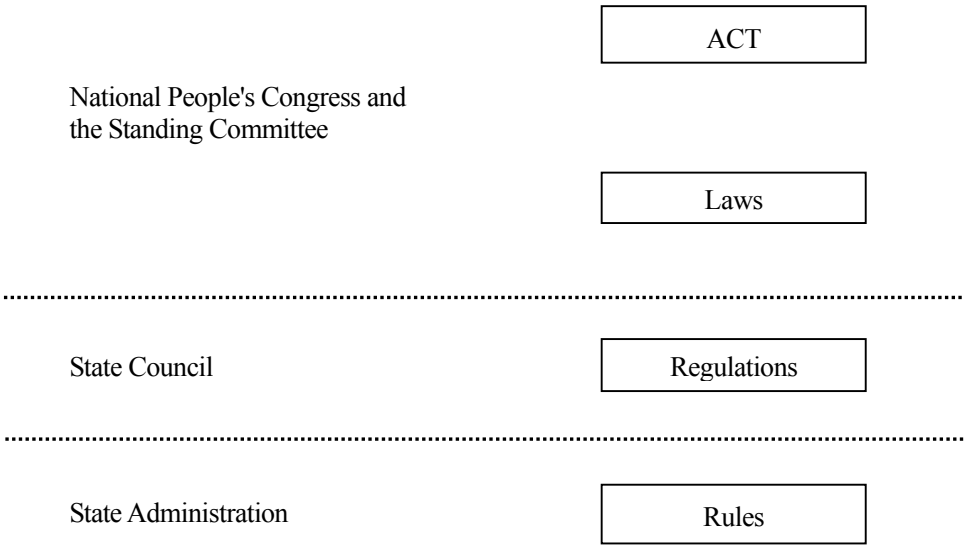

Figure 3.2-2 Hierarchy of Legal Instruments in China

3.2.3 Some Regulations and Standards Related to RWM

GB9133-95 Standard for Classification of Radioactive Wastes
GB6249-86 Regulations for Environmental Radiation Protection of Nuclear Power Plant
GB9132-97 Regulations for Near Surface Disposal of Low and Intermediate Level Radioactive Waste

GB145691-93 Characteristic Requirements for Solidified Waste of Low and Intermediate Level Wastes-Cement Solidified Waste
GB12711-91 Standard of Safety for Low and Intermediate Level Solid Radioactive Packages
GB13600-92 Regulation for Disposal of Solid Low and Intermediate Level Radioactive Wastes in Rock Cavities
GB15219-94 Quality Assurance for Packing Used in the Transport of Radioactive Material
EJ1O42-96 Packaging for Low and Intermediate Level Solid Waste-Steel Container
EJ914-94 Cement Container for Low and Intermediate Level Solid Waste

Some important items contained in these regulations and standards are:

- For classification
- Gaseous waste
  low level $\leqq 4\times10^{7}$ Bq/m^3
  mid level $>4\times10^{7}$ Bq/m^3
- Liquid waste
  low leve $\leqq 4\times10^{6}$ Bq/L
  mid level $>4\times10^{6}$ Bq/L or $\leqq 4\times10^{10}$ Bq/L
  high level $>4\times10^{10}$ Bq/L
- Solid waste
  (leave out)
- Exempt waste
  The waste contains small amount of radioactive materials and which cause the annual dose to the public is less than 0.01mSv. The collective dose to the public is less than 1man.Sv/a.

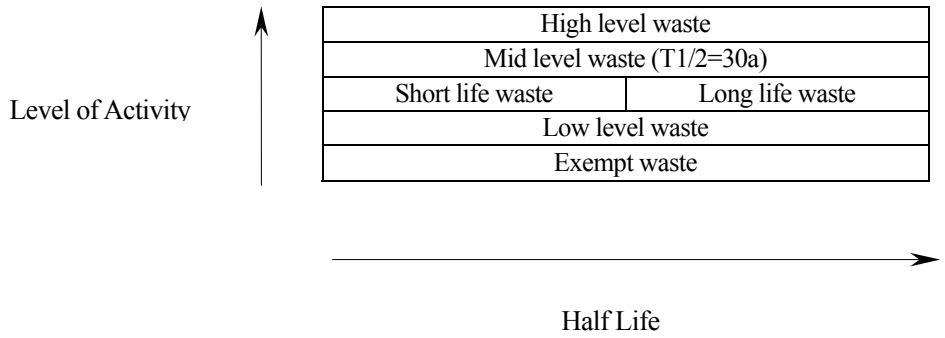

Figure 3.2-3 Framework of Classification for Radioactive Waste

- Near surface disposal for the low and intermediate level radioactive waste
- Consider 300-500 years, no unacceptable release to the environment, ensure the safety of the human being and environment
- Half life less than 30 years or only contain small amount of waste whose half life longer than 30 years
- Exposure to the workers and public must follow the ALARA

Regional near surface disposal is implemented for the low and intermediate level waste. Currently, the primary phase of the northwest repository, which is located near the Gobi desert, is complete and already accepts some wastes. According to the plan, the repository with a total capacity of 200 thousand cubic meters will be fulfilled by stages. For phase 1, it is about 60 thousand cubic meters including 18 disposal units, while the primary phase is about 20 thousand cubic meters including 6 disposal units.

The Beilong repository in Guangdong province is about 5km away from the Daya Bay Nuclear Power Station Plant (DBNPS). The design capacity of Phase 1 is 80 thousand cubic meters, and the capacity for the primary phase is 8800 cubic meters. The assessment report of environmental impact for Beilong was approved by SEPA in March 1998.

These repositories adopt multi-engineered barriers and natural barriers, and under the effective supervision.

Engineered barriers: solidification bulk + container + engineered structure

Natural barriers: Good retarding capacity to radioactive substance. Retarding the radioactive substance after engineered barriers failure

Effective supervision: Prevention from accidentally intrusion

The low and intermediate wastes should be kept in the repositories for 300 years at least and decay to safe level.

- High level radioactive wastes

The deep geology disposal will be implemented to high level wastes. The current work involves study on vitrification technique for HLW, site screening and evaluation, analogue study, safety and environmental assessment study for the deep geology disposal of HLW, and some laboratory work, which includes the research on the migration of radionuclides in buffer and backfill materials. In addition, the initial work on the underground lab. For geology disposal is also carried on.

3.2.4 RWM Facilities

There are 23 waste storage facilities in provinces. Most of them are under operation, some are nearing commissioning. The urban waste storage facilities mainly accept the radioactive waste from hospitals or nuclear technique applications, e.g. radiograph.

Most of the large nuclear facilities have their own radioactive wastes treatment, storage facilities. The common techniques used in radioactive wastes reduction are incineration and compaction. The main solidification technique is cementation.

3.2.5 Inventory of Radioactive Wastes in Storage (Qin Shan NPP as a Sample)

3.2.5.1 Low-Level Radioactive Waste

Gaseous radioactive wastes and extremely low-level liquid radioactive wastes generated at nuclear facilities are processed so that their radioactivity is reduced to a level below the standards prescribed by law. They are then released into the atmosphere or sea. Other liquid wastes are concentrated solidified and solid wastes are put into containers following a volume reduction and solidified). These are then safely stored at the facilities temporarily. Table 3.2-1 shows the amount of low-level radioactive wastes.

Table 3.2-1 Amount of Low-Level Radioactive Wastes

Category	Facility	Major Materials	Total Volume (m^3)
Waste managed in nuclear power plant	Generated by operation of nuclear power reactor	Concentrated waste, miscellaneous solid waste, spent resin, etc.	About 840 (as of the end of December 2000)

3.2.5.2 High-level Radioactive Waste (Qinshan NPP)

About 200 spent fuels are stored at spent fuel pool temporarily (as of the end of December 2000).