3.8 Radioactive Waste Management (RWM) Status in Thailand

The "Atom for Peace" program was launched after the end of the World War II. This stimulated the concepts of having an atomic energy research center available in Thailand. The Office of Atomic Energy for Peace (OAEP) was established serving as the government authority implementing the respective works and activities.

The radioactive waste in Thailand is composed of low level wastes from the application of radioisotopes in medical treatment, research, education, industry, and the operation of the 2 MW TRIGA Mark III Research Reactor and the production of radioisotopes at the OAEP. The Wastes from these activities are collected and treated by the OAEP using chemical precipitation methods for liquid waste and volume reduction process, such as compaction and incineration for solid waste. In addition, the high activity of sealed radiation sources, i.e., Cs-137, Co-60 and Ra-226 are also accumulated. The Radioactive Waste Management Division (RWMD) is the centralized radioactive waste management in the country and is responsible for all technical, radiological, environmental and safety activities associated with every unit operation of waste management. Moreover, due to increasing of radioactive wastes produced from radioisotope applications, the new centralized waste processing and storage facility, which is attached to the new Nuclear Research Center at Ongkrarak district in Nakornnayok Province, will be established in the near future.

3.8.1 National Policy for Radioactive Waste Management

Since the Thai Atomic Energy Commission (Thai AEC) set the policy that the Office of Atomic Energy for Peace (OAEP) has to render the service of management of the radioactive wastes to all radioisotope users in Thailand. The mission has assigned to the Radioactive Waste Management Division (RWMD), serving as the National Centralized Radioactive Waste Management Operating Organization.

At the moment, there is an interim radioactive waste management policy which states that:

- Radioactive Waste needs to be safely managed in accordance with internationally agreed principles.
- Reuse/recycle and minimization of radioactive waste should be taken into account of reducing waste generation.
- Radioactive Waste needs to be classified by method of treatment, conditioning and disposal.
- Appropriate Research and Development to support the operational and regulatory is needed.
- Spent Sealed Radiation Source should be returned to the supplier/manufacture.
- Safety and Security of spent radiation source need the responsibilities of all parties, e.g., owner/licensee, regulatory body and the National Centralized Radioactive Waste Management Operating Organization.

3.8.2 RWM Practice

3.8.2.1 Regulatory Framework

The regulatory function of Thailand is conducted by two organizations: the Office of Atomic Energy for Peace at the Ministry of Science Technology and Environment and the Department of Medical Science at the Ministry of Public Health. Both organizations work as secretariat of the Thai Atomic Energy Commission (Thai AEC). The Office of Atomic Energy for Peace looks after the utilization of radioactive materials and other radiation sources, while the Department of Medical Science looks after X-ray machines.

The first Thai legal instrument concerning nuclear energy, the Atomic Energy for Peace Act, B.E. 2504 (1961), was enacted and became effective on April 26, 1961. Both the Atomic Energy Commission (AEC) as a policymaking organ and the Office of Atomic Energy for Peace (OAEP) as its executive organ have been established by virtue of this Act.

The Office of Atomic Energy for Peace is responsible for licenses the utilization of radiation sources other than X-ray machines. The responsibilities include authorization and inspection. Other responsibilities are the calibration of radiation protection instruments, the operation of environmental surveillance program, radioactive waste management, and the information exchange.

-Draft Regulation on Radioactive Waste Management.

The regulation on RWM was first drafted in 1993 with the assistance of IAEA Technical Co-operation, entitled, "Upgrading of Waste Processing Facilities." Because the process of adopting new laws or regulations or modifying existing ones has been delayed, the first draft is not yet being implemented. In March 2000, the minister of MOSTE ordered the OAEP to submit the draft RWM regulation to be considered by the newly appointed special committee. The second draft was then prepared based on the latest draft document (1998) on RWM Model Regulations distributed by the IAEA for the Interregional Project on "Strengthening Radiation Protection and Waste Safety Infrastructure," the objective of which is to provide RWM model regulation and guidance on their implementation. The draft has been proposed to the minister of MOSTE for approval and to be enacted as a ministerial regulation. At present, it is being reviewed by the Council of State.

According to the second draft RWM regulation, it is concerned with establishing the policy, strategy and systems for waste management, and the legal and regulatory framework (Table 3.8-1).

Table 3.8-1 Content of Current Draft RWM Regulation Proposed to the MOSTE

Article Number	Content
1	Definition
2	Radioactive Waste Classification
3	Appointment of RWM officer
4	Radioactive Waste Inventory
5	Sorting, Segregation, Collection and Characterization of Radioactive Waste, Labeling of Waste Container
6	On-site Pretreatment Zone
7	Right to On-site Treatment and Dispose
8	Request for Servicing
9	Transport of Radioactive Waste by Licensee
10	Management of Spent Sealed Radiation Source
11	Emergency Response by Licensee
12	Service Fee
13	Promulgation of the Ministerial Regulation

3.8.2.2 Organization and Responsibilities

3.8.2.2.1 OAEP Organization

OAEP was established in 1961 and was given duties in compliance with the resolution of the Thai Atomic Energy Commission (Thai A.E.C) and under the authority of the Ministry of Science, Technology and Environment. In accordance with its statutory functions, OAEP responsibilities from a practical viewpoint comprise three main aspects of activity, as follows:

- performing the regulatory roles pursuant to the Atomic Energy for Peace Act
- coordinating with in-country and related foreign organizations, the execution of the country atomic energy programs undertaking the research and development in nuclear technology including the cooperation of the national research center and the Thai Irradiation Center

Moreover, to accomplish the Thai A.E.C. function, the Commission had appointed sub-committees to carry out and give recommendation or advice on the works on atomic energy for peace and other related regarding legal proceeding, legislation, nuclear energy utilization and safety, and issuing license. The organization chart can be seen in Figure 3.8-1.

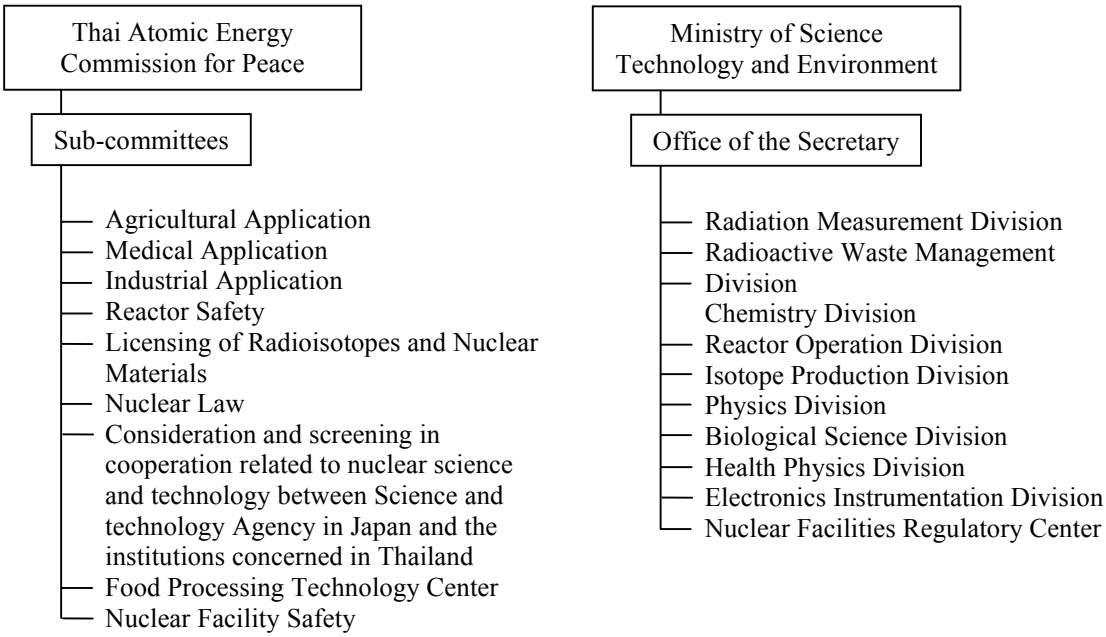

Figure 3.8-1 Governmental Organization Regarding Nuclear Energy

3.8.2.2.2 Radioactive Waste Management Organization and Responsibilities

The RWMD has the following responsibilities:

- Provide services to collect, characterize separate, treat, condition transport and store the radioactive waste, as well as to decontaminate radioactive substances
- Undertake research and development for methods of collecting, characterizing, separating, storing of radioactive waste and decontamination of radioactivity; the study on the recycling of radioactive waste, its permanent and interim storage; the study of the impact of radioactive waste; and the preparation for decommissioning nuclear instruments and assessment of radioactive waste management

In addition to the actual waste management functions assigned, the overall responsibilities of the RWMD included every matters concerning radioactive waste, e.g., teaching students from universities in research related to nuclear application, lecture in various training courses in OAEP, responsibility for public relations in radioactive waste and also working for the new centralized waste processing and storage facility, the new Nuclear Research Center at Ongkrarak district in Nakornnayok Province. The organization chart of RWMD is shown in Figure 3.8-2.

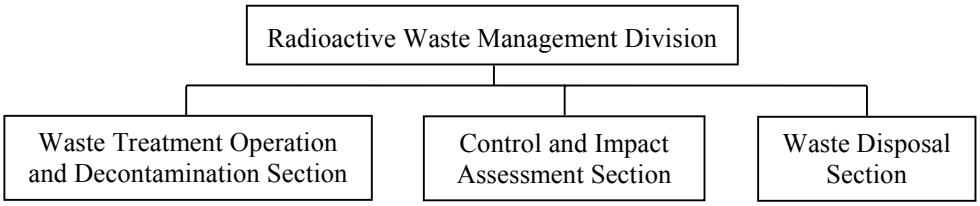

Figure 3.8-2 RWMD Organizational Chart

There are three sections divided by their responsibilities:

- Waste Treatment Operation and Decontamination Section
  - Provides services on waste management; collection, treatment, conditioning, interim storage and decontamination services
  - Controls radioactive waste discharge to the environment
  - R&D on waste management and decontamination technology

- Waste Assessment and Control Section
  - Assesses radiological environmental impacts due to liquid waste treatment at the OAEP
  - Conducts the radiological surveillance around the OAEP
  - Provides analytical service to other governmental and private organization for non-nuclear activities prior to discharge liquid waste in accordance with the waste regulations
  - Provides analytical service in environmental samples for specific radioisotopes, i.e., radionuclides in U and Th series

- Waste Disposal Section
  - Researches on siting for Potential Repository for LILW
  - Establishes the acceptance criteria and guide line for LILW disposal
  - Operates and controls on the national repository site in the country (if available)

3.8.3 Criteria Used to Define and Categorize Radioactive Waste

At present, the radioactive waste produced in Thailand is categorized as low level wastes and spent sealed radiation sources. The activities of low level wastes are in the range of 3.7-37 Bq/L for liquid and about background level to 20 microsievert per hour. The activities of the spent sealed radiation sources can be considered as a high activity waste ranging from few kilo-becquerel up to some ten gega-becquerel per piece.

Regarding the draft of Ministerial Regulation B.E.2544 (year 2001) is being reviewed by the Council of State. Article 2 in the draft describes the criteria and classification of radioactive waste as follows:

Article 2. Radioactive waste shall be classified in according to the characteristics, activity concentration and half lives of the radionuclides present.

Class	Description
(1) Very low level waste	Radioactive waste containing activity concentrations and/or total activities less than clearance level
(2) Low level/short lived waste	Radioactive waste containing short lived radionuclides with half lives less than 100 days that will decay to clearance levels within three years
(3) Low and Intermediate level/short lived waste	Radioactive waste containing beta/gamma emitting radionuclides with half-life 100 days to less than 30 years which will not decay to clearance level within three years and/or alpha emitting radionuclides with an activity less than 400 Bq/g and a total activity less than 4000 Bq in each waste package
(4) Low and intermediate level/long lived waste	Radioactive waste containing radionuclides with concentrations above those for (3) and which does not generate heat at above 2 kW/m^3 of waste
(5) High level waste	Radioactive waste containing radionuclides with concentrations above those for (4) which generates heat at above 2 kW/m^3 of waste

3.8.4 Radioactive Waste Management Facilities

3.8.4.1 Current Status

At present, there are waste processing facilities and waste storage facilities at the OAEP located at Vibhavadi-Rangsit Road, Chatuchak, Bangkok. Table 3.8-2 shows the details of Radioactive Waste Management Facilities at the OAEP.

Table 3.8-2 Radioactive Waste Management Facilities at the OAEP, Bangkok

Facilities	Items	Capacity	Type of waste
Solid Waste Treatment Plant	Incinerator equipped with off gas cleaning system	15kg/hr	Burnable waste
	Compactor	40 tons	Compactable waste
Low Level Liquid Waste Treatment Plant	Accelerator for chemical precipitation	$5m^3$	Aqueous waste low salt content
	Sand Filter		
	Ion-exchange resin		
	Stainless steel container for storage	$5m^3$	Organic liquid waste
Interim Storage Facilities	Storage plant no. 1	$65m^2$	Spent SRS
	Storage plant no. 2	$80m^2$	RI waste (LLW)

3.8.4.2 Future Plan

3.8.4.2.1 New Radioactive Waste Management Facilities

In June 1993, the government approved the New Nuclear Research Reactor Center Establishment Project, which comprises 10 MW Research Reactor, Radioisotope Production Facility and Centralized Waste Processing and Storage Facility. The OAEP, in addition to the above nuclear facilities mentioned, will be moved to about 60km northeast of Bangkok. The Project is now in the process of submittal all requirement documents for construction permit approval by the Thai-AEC. The construction period is forecasted to be two years afterward. The Centralized Waste Processing and Storage Facilities (WPSF) will be divided

into two separate reinforced concrete buildings - the Waste Processing Building (WPB) and the Waste Storage Building (WSB).

- WPB - 29.5 x 29.5 x 12.6m^3
  Aqueous Liquid Waste Processing facility
  Organic Liquid Waste Processing facility
  Solid Waste Processing facility
  Conditioning facility
- WSB - 58 x 44 x 6.3m^3 (for 20 years interim storage)

3.8.4.2.2 Radioactive Waste Disposal Plan

The studies on suitable design for central disposal site in Thailand have been concluded to be near surface disposal. Thailand, among other countries, has participated in the RCA Project entitled, "Preparation for the Disposal of LILW with emphasis on Non-power Sources," initiated in 1996.

The main outcome of the project is the identification of reference repository concepts in the region. There are altogether six concepts, wherein Thailand is in Concept C. This concept means disposal of LILW in near surface in engineered concrete vault with drainage system and multilayered covers, constructed in saturated/unsaturated zone on a site with changing level of water tables.

3.8.5 Inventory of Radioactive Wastes

Radioactive Waste in Thailand is generated from radioisotope applications in the field of medical diagnosis and therapy, education and research and industry.

The arising wastes can be classified into low level-short lived waste and spent sealed radiation sources. Inventory to Radioactive Waste and waste accumulation in Thailand are shown in Table 3.8-3.

Table 3.8-3 Cumulative Quantity of Radioactive Waste stored at the OAEP in 2001

Categories	Radionuclides	Volume (m^3/y)	Total Accumulation
Low Level Waste - Solid - Liquid - Gas - Organic liquid Ion Exchange Resin (from Research Reactor and Waste Treatment Plant)	^{125}I, ^{131}I, ^{99}Tc, ^{3}H, ^{14}C, ^{35}S, ^{32}P	50	450 (200L drum)
	^{137}Cs	200	none
	^{3}H, ^{14}C	< 1	5 m^3
	Activation Products, Corrosion Products, Fission Products	< 0.3	2 m^3
Spent SRS from Medicine, Research, Education and Industry	^{60}Co, ^{85}K, ^{90}Sr, ^{109}Cd, ^{137}Cs, ^{210}Po, ^{226}Ra*, ^{241}Am, $^{241}Am/Be$	~ 6Ci	806 pieces (exclude ^{226}Ra)

*4823.6mg (948 pieces) of ^{226}Ra has been conditioned in ten concrete lined steel drums since February 2001.

3.8.6 Decommissioning Plan for Thai Research Reactor

Existing Research Reactor.

The first Thai Research Reactor (TRR-1) was MTR swimming pool type reactor manufactured by Curtis Wright of the US, which was commenced in 1962. The core was replaced by the 2 MW. TRIGA Mark III type (called TRR-1/M1) of General Atomic of the US in 1977. The structure of reactor pool, reactor core and core diagram are shown in figure 1, 2 and 3, respectively. The existing research reactor was licensed internally by the OAEP on the behalf of the Thai A.E.C. Since the TRR1/M1 is operated by the OAEP, the government sector itself, the license was issued as lifetime cycle with no expiry date. The Nuclear Facility Regulatory Centre and Health Physics Division of the OAEP are responsible for nuclear safety and radiation safety, respectively.

Decommissioning Project.

The Thai Research Reactor has been operated to serve the nation need in research and development in nuclear science and technology for over 38 years. This long period of services made the reactor components, equipments, and building reaching aged and costly for maintenance. In addition, the cabinet had a resolution in 1989 to relocate the TRR-1/M1 to a more appropriate and safe location. Regarding these, the OAEP has designed to construct a new research reactor and decommissioning the TRR1/M1 at the same time.

Two years later in 1991, the OAEP received the IAEA Technical Assistance Project on Relocation of the Nuclear Research Center (THA/4/012). Under this project, the IAEA had dispatched an expert to assist the OAEP regarding decommissioning activity for the TRR-1/M1. Meanwhile the OAEP has appointed a working group from Reactor Operation Division, Health Physics Div., Waste Management Div. and Nuclear Facility Regulatory Centre to administer the decommissioning project. Upon the assistance from the IAEA expert, and the IAEA Safety Series No. 105 (The Regulatory Process for the Decommissioning of Nuclear Facilities, 1990) as guideline, the OAEP has set up a Conceptual Decommissioning Plan for the TRR-1/M1 in June 1991. The content in the plan consisted of:

- Decommissioning Option. According to the Decommissioning Concepts, the OAEP has an aim to decommission the TRR-1/M1 to Stage 3 or unrestricted site use but without demolition of the reactor building. The TRR-1/M1 will successively be used and displayed as the historic landmark of the first accession to the controlled nuclear fission reaction in Thailand.
- Organization Performing Decommissioning. The Reactor Operation Division is responsible for shutdown of the reactor, dismantling of equipment, nuclear fuel, reactor core and core components. The Radioactive Waste Management Division is responsible for decontamination of surfaces and collection of the decommissioning wastes including the transportation to the disposal site after treatment. The Health Physics Division is responsible for regulatory process and radiation protection program for the decommissioning project. The Nuclear Facility Regulatory Centre is responsible for the safety assessment of the decommissioning project.

- Decommissioning Activity. Work plan after final shutdown of the reactor will be as follows:
  - Dismantling
    - the reactor core, fuel element and core components be dismantled
    - all heat transport fluids be removed
    - contaminated parts of the reactor be removed
    - ventilation systems shall be shutdown and replaced by the conventional ones
  - Decontamination
    - the surface of the pool be removed and repainted
    - all the floor of the reactor building be decontaminated and cleaned up
  - Waste Handling
    - the decommissioning waste be transported to the temporary waste storage for treatment and to the waste disposal site
  - Monitoring and Surveillance
    - radiation dose at the reactor floor shall be lower than the safety dose limit
- Schedule. Back to 1991, the original plan of decommissioning project was expected to be complete in ten years after the Conceptual Decommissioning Plan was approved. The decommissioning schedule for TRR-1/M1 was set out as shown in Table 3.8-4, while the principal design parameters are shown in Table 3.8-5.

Table 3.8-4 Decommissioning Project Schedule

Preparation of Conceptual Decommissioning Plan	1994-1996
Review and Approval of the Conceptual Decommissioning Plan	2000
Preparation of Detailed Decommissioning Plan	2001
Submission of Detailed Decommissioning Plan	2002
Review and Approval of Detailed Decommissioning Plan	2002
Reactor Shutdown	2003
Defuelling	2004
Decommissioning and Dismantling	2004-2005
Fuel Removal (from reactor pool)	2004
Fuel Storage and Disposal	2005
Final Survey	2006
License Termination and Site Release for Use	2006

Remark: It is noted that the project is about five years behind schedule. One reason is that the New Nuclear Research Center project is delayed.

Table 3.8-5 Principle Design Parameters

Reactor type	TRIGA Mark III
Max. steady-state power level	2000 kW (thermal)
Max. pulse	2.1% δk/k ($3.00)[a]
Fuel element design	
Fuel-moderator material	U-ZrH1.6[b]
Uranium content	8.5%wt, 20%wt
Uranium enrichment	20% U-235
Shape	Cylindrical
Length of fuel	38cm. (15in.) overall
Diameter of fuel	3.63cm. (1.43in.) OD
Cladding material	Type 304 SS
Cladding thickness	0.051cm. (0.020in.)
Number of fuel elements	100 (nominal)
Excess reactivity, max.	6.3% δk/k (cold, clean)[a]
Number of control rods	
Safety-transient	1
Regulating	1
Shim	2
Safety	1
Total reactivity worth of rods	10.12% δk/k[a]
Reactor cooling	Natural convention of pool water

[a]Reactivity: $1 = 0.7% δk/k
[b]The nominal H/Zr ratio is 1.60 and the maximum value is 1.65.

- Regulatory requirements
- Safety assessment
- Radiation protection program
- Q.A. program
- Records and documentation
- Waste Management. Radioactive waste arising from decommissioning (85% by volume) is low level waste and generates no heat which can be packaged without shielding. The volume of waste can be reduced by mechanical, thermal and chemical methods. Decommissioning waste will be fixed into cement before shipment to the disposal site. Volume of waste will be less than 100 cubic meters.
- Final radiation survey

3.8.7 Future Directions

Since the OAEP has planed to establish a new nuclear research center at Ongkarak district in Nakornnayok Province, a new waste management center consisted of the waste processing and storage facilities (WPSF) will exist.

At this WPSF, there will be facilities for accepting of incoming waste from within the center and from outside, treatment plants for both liquid and solid wastes, a conditioning facility, a well-equipped decontamination hall, and a storage building for accumulation of conditioned waste packages.

The OAEP also considers that there will be a need for a repository in the future. The proposed repository will be a fully engineered facility provides with multibarrier system to

minimize and maintain within acceptable levels the consequence of any potential releases of radioactive materials into biosphere.

The national system for radioactive waste management should be more strengthened. It is necessary to create a comprehensive and reliable but transparent waste management policy that matches with the ever growing need for nuclear applications in modern industrial society accordance with the International Basic Safety Standard and to provide assurance for confidence and understanding to the general publics in the country.

3.8.8. Reference

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