Chapter 19

DECOMMISSIONING

This chapter of the SAR provides information on the facility design and the operational procedures to facilitate the decommissioning process.

The term decommissioning refers to administrative and technical actions taken to allow removal of some or all of the regulatory controls from a nuclear facility. These actions involve decontamination, dismantling and removal of radioactive materials, waste, components and structures. RTP has been in operation since 1982, however, there is no foreseeable intention to shutdown indefinitely the facility in the immediate future. ~~Recently, in 2005, a decommissioning plan for the RTP and other relevant facilities is not yet carried out and the decommissioning plan proposed for RTP is still under study.~~ Therefore, there is no immediate need for the authority to make a decision on a National policy on Decommissioning of Research Reactor/Nuclear Installation. National Policy on Waste Management is in progress. ~~Moreover, a national plan for radioactive waste management is not available.~~ However, from the early phases of facility design and construction and during operation, the aspects that facilitate decommissioning process have been considered.

19.1. Considerations during Design and Construction

During the design and construction phases of RTP, the aspects to facilitate the decommissioning process and reduce occupational exposures such as selection of material to reduce activation products, use of modular for easy dismantling, designing to avoid contamination or to allow easy decontamination have been considered. Besides, the liquid waste treatment station, the spent fuel storage, ~~the flask for spent fuel transferring from the reactor pool to the spent fuel storage (not presently available),~~ and the solid radioactive disposal facility were designed and constructed.

The main materials used in the reactor core components are made of high quality aluminum alloy. This alloy is used in the main structures such as reactor pool tank: aluminum liner, beam tube, reflector: aluminum housing, thermal column: graphite-filled aluminum, rotary specimen rack, detectors (standard commercial fission chambers: seal-welded aluminum and transient control rod. The other 3 control rods: regulating, shim and safety rods are made of sealed type of 304 Stainless Steel.

To reduce contamination and to allow easy decontamination, in-core structures of simple design with smooth finishings, the floors of the reactor hall, the corridor and laboratories for radio-isotope production are welded by continuous PVC tiles coated by plastic. Meanwhile, the primary and secondary cooling system that consists of pump, heat exchanger, temperature probes, N-16 diffuser and associated valves & piping are made of and coated by stainless steel and aluminum alloy. Furthermore, existing active ventilation system is available and can be used to facilitate control of airborne contamination that may arise during decommissioning work.

To facilitate handling and transport, the facility is designed in the form of open pool-type with in-core structures of modular shape. Provision of overhead crane to transfer heavy and contaminated or activated components and adequate space and entrance door for direct entry of heavy transport vehicles for loading of heavy loads. Wide and smooth access road allows for heavy transport vehicles to reach the reactor building.

As temporary storage of contaminated component, the biological concrete structure of the reactor can be used prior to transportation to a disposal site. The biological shield is designed such that it can even be converted into a permanent disposal facility.

The waste management center (WMC) in Building No.30 is designed for temporary storage of low and medium level solid radioactive and liquid waste. Solid wastes includes spent ion-exchange resins, contaminated clothing, tissues, glassware, etc, are segregated at source by disposing it in appropriate containers. Two types of foot-pedal operated bins are provided in each laboratory and working area; one for compressible waste and the other for non-compressible waste. The compressible waste is then placed in a 220-liter steel drum and compressed by means of a baling press. Waste is continuously added into the drum as the compression proceeds until the drum is full when it is covered and sealed. Solid waste known to contain only short-lived radionuclide are stored on site to allow for decay of its radioactivity and subsequently disposed of as with normal waste. In the case of waste containing or is contaminated with long-lived radionuclide, it will be sent to Building No. 33 with a 600 m^2 measuring from side to side for storing the steel drums of radioactive wastes.

Meanwhile, for radioactive liquid waste, it is treated to remove as much of the radioactive contents as practically achievable so that it can be diluted and dispersed safely into the environment.

19.2. Considerations during Operation

Development of decommissioning technologies is desirable from economical and safety points of view. Social and environmental impact must be one of important issues to be considered in decommissioning nuclear facilities. A public dose caused by decommissioning activities is required to be evaluated as an environmental impact study in planning of a decommissioning project, which is a requirement of the guideline for decommissioning.

The relevant operational records of the RTP include details of:

i. Operational history of the reactor facility

(a) details of the operating history of the reactor, including records of:
— fuel failures and fuel accounting;
— incidents leading to spillage or inadvertent release of radioactive material;
— radiation and contamination survey data, particularly for plant areas that are rarely accessed or especially difficult to access;
— releases that could potentially affect groundwater;
— radioactive inventory; and
— wastes and their location.

(b) details of modifications to the plant and maintenance experience including records of:
— updated 'as built' drawings and photographs, including details of the materials used;
— special repair or maintenance activities and techniques (e.g. effective temporary shielding arrangements or techniques for the removal of large components); and
— details of the design, material composition, and the history and location of all temporary experiments and devices.

ii. Survey of the plant

In concreting the dismantlement project, it is important to evaluate the concentration of radioactive materials which are generated by activated components in the reactor or biological shield concrete and are materials attached to the equipment and piping as the contamination. The amount of activated concrete must be determined. There shall be minimal radioactive gas be released during decommissioning.

Outline of the plant survey:-

- Measurement of the neutron flux and gamma spectrum
- Evaluation of the activated radioactivity/contaminated radiation/fission products
- Evaluation by the analysis code
- Estimation of the amount of waste based on the evaluation results

A preliminary estimate of the maximum volume of waste generated from a decommissioning of a TRIGA reactor is given in Table 19-1.

Table 19-1 Estimated Maximum Volume of Waste Generated After D&D of TRIGA Reactor Project

	Type of Waste	Volume (M^3)
1.	Concrete	200
2.	Aluminium tank	8
3.	Stainless steel & Aluminium Pipings Heat exchanger	5
4.	Graphite	3
5.	Lead	3
6.	Fuel elements (Assuming each fuel element is converted into 0.5 M^3 of conditioned waste)	65
7	Miscellaneous	10
8	Tritiated water	25
	Total estimated volume	319

The TRIGA Mark II Research Reactor at MINT

~~ii. Development of reactor decommissioning technology~~

MINT will continue to follow progress in the field of decommissioning technology available in the world. A program will be set up to make assessment of this technology and make recommendations as to select the most appropriate technology to be used in the future decommissioning program of the reactor.

~~Decommissioning technology development program will be applied for nuclear power plants in the areas of decontamination and dismantling technologies, radioactivity measurement, waste processing and recycling of metal and concrete material. Technology development was also carried out in term of remote dismantling techniques, high performance decontamination, radioactivity measurement, and computer programs for planning and management of decommissioning.~~

~~Engineering support system is developed in the dismantlement of the reactor. This system supports general engineering (such as evaluation and optimization of workload, radiation exposure dose and cost of dismantlement) by using the latest calculation technology in the comparative study of dismantlement procedure, method and schedule etc. In addition, simulation system of the dismantlement by technology of virtual reality (VR) will be developed to utilize in the formulation of rational dismantlement project, training of workers and so on.~~

19.3 Administrative and technical plans

Prior to decommissioning activities for the RTP, a national policy, strategies and decommissioning plan must be present.

Matters on policy that must be determined are:

1. Decision on cessation of reactor operation
2. Fate of spent fuels
3. Residual activity in facilities, materials etc.
4. Cost for decommissioning, responsibility
5. Recycling and reuse
6. New use for the current site
7. International co-operation
8. Restricted site release and unrestricted site release

Matters on strategies for decommissioning that must be determined are:

1. In stages or all at once
2. Decontamination of contaminated items
3. Release of all decontaminated facilities and areas
4. Final disposal of radioactive wastes with different options
5. Waste minimization by minimize, reuse and recycle
6. Establishment project management team for efficient tasks management

For a decommissioning plan documents preparation, IAEA Safety Reports series No. 45, Standard Format and Content for Safety Related Decommissioning Documents can be refer as a guide for preparation of the plan once a policy and strategies have been determined. Matters relevant for the RTP decommissioning can be inserted into the standard format while non relevant matters can be taken out.

19.3. Conclusion

The RTP was put into operation since 1982, an initial decommissioning plan for the RTP and relevant facilities should be established as early as possible (as recommended by IAEA [4]). In the initial stage, the following matters should be included for the decommissioning of the RTP:

- Policy, Regulatory requirements and guidelines
- Decommissioning strategies
- Decommissioning plan
- Decommissioning activities
- Facility description or components of the reactor
- Safety principles and criteria
- Preparation of estimated costs and determination of funding source.

References to Chapter 19

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Standard Format and Content for Safety Related Decommissioning Documents - Safety Standards Series No. 45, IAEA, Vienna, 2005.

2. INTERNATIONAL ATOMIC ENERGY AGENCY, Research Reactor Core Conversion Guidebook, IAEA-TECDOC-643, Vienna, 1992.

3. INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Assessment of Research Reactors and Preparation of the Safety Analysis Report - Safety Guides. Safety Series No. 35-G1, IAEA, Vienna, 1994.

4. INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Nuclear Power Plants and Research Reactors - Safety Standards Series No.WS-G-2.1, IAEA, Vienna, 1999.

5. Puspati, PPA-R5, Safety Analysis Report for PUSPATI Triga Mark II – Reactor Facility, 1983.