MALAYSIA

a. National Framework for management of radioactive waste and spent fuel

Currently, Malaysia has yet to decide embarking on nuclear power program, and all nuclear activities are limited to the applications of such technologies in the industrial, medical, agricultural, and research. The first radioactive had been introduced in Malaysia in ninety sixties when it was used in hospital. Beside hospital the country has also a long history of tin mining activities. These mining activities generate a sizable volume of radioactive waste or residues. Certain minerals, such as monazite, illminite, and zircon - which contain natural radioactive elements such as uranium, thorium and radium, coexist with tin ore or cassiterite in the ground. In the process of extracting tin, these radioactive elements become more concentrated and become by-products of mineral processing industries.

In Malaysia, likes other countries, all producers or waste owners are required to be responsible for the safe management of radioactive wastes they generate or own. They need to comply the law requirements enforced by the regulatory body i.e. Atomic Energy Licensing Board (AELB). They are required to ensure adequate protection of workers, public and the environment. They need to have qualified and enough staff, equipment, facilities, training programme, operation procedure and quality management programme. They need to keep all appropriate records and information regarding the waste generation, processing, storage and disposal and inventory of waste. With regard to control of radioactive waste generation, the producer shall ensure that the generation of radioactive waste is as minimum as possible. Recycling and reuse is encouraged to be considered.

Malaysia also does not allow any importation of radioactive waste. It means no person is allowed to bring any radioactive waste into Malaysia. This policy is also applied to disused sealed radioactive sources (DSRS). Users of DSRS are also required to have letter of undertaking from the supplier when they want to import radioactive sealed sources. It means that the DSRS needs to be sending back to the country of origin when it is no more use.

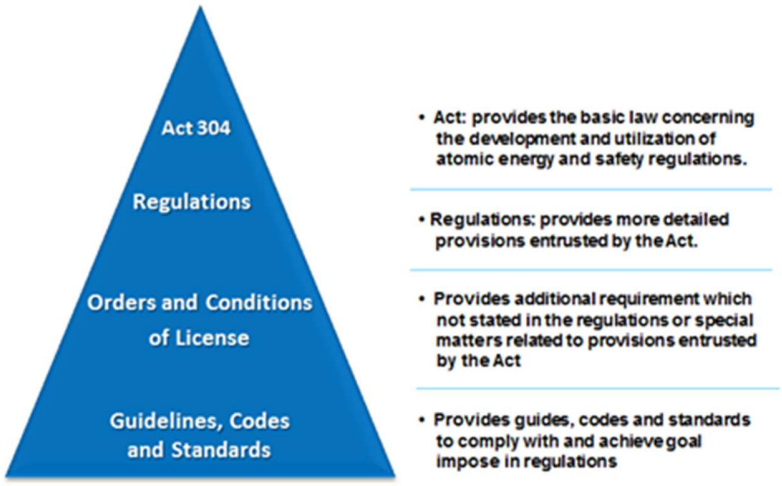
Malaysian Nuclear Agency (Nuclear Malaysia) has been given the responsibility to provide services in the management of the radioactive wastes produced in Malaysia. Nuclear Malaysia is also recognised as a National Radioactive Waste Management Centre. Users without facilities and waste management expertise may request assistance from Nuclear Malaysia in solving their problems. All services are chargeable depending on type and characteristics of wastes. There is a centralised storage facility at Nuclear Malaysia to store radioactive waste from all over the country.

b. National legal and regulatory framework

Control over the use of radioactive substances (including radioactive waste) in Malaysia began in 1968 when the Parliament passed the Radioactive Substances Act 1968. Due to rapid development of atomic energy activities in Malaysia which requires more effective control, inspection and enforcement, the Atomic Energy Licensing Bill was drafted and was passed by Parliament in April 1984 and gazetted in

June 1984 as the Atomic Energy Licensing Act 1984 (Act 304).The Act came into force on the 1st February 1985. The hierarchy of legal system in Malaysia is shown in Figure 1.

Figure 1: Hierarchy of Legal System in Malaysia Related to Atomic Energy



There are four main regulations made under the Act 304 namely:

- Radiation Protection (Licensing) Regulations 1986;
- Radiation Protection (Transport) Regulations 1989;
- Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010; and
- Atomic Energy Licensing (Radioactive Waste Management) Regulations 2011

1.1.2 Structure and System (Regulatory organizations)

The Atomic Energy Licensing Board (AELB) which was established under Section 3(1) of the Act 304 in 1985 is an enforcement body for the implementation of the Act 304. The functions of the AELB as stated in the Act 304 are as follows:

- To advise the Minister and the government of Malaysia on matters relating to the Atomic Energy Licensing Act 1984 and developments pertaining thereto with particular reference to the implications of such developments for Malaysia;

- To exercise and supervision over the production, application and use of atomic energy and matters incidental thereto;

- To establish, maintain and develop scientific and technical co-operation with such other bodies, institutions or organizations in relation to nuclear matters or atomic energy as the Board thinks fit for the purposes of the Atomic Energy Licensing Act 1984;

- Where so directed by the government of Malaysia, to perform or provide for the performance of the obligations arising from agreements, conventions or treaties relating to nuclear matters or atomic energy to which Malaysia is a party where such agreements, conventions or treaties relate to the purposes of the Atomic Energy Licensing Act 1984 ;and
- To do such other things arising out of or consequential to the functions of the Board under the Atomic Energy Licensing Act 1984 which are not inconsistent with the purposes of this Act, whether or not directed by the Minister.

Since the enforcement of the Act 304, a major part of the responsibility is under the jurisdiction of the Atomic Energy Licensing Board. However, the control of application for medical purposes is under the jurisdiction of the Director General of Health, Ministry of Health, on behalf of the Atomic Energy Licensing Board.

Under the Act 304, any person who deals with radioactive waste needs to have a licence. Also, no person shall dispose of or cause to be disposed radioactive waste unless he is the holder of a valid licence issued by the Atomic Energy licensing Board. Primary legislation, regulations, regulatory organization, specific activities and facilities under regulation, and guidance on implementation

c. Radioactive waste management, decommissioning and spent fuel strategy and current practices & technologies

At present radioactive wastes generated in Malaysia come from industries, hospitals, universities and research institutes and they are committed to minimize release of pollutants to air, water, and land, and promote waste minimization, volume reduction, treatment, conditioning, and recycling. All precautions are taken into account to minimise the generation waste.

There is also a specific procedure for collection, control and treatment of radioactive waste activities as specified in the Nuclear Malaysia's safety, health and environment manual. The Waste Technology Development Centre (WasTeC), an organization within Nuclear Malaysia, is given responsibility to manage radioactive waste. WasTeC is also recognized as a national centre for management of radioactive waste in Malaysia. Malaysia also practice centralised storage facility for radioactive waste and disused sealed radioactive sources (DSRS). In this centre, radioactive wastes are categorized and separated based on their types, solid or/and liquid according to the standard classification of radioactive waste established by the AELB in the Atomic Energy Licensing (Radioactive Waste Management) Regulations 2011. Radioactive waste in Malaysia is classified in accordance with the above regulation.

At present Malaysia does not have any spent fuels. There is no nuclear power reactor in Malaysia. Malaysia, however, Malaysia has a small research reactor, 1MW TRIGA Mark II, in operation at Nuklear Malaysia. Nevertheless, until now there is no spent fuel produced by the reactor.

There is no decommissioning activity in Malaysia for nuclear facility. However, recently a rare earth extraction plant contaminated with naturally occurring radioactive materials (NORM) had been

decommissioned and all residue and contaminated items had been sent to disposal facility at Banjaran Kledang. This facility is licenced by the AELB and only for disposal of NORM residue or only.

Nuclear Malaysia uses operating budget (Government budget) and trust fund budget (producer pay) for managing radioactive waste at its facility. However, under the provision of the Act 304, licensee (private company) is required to provide a financial guarantee to cover the expected cost of waste management and decommissioning of their facilities.

d. Radioactive waste classification, waste and spent fuel quantities (inventory) (including disused sources that are declared radioactive waste)

Classification of radioactive waste is very important and will serve for many purposes. Therefore in 2011 the Government of Malaysia gazetted a regulation purposely to manage radioactive waste safely. The regulation is called the Atomic Energy Licensing (Radioactive Waste Management) Regulations 2011. The classification system under this regulation also takes into consideration the potential hazard of different radioactive waste. Radioactive waste in Malaysia is classified as follow:

1. Cleared Waste

Cleared waste is materials containing level of radionuclides at activity concentrations less than those specified in the Second Schedule of the Atomic Energy Licensing (Radioactive Waste Management) Regulations 2011. All wastes fall under this category can be disposed of at sanitary landfill without any further action.

2. Low Level (Short lived)/Decay Waste

Low Level (Short lived)/Decay Waste is a low level waste containing short lived radionuclides only (half-lives less than 100 days) that will decay to clearance levels within three years after the times of its generation. Most of the radioactive waste comes from nuclear medicine activities fall under this category.

3. Low and Intermediate Level Short Lived Waste (LILW-SL)

Low and Intermediate Level Short Lived Waste (LILW-SL) is radioactive waste which will not decay to clearance levels within three years containing beta/gamma emitting radionuclides with half-lives less than thirty years or alpha emitting radionuclides with an activity concentration less than 400Bq/g and a total activity less than 4000Bq in each radioactive waste package.

4. Low and Intermediate Level Long Lived Waste (LILW-LL)

Low and Intermediate Level Long Lived Waste (LILW-LL) is a radioactive waste containing radionuclides with activity concentrations more than LILW-SL but which does not generate heat at above $2kW/m^3$.

5. High Level Waste (HLW)

High Level Waste (HLW) is a radioactive waste containing radionuclides with activity concentrations more than LILW-SL but which generates heat at above $2kW/m^3$.

The inventories of radioactive waste currently in storage facility are summarised in Table 1. However, liquid waste has been treated and discharge into the environment.

Table 1 Radioactive Waste In Storage (including spent fuel that is considered waste)

Route Waste Class	Processed (type)/ Unprocessed)	Total Current Volume (m^3)	Estimated Disposal Volume (m^3)	Distribution (%)							Planned Disposal Route (if known)
				RO	FFE	RP	NA	DF	DC / RE	ND	
Total of all Classes		(m^3)	(m3)	(%)	n/a	n/a	(%)	n/a	(%)	(%)	
Line for each class (as per national classes or IAEA classification)	Solid LILW-SL	(m3) 447.8043	(m3) 0	(%) 0	n/a	n/a	(%) 100	n/a	(%) 0	(%) 0	
Disused sealed radioactive sources (DSRS)	8063 units.	-	-	-	-	-	-	-	-	-	Borehole disposal Concept (BDC)

NEWMDB waste origin type codes:

RO – reactor operations

FFE – fuel fabrication & enrichment

RP – fuel reprocessing

NA – nuclear applications

DF - defence

DC/RE – decommissioning & remediation

ND – Not Determined

Table 2 Radioactive Waste Disposed (as disposed volume)

Waste Class	Processed (not)	Total Volume (m^3)	Distribution (%)							
			RO	FFE	RP	NA	DF	DC / RE	ND	Disposal Route Used
Total of All Classes		(m^3)	(%)	n/a	n/a	(%)	n/a	(%)	(%)	
Line for each class (as per national classes or	Liquid LILW-SL	(m^3)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Discharged after

IAEA classification)		15341.5								treatment

(Note: Abbreviations as in Table 1)

Table 3 Spent fuel in Storage (MTHM)

Type	Current Amount (NPP)	Current Amount (Research Reactors)
Total Spent Fuel Storage	n/a	n/a
Wet storage (AR)	n/a	n/a
Wet storage (AFR)	n/a	n/a
Dry storage (AR)	n/a	n/a
Dry storage (AFR)	n/a	n/a
Total spent fuel held in storage for other countries (amounts also included above)	n/a	n/a

Table 4 Spent fuel sent for reprocessing (in the country or sent to another country)[1] (MTHM)

Type	Current Amount (NPP)	Current Amount (Research Reactors)
Total amount Spent Fuel sent to Reprocessing (in your country)	n/a	n/a
Total amount Spent Fuel sent to Reprocessing (in another country)	n/a	n/a
Total amount of Spent Fuel received from another country for reprocessing and recycling	n/a	n/a
Total amount of Spent Fuel(MTHM) or radioactive waste (cubic metres) returned to country of origin for storage/disposal	n/a	n/a

AR = "at reactor site", including fuel pools at NPP

AFR = "away from reactor site"

In the case of disused sources not included in volumes according to the relevant national waste classes, please include a similar table for disused sources declared as numbers of items stored and disposed.

[1]All years

Table 5 below shows a translation matrix from national classification system to IAEA classes.

Table showing conversion factors from stored waste volumes to disposed waste volume for forecasts, if required.

Table 5 Example of a translation matrix (from NEWMDB) that can be used for transition from a national classification system to IAEA classification (see Section 3)

National Waste Classification Name	**VLLW**	**LLW**	**ILW**	**HLW**
Low Level (Short lived)/Decay Waste	100%			
Low and Intermediate Level Short Lived Waste (LILW-SL)		90%	10%	
Low and Intermediate Level Long Lived Waste (LILW-LL)			100%	
High Level Waste (HLW)				100%

a. Tabulation of processing, storage and disposal facilities for waste and spent fuel, including their capacities and status

Tabular information of spent fuel facilities Total number of Fuel cycle facilities (by type and status) from INFCIS types "Spent Fuel Storage"; "Spent Fuel Reprocessing and Recycling" and "Spent Fuel Conditioning" Total number of waste management facilities (by type and status) from NEWMDB

Table 6 (sample of data based on format of table from INFCIS)

Type	**Planned**	**Construction**	**Commissioning**	**In Operation**	**Shutdown**	**Decomm.**	**Other**	**Total**
Spent Fuel Storage	1	0	0	0	0	0	0	1
Spent Fuel Reprocessing and Recycling	0	0	0	0	0	0	0	0
Spent Fuel	0	0	0	0	0	0	0	0

Type	Planned	Construction	Commissioning	In Operation	Shutdown	Decomm.	Other	Total
Conditioning								
Spent Fuel disposal	0	0	0	0	0	0	0	0
Waste processing	0	0	0	0	0	0	0	0
(multiple lines by country waste class)								
Waste storage:	0	0	0	1	0	0	0	0
(multiple lines by country waste class)								
Waste disposal:	1 (Borehole Disposal Concept)	0	0	0	0	0	0	1
(multiple lines by country waste class)								

Table 7 Summary of major sources of waste (from IAEA PRIS, INFCIS & RRDB databases)

Type	Planned	Construction	Commissioning	In Operation	Shutdown	Decomm.	Other	Total
Research reactors*	0	0	0	0	0	0	0	0
Nuclear Power reactors	0	0	0	0	0	0	0	0
Spent Fuel Reprocessing and Recycling	0	0	0	0	0	0	0	0
Other (define)**	-	-	-	-	-	-	-	-
(multiple lines if required)								

* Note: research reactors with medium or high power from RRDB

Note: "Planned" means it has been identified in a national report, strategy, or formal plan. It includes: Planned, Under Study-Assessment, Siting-Design phases

** if applicable, where included in national inventory, e.g. decommissioning of contaminated facilities, cleanup of accident related sites

1. Trends and future prospects (volumes of waste and spent fuel arising, waste and spent fuel management facilities)

At present the Government of Malaysia has yet decided to send the future spent fuel produced from 1MW TRIGA (reactor TRIGA PUSPATI (RTP)) research reactor to United State of America (US) for disposal. One of the main reasons is the control console of the reactor just replaced to digital. The other auxiliaries were also had been changed. The next plan is to build wet storage facility for spent fuel.

Table 8 e. Trends and future prospects (estimation of volumes of waste and spent fuel arising, waste and spent fuel management facilities)

Type	Current Amount MTHM	Estimated Current amount when prepared for disposal*	Current Disposal Capacity	Total forecast at 2030		Total forecast at 2050	
Spent Fuel Storage	0			0		0	
Wet storage (AR)	0			0		0	
Wet storage (AFR)	0			0		0	
Dry storage (AR)	0			0		0	
Dry storage (AFR)	0			0		0	
Total amount Spent Fuel sent to Reprocessing and Recycling	0			0		0	
Total amount Spent fuel disposed	0		0	0		0	
Waste in storage:	(m3)	(m3)		(m3)		(m3)	
(multiple lines by country waste class or IAEA classification)	(m3)	(m3)		(m3)		(m3)	
Waste disposal:	(m3)		(m3)	(m3)		(m3)	
(multiple lines by country waste	(m3)		(m3)	(m3)		(m3)	

Type	Current Amount MTHM	Estimated Current amount when prepared for disposal*	Current Disposal Capacity	Total forecast at 2030		Total forecast at 2050	
classor IAEA classification)							

AR = "at reactor site"

AFR = "away from reactor site"

* calculated equivalent amount when waste has been conditioned and packaged for disposal as per table of conversion factors given.

Sources of data, assumptions (especially for future waste forecasts) and references

text field that summarizes significant sources of data, assumptions (e.g. number and expected life of NPPs, number being decommissioned, etc), etc

List of references

date of profile preparation