6. Status on the Regulatory Aspects in NORM/TENORM Activities and Wastes in Malaysia

6.1 Introduction

In Malaysia, the use of radioactive materials are mostly in the industrial, medical, research or educational applications. Inevitably the applications will generate radioactive waste, which require proper control to prevent detrimental effects to life and the environment. Another source of radioactive waste, which is a legacy of our history as a major tin mining nation is the Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM). This is due to the fact that the earth's environment itself contains naturally occurring radioactive materials (NORM).

Basically there are three sources of radioactive waste in Malaysia:

a) Waste generated from usage of radioactive materials from industry, medical, research and educational purposes;
b) TENORM waste resulting from activities related to the enhancement of NORM in the environment
c) Spent fuel from research reactor

In Malaysia, the most common activity related to TENORM are industrial activities related to the mining and the subsequent processing, resulting in the increase of the naturally occurring radioactive materials. The issues related to NORM and TENORM attracted a lot of public interest and the mass media in the late 1970s. Since Malaysia was a major tin producer and currently active in oil and gas industry, there is growing concern related to the TENORM wastes issues.

Table 1 Radioactive Waste Management Policy

Activities related to TENORM		
Types of Waste	**Solid Waste**	**Liquid Waste**
Policy	Stored by the user.	Stored by the user
Licensing requirement	Waste storing facility which must be comply with Atomic Energy Licensing Board criteria.	Waste storage tank
License conditions	The waste shall be stored in the waste storing facility. For disposal purpose, the licensee are required to carry out a risk assessment to any proposed dis-posal site as to demonstrate that the discharge will not exceed the limit for the member of the public (1 mSv/y)	Can be discharge to the environment if the radioactivity for liquid below the discharge limit, for example for discharge the ^{226}Ra to the environ-ment is 1 Bq/l.

6.2 TENORM Industries in Malaysia

In Malaysia, the wastes associated with TENORM are generated mostly in the tin mining and smelting, processing of minerals and oil and gas industry.

6.2.1 Mineral Processing and Mining Industry

Certain minerals of tin-mining byproduct, such as amang (heavy mineral sand), monazite, ilmenite, zircon or xenotime contain natural radioactive elements such as uranium, thorium and radium co-exist with the tin ore or cassiterite in the ground. Down-stream processing of ilmenite, zircon and monazite produces end products such as titanium oxide (as pigment in paint, paper plastics, cosmetics, etc), zirconium (used in ceramics, refractory, catalysts, or fuel cladding and structural materials in reactors) and rare earth elements (electronics, illumination, superconductors, ceramics, etc).

In the process of the mineral extraction process, these radioactive elements become more concentrated and need proper management. This type of waste derived from this tin mining and mineral processing industry has a low specific activity but long-lived alpha emitters.

6.2.2 Oil and Gas Industry

Another important source of TENORM is from the oil and gas industry – in this case mostly from the oil sludge and scales from oil well production and oil refineries. The most dominant radionuclide in oil sludge are ^{226}Ra and ^{226}Ra, whereas U and Th contribution is very small compared to other minerals such as ilmenite, zircon, etc. The total specific activity in oil sludge/scale ranged from 200 – 13, 000 Bq/kg.

In the above processes, TENORM may remain in solution, precipitate, sludge, scales particulates or residues within the production process itself or the waste streams. The waste associated with TENORM account for a significant number of the radioactive waste management problem in Malaysia. TENORM wastes characteristics are the presence of long-lived alpha radionuclides and present in very large volume compare to other types of radioactive waste.

All these materials as mentioned above in paragraph (1) and (2) are not intended to be recovered but since the radionuclide co-exists with other minerals, the radioactivity enhancement is rather unintentional. This is the case of the oil and gas, tin mining and mineral processing industries. Since Malaysia was a major tin producer in the world and current activities in oil production, the amount of waste generated is quite substantial.

6.3 Law and Regulations

The Atomic Energy Licensing Act 1984 (Act. 304)[1)] provides the regulations and control of atomic energy and for all activities related to it. The main objective of the Act is to ensure safety of radiation workers, members of the public and the environment from radiation hazards as a result of activities related to atomic energy. The regulatory body is the Atomic Energy Licensing Board (AELB).

The Act 304 prescribed by provision of Section 12(1) b quotes:
"Without prejudice to the requirements of any other law, no person shall dispose of any radioactive material, nuclear material, prescribed substance or irradiating apparatus, unless he is the holder of a valid license issued under section 16(5) by the Board".

With regard to discharge or release of radioactive material or waste including TENORM into the environment, Section 51 of the Radiation Protection (Basic Safety Standards) Regulations 1988 [2)] authorized the AELB in specifying the release limit, taking into account the following considerations:

- Pre-operational environmental monitoring;
- Determination of critical pathway;
- Selection of critical group of population;
- Assessment of radiation exposure to members of the public.

The licensee has the obligation in carrying out effluent monitoring and even environmental monitoring if deemed necessary.

6.4 Management of TENORM

Under the present law, management or disposal of radioactive waste is specifically dealt with under Sections 26-31 of the Atomic Energy Licensing Act 1984 (or Act 304) [3], which empower Atomic Energy Licensing Board (AELB) to ensure that the user obtain appropriate license for activities dealing (accumulate, transport or dispose) with radioactive waste and to take appropriate actions to rectify situation which deemed unsafe.

The AELB will consider the issuance of the license after scrutinizing applicant's capability. In the case of TENORM, a person intending to dispose of the waste should apply for a license under Class G, which is:

a) To dispose of radioactive materials, prescribed substances or their wastes;
b) To store radioactive materials, nuclear materials, prescribed substances or their wastes prior to their disposal; or
c) To decommission a milling installation, nuclear installation, waste treatment facility, irradiating apparatus or sealed source apparatus

For any disposal activity of NORM/TENORM, the licensee is required to submit a Radiological Impact Assessment (RIA) to the Atomic Energy Licensing Board, demonstrating that the dose limits to the workers and members of the public do not exceed those stipulated in the Atomic Energy Licensing Board 304 and the Regulations.

On the other hand, with regard to the waste generated from the oil and gas industry, the licensee is required to fulfill the requirement imposed by the authority.

A document was issued by the AELB in early 1996, LEM/TEK/30 SEM 1, regarding guidelines on handling and radiological monitoring of TENORM from oil and gas industry. This document was superceded by a revised edition, LEM/TEK/30 SEM 2 [4], in September 1996. Among others, it addresses the requirement and format for radiological impact assessment. For the management of oil sludge containing TENORM. Under the transport regulations, NORM/TENORM is addressed under low specific activity materials (LSA) or surface contaminated object (SCO).

6.5 Exclusion, Exemption and Clearance on NORM/TENORM Waste

Related to the NORM/TENORM waste, under the Atomic Energy Licensing Act, 1984 (Act 304), there is no provision specifically stipulated under the act that provide exclusion of the radioactive waste especially related to NORM/TENORM waste in Malaysia but the Act did provide the provision for the exclusion for the activity of prospecting or mining for any radioactive materials, nuclear materials or prescribed substance. These activities shall be governed by the relevant laws relating to mining.

Nevertheless, any person who, in carrying out either of the activities of prospecting or mining or both, encounters, discovers or comes into possession of any radioactive materials, nuclear materials or prescribed substance shall immediately report such fact to AELB in writing and shall comply with all directions that the AELB may give in the matter, being directions not inconsistent with the relevant laws related to mining.

Apart from the exclusion for activity of prospecting and mining of such radioactive materials and nuclear materials, AELB has imposed the exclusion that do not need to be subject to regulatory control that is by adopting the criteria recommended by the IAEA as stipulated in the IAEA Safety Series No. 26 "Radiation Protection of workers in the Mining and Milling of radioactive Ores" [5], which shall not exceed 0.05 weight% of the elements uranium or thorium as a guideline to be used to exclude the radioactive materials and waste from NORM/TENORM activities from the regulatory control. This guideline was established for our internal technical document known as KOD/EMT/37 Corrigendum 1 "Methods of calculation for Uranium and Thorium in the mineral sample" [6].

Due to the economic reasons and the price of tin and it's by-product such as amang and other mineral processing in the market is not viable and profitable so much so not significant in the business and trade industries at that particular time, the government has decided to made-up the policy to exempt some of this materials from the regulatory control under the Atomic Energy Licensing Atomic Energy Licensing Act, 1984.

There are two orders that has been gazette to exempt this NORM/TENORM radioactive mineral that is:

(a) Atomic Energy Licensing Atomic Energy Licensing Act, 1984, "Atomic Energy Licensing (Small Amang Plant) (Exemption) Order 1994 [7]; and

(b) Atomic Energy Licensing Atomic Energy Licensing Act, 1984, "Atomic Energy Licensing (Ceramic Factory) Order, 1998"[8], which give the exemption to any ceramic manufacturing factory which uses zirconium silicate that contains radioactive material as whitening or glazing material in small amount in the manufacturing process. Every ceramic factory is exempt from the Atomic Energy Licensing Atomic Energy Licensing Act, 1984 subject that the activity concentration of the radioactive materials contained in zirconium silicate does not exceed the level as stated in Table 2.

Table 2 Exemption Level – Activity Concentration of Radioactive Material in Zirconium Silicate

Nuclide	Activity Concentration (Bq/g)
^{214}Bi	10
^{226}Ra	10
^{228}Ra	10
^{228}Th	1
^{232}Th	1
^{238}U	10

On the other hand, with regards to the clearance levels, AELB had imposed several requirements to the industries to be fulfilled such as imposing this clearance levels to one of the mineral processing company (which extract rare earth from the monazite and left thousand of cubic meters of radioactive waste of thorium waste) called Asian Rare Earth Private Limited, which in the process of decommissioning and decontamination their plant.

Only the contaminated equipment and building materials that did not exceed the levels of 0.5 μSv/hr for fixed contamination and 0.04 Bq/cm^2 for non-fixed contamination will be exempted from the regulatory control before these equipments and materials can be disposed to the approved disposal site.

Furthermore, the acceptable radioactivity levels (clean-up criteria) for soil and pavement shall be disposed to the site is:

(a) From ground surface to a depth of 1 m.:
0.33 Bq/g for ^{238}U (not including background)
1.00 Bq/g for ^{232}Th (not including background)
$<1.00 = (^{238}U/0.33) + (^{232}Th/1.00)$

(b) From a depth of 1 m. to bedrock:
0.9 Bq/g for U-238 (not including background)
1.00 Bq/g for Th-232 (not including background)
<1.00 = (U-238/0.33) + (Th-232/1.00)

(c) Combined Th-232 and U-238:
<1.00 = (U-238/0.33) + (Th-232/1.00)

Apart from that, the clearance limit for the discharge of the effluent from the plant for the mineral processing industry is based on the Ra-226 that is 1 Bq/l.

Every plant that operate and deal with the NORM/TENORM activities shall ensure that the discharge limit of 1 Bq/l for Ra-226 not to be exceeded before discharge any effluent to the environment. But in the case of more than one industries related to this NORM/TENORM activity are operated in the same industrial park or are located just beside each other, the AELB has imposed the constraint for the discharge limit that shall be come into force at least 1/3 of the normal discharge limit (i.e. 0.33 Bq/l) before any effluent can be discharge to the environment.

6.6 Conclusions

The NORM/TENORM waste has been generated from these tin mining or oil exploration and extraction industries over the decades, which have and playing a critical role in spurring the economic growth of the country, are in operation, radioactive materials will inevitably be extracted from the ground as part and parcel of tin ore and crude oil extracted. By leaving bulk of quantities of TENORM's waste unattended around the country is very disturbing to the national conscience and in long-run, it will give a perception that a Government is irresponsible for not finding a lasting solution to this problems. What is even more regrettable is that this problem is largely yesterday's problem since most of the NORM/TENORM waste extracted from the ground and often left unattended around the country have been accumulate over decades of mining activities.

With regards to this problems, at this point, although the government of Malaysia did not provide any provision in the law for the exclusion of TENORM waste specifically, but the government did imposed the criteria for exclusion of this waste by adopting the guideline limit established by the IAEA Safety Series 26.

This is very vital to the authority to overcome the problems in managing some of the waste related to the TENORM industries. As least, we can avoid any doubt or ambiguous to exclude some of this waste from the regulatory control.

Furthermore, due to economic reason and the price of tin and its by-product is not viable and profitable so much so not significant in the business and trade industries, several practices have been exempted from the regulatory control under the Atomic Energy Licensing Act, 1984.

Apart from that, at present, one of our licensee that dealt with mineral processing industry has no longer operated and in the process of decommissioning and decontamination of their plant. They had decided to decommission and disposed their waste at the approved

disposal site. Some of the waste has started to be transported to the disposal site, which has been approved by the authority in conjunction with the Perak State Government.

Several clearance levels have been set up by the authority especially for the fixed and non-fixed contamination for equipment and building materials. Clean-up criteria of contaminated soil from the plant and the discharge limit for the liquid effluent from the plant to be released to the environment.

At present, Malaysia does not have any policy yet on the management of radioactive waste. We do hope and belief that in the near future, the government of Malaysia will come out with a national policy for managing the radioactive waste in TENORM industries as to protect the human health and the environment from the potential hazard and risk generated by these waste.

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