

8. Current Status on Decommissioning/Clearance in Malaysia

8.1 Decommissioning of a monazite processing plant

In Malaysia, one monazite cracking plant to extract rare earth elements operating since 1982. The factory situated in the northern part of Malaysia. The by-product or waste as a result of the operation was thorium and radium sludge, thorium contaminated equipments and the processing plant itself. The company has ceased its operation in January 1994 as a result of growing discontentment from the public.

The waste was temporarily stored at the Long Term Storage Facility (LTSF). About 84,822 drums (size of 200 L) of waste containing thorium hydroxide and contaminated material were stored in the LTSF. This company still licensed by the AELB to store the radioactive mineral waste. But in 2003, the company applied to decommission the plant. The plant decommissioning and decontamination (D&D) activities had been commenced in September 2003 and completed in October 2005.

An American-based company has been appointed to carry out the safety assessment, the design and construction of the repository.

This D&D project was divided into 2 phase::

- Phase 1 – rehabilitation of plant site and ‘Waste Water Treatment Site’ (WWTS) from the radioactive contamination to the original condition where all of the contaminated materials was disposed into disposal facility called ‘Engineered Cell 1’(EC 1).
- Phase 2 – transfer and dispose of the thorium hydroxide waste in the ‘Long Term Storage Facility’ (LTSF) into the disposal facility called ‘Engineered Cell 2’(EC 2).

The first phase of the D&D project was completed. The inventory of wastes disposed in the EC 1 are:

- Contaminated soil excavated – approximately 66,000 m³
- Contaminated Concrete & rubble – approximately 6,330 m³ and
- Contaminated material – approximately 2,000 m³

Meanwhile, the phase 2 of the D&D is now in the beginning process starting September 2007 and it is expected to be completed in 3 years time. Among the planned activities include:

- To decommission the LTSF stage by stage and installation of the ventilation system to reduce the radon and thoron gaseous release to the environment. It is expected the

concentration of radon about 200 -1000 X 10³ Bq/m³ and up to 30 X 10³ Bq/m³ for thoron from the previous study.

- To categorization the waste into thorium waste and contaminated material based on external radiation at the surface, 50uSv/hr will be used as a limit to separate the waste. The waste is categorized as thorium waste if the external radiation level exceed the limit of 50uSv/hr and the waste with level of external radiation below is categorized as contaminated material.
- The inventory of wastes to be disposed in the EC 2 are approximately:
 - Thorium waste – 16,200 m³
 - Contaminated material – 9,900 m³
 - Rubble & others - 20,200 m³
- Thorium waste will be stabilized by mixing with 15% cement and 5% of additive (calsium sulphate).
- Built-in concrete box will be used to contain the stabilized thorium waste in the EC 2. Whereas the contaminated material will be dispose of direct into the EC 2.
- There will be only one final cap to cover both EC 1 and EC 2.

8.2 Clearance

The Atomic Energy Licensing Act 1984 (Act 304) was gazetted on the 24th June 1984 and enforced on the 1st February 1985. This Act provides for 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.

Under the Act 304, the management or disposal of radioactive waste is specifically dealt with under Sections 26-31 of the Atomic Energy Licensing Act 1984. These sections empower the Atomic Energy Licensing Board (AELB) to ensure users (licensees) to obtain appropriate license prior to dealing (accumulate, transport or dispose) with radioactive waste and to take appropriate actions to rectify situation which deemed unsafe.

Since this Act came into force, the Government of Malaysia with the recommendation of the AELB has gazetted several regulations and orders which exempt certain activities as follows:-

a) Atomic Energy Licensing (Exemption)(Small Amang Factory) 1994

"small amang factory" means any factory processing amang which may cause exposure of ionizing radiation to the whole body of a worker not exceeding 50 milisieverts (mSv) per annum.

b) Atomic Energy Licensing (Exemption)(Lighting Arrester) order 1990

"lightning arrester" means an instrument which contains radioactive material and is fixed on a structure to avoid the structure from being struck by lightning.

c) Atomic Energy Licensing (Smoke Detector) Orders 1990

Every person who has in his possession any smoke detector containing radioactive material *is exempted* from the provisions of the Atomic Energy Licensing Act 1984 on condition that-

- the smoke detector is or is intended for his own use;
- the smoke detector is purchased from a seller who is licensed by the Atomic Energy Licensing Board; and
- when it needs to be disposed of, the smoke detector is returned to the manufacturer or seller, or delivered to a radioactive waste disposal agency recognized by the Atomic Energy Licensing Board.

d) Atomic Energy Licensing (Exemption)(Low Activity Radioactive Material Order) 2002

"low activity radioactive material" means check source, calibration source and reference source that will not cause radiological risk to a person either by external exposure or internal exposure or both

Since Malaysia does not have any specific regulation on disposal and management of radioactive waste, AELB enforces the waste management policy through its licensing procedure and conditions of license issued to the licensee.

A regulation for Radiation Protection (Radioactive Waste Management) has been drafted and is being reviewed by the Sub-Standing Safety Committee. It will apply to all aspects of radioactive waste management, including collection, segregation, characterization, classification, treatment, conditioning, storage and disposal where the waste arises from medical, industrial and research applications.

The international documentations also available for the company to refer in a case of there are no regulations provided by the AELB. Such documents related to the D&D activities among others are:

- ICRP Publications No.81 (ICRP 81)
- IAEA Safety Series No.111-F (IAEA, 1995)
- IAEA TECDOC- 1270

8.3 NORM and TENORM

Major NORM residues in Malaysia are sludge and scales from the oil and gas production industry, thorium hydroxide from monazite and xenotime processing to extract rare earth elements, tin slag from tin smelting plant, iron oxide from ilmenite processing for synthetic rutile production through chloride process, red gypsum from ilmenite processing for titanium dioxide (TiO₂) pigment through sulphates process, polishing sludge from glass panel manufacturing industry and residues from decontamination and decommissioning (D&D) process of rare earth production plant. As for the residues, the acronym TENORM for Technologically Enhanced Naturally Occurring Radioactive Material is frequently used in Malaysia.

8.4 Sludge and Scales

At the oil and gas production facilities, sludge accumulates in the processing vessels whereas scales are deposited on the interior surface of the production components when there is a temperature or pressure drop. With the introduction of scale inhibitors, less scale is accumulated. The volume of sludge generated is substantial. Treatment of sludge generates secondary residues such as matured sludge from sludge farming, chemical extraction residues and incineration ash. The radium concentration of the various types of treated and untreated oil and gas industry residues from Malaysia have been reported (Omar et.al, 2004). The highest mean Ra-226 and Ra-226 concentrations of 114 and 130 Bq/g, respectively, were measured in scales. However, the volume of the scales generated is small as compared to the sludge. Overall, about 75 % of the waste, mostly untreated sludge and residues from chemical extraction of sludge is having radioactivity level similar to the normal soils of Malaysia.

8.5 Licensing & Enforcement

The Radiation Protection (Basic Safety Standard) Regulations, (1988) and Radiation Protection (Licensing) Regulations (1986) cover all aspects of 'dealing' with radioactive and radiation sources including NORM. Dealing means any activity involving manufacturing, trading, producing, processing, purchasing, owning, using, transporting, transferring,

handling, selling, storing, importing or exporting radioactive material. Dealing with NORM requires a license, either license Class A (milling of radioactive materials) or Class D (transport of radioactive materials) or Class E (Export or import of radioactive materials) or Class G (disposal, storage, and decommissioning of milling installation, waste treatment facility) or Class H (miscellaneous, e.g. services for decontamination and decommissioning work, treatment of sludge and scales, etc). Together with the license, AELB usually issues license conditions to be fulfilled by the licensees.

Generally, everything is considered radioactive until it has been exempted by the authority. At the moment, there is no common NORM concentration level to define what is radioactive. At the operational level, however, a limit of 0.05 % uranium plus thorium (adopted from IAEA, 1983) in minerals and ores is used by AELB for handling such materials. As for the management of sludge and scales from the oil and gas industry, AELB is in the process of drafting the Code of Practices (CoP). It is common to adopt a control limit based on the Total Activity Concentration (TAC) of Ra-226 and Ra-228 based on the following formula:

$$\text{TAC} = (6 \times \text{Ra-226}) + (8 \times \text{Ra-228}) \text{ where Ra-226 and Ra-228 are the activities in Bq/g.}$$

In principal, if the residues exceed the control limit, it will be controlled by the regulatory agency as TENORM wastes. The wastes will be exempted from the control and can be handled as ordinary hazardous waste if the TAC is below the control limit.

Instead of source radioactivity level, a general approach adopted by AELB is the use of the annual limit of 1 mSv/y additional dose to the members of the public as the control limit. This means that any activities related to NORM handling such as treatment, reuse and disposal exceeding this control limit will be licensed.

The current practice prior to the approval of a landfill disposal activity is that the licensee should submit a Radiological Impact Assessment (RIA) to the AELB. It is common to undertake the task using a computer code, RESRAD, developed by the Argonne National Laboratory US. The RIA should as much as possible use site specific parameter and demonstrate that the dose to the members of the public do not exceed the limit stipulated in the Act or Regulations. In practice, AELB is using a constraint limit of 0.3 mSv/y. In some cases, radiological monitorings maybe required to be carried out after the disposal.

Some NORM activities or sludge have exempted from the regulatory control after studies have been made by AELB. The examples of such exemption are the use of zircon for ceramic tile manufacturing (AELA, 1998) and copper slag, mostly for blasting.

Small amang (tin mine tailings) factory (annual dose to a worker < 50 mSv/y) is exempted from the provision of the Atomic Energy Licensing Act 1984 on condition that the factory is registered with the AELB and the factory follows the guidelines issued by the AELB. In conjunction with this, two guidelines have been released for the Small Amang Factory i.e. Guideline for the Safe Transportation of Radioactive Minerals In the Amang Upgrading Industry (1994) and Guideline for Radiation Protection Guide for Small Amang Factory (1994). But, there is yet specific guideline for minerals residues handlings.

With regard to the oil and gas industry residues that contains hazardous and radioactive materials, it is categorized as scheduled waste by the Department of Environment (DoE) and as radioactive waste by the Atomic Energy Licensing Board. In fact, as a precautionary measure, AELB has classified the oil and gas industry residues as TENORM waste. The coordinated approach has been agreed whereby the AELB has to declassify the waste from radioactive category before it can be treated at the Hazardous Waste Treatment and Disposal Center approved by the DoE.

8.6 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" , 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”.

Due to the economic reasons and the price of tin and its 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; and
- b) Atomic Energy Licensing Atomic Energy Licensing Act, 1984, “Atomic Energy Licensing (Ceramic Factory) Order, 1998”, 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.

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 per hour 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 meter:
 - 0.33 Bq/g for U-238 (not including background)
 - Bq/g for Th-232 (not including background)

$$<1.00 = (U-238/0.33) + (Th-232/1.00)$$

b) From a depth of 1 meter to bedrock:

0.9 Bq/g for U-238 (not including background)

1.00Bq/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.