Annex 3

Session Summary of
FNCA 2020 Workshop on
Radiation Safety and Radioactive Waste Management Project

Session 3 : Country Report

1) Australia (Mr. Duncan Kemp, Australian Nuclear Science and Technology Organisation (ANSTO))

Australia is a very large and very resource rich country. There are mineral deposits of every type and these are exploited to supply domestic and international demands for the minerals. The mining industry is 11% of Australia's revenue, (about 50% of international trade) and the industry is valued at $220,000,000,000 per annum.

With all this mining, milling and refining in Australia comes the associated challenge of managing the naturally occurring radioactive material (NORM) that is found in the ore. Only material which is modified by humans is regulated within Australia, and these are regulated by the local authorities (9 radiation protection regulators, plus other specialised regulators such Oil and Gas regulator, Environmental Protection Agencies).

In the mining and refining process the material is well controlled, however when the NORM is separated from the product special controls need to be put in place. NORMs are managed by setting an exemption criteria, typically around 1 Bq/g, with material above that monitored by regulators.

There are reuse and recycling options of NORMs which include:

- soil conditioning additive in agriculture, with particular reference to phosphate binding;
- substitute for clay, or as a clay additive, in the manufacture of construction materials such as bricks and tiles;
- road base construction material;
- substitute for natural gypsum in the manufacture of plaster wall board;
- filler in the production of rubbers and PVC.

The disposal options for NORMs include:

- into the ocean in the case of offshore facilities at a dilute level
- Landfill for slags and other processing wastes
- Placed back into the mine when the extraction has completed
- Capping tailings dams

2) Bangladesh (Dr. M. Moinul Islam, Bangladesh Atomic Energy Commission (BAEC))

A brief description of regulatory frame work, radioactive waste arising and short inventory of DSRS are shown in the presentation. Radioactive material containing no significant amount of radionuclides other than naturally occurring radionuclides NORM wastes can arise from any industrial process that handles

natural materials. The possible sources of NORM include Oil and gas production, Geothermal energy production, Coal fired power plants, Drinking water treatment, Fertilizer plant etc. The analysis of oil sludges has been mentioned in the presentation. According to existing policy NORM shall not be addressed as Radioactive Waste if otherwise not specified by the Bangladesh Atomic Energy Regulatory Authority/Government. Exemption level of NORM radionuclides described in the Nuclear Safety and Radiation Control Rules 1997 (Schedule-II). On site deposition is the end point of the NORM management system in the country.

3) China (Mr. Hongxiang An, China Institute for Radiation Protection(CIRP))

Radiation environment issues from NORM have attracted the attention of the stakeholders in China. Chinese government has gradually strengthened the supervision of the radiation environment in this field. According to the requirements of related laws and regulations, it is required that regulatory objects on NORM should be Identified, enterprises list of NORM should be established, radiation environmental impact assessment should be conducted, radioactive pollution prevention and control facilities should be operation simultaneously, and etc. Second National Pollution Source Survey was conducted from 2017 to 2019, and NORM survey is one of the components of this survey. More than 30,000 enterprises have been investigated. More than 2,000 enterprises have been identified to survey. For the identifying survey, analysis of nearly 5000 solid samples and more than 400 water sample. There are more than 500 enterprises whose solid samples with a concentration of nuclide activity are above 1Bq/g. All the identifying survey has completed. There are more than 500 enterprises in the solid samples with 238U, 232Th and 226Ra single-nuclides radioactivity concentrations exceeding 1Bq/g. There are some current issues on the national level in China including storage and disposal facilities of industrial solid wastes, hazardous wastes and radioactive wastes in China have explicitly excluded NORM wastes, distribution of NORM wastes in China is relatively scattered, and the quantity is far more than that of radioactive wastes produced by nuclear industries, which is not suitable for long-distance transportation, management problems are more complicated, due to the half-life of natural radioactivity which is particularly long. China should implement NORM management based on graded approach.

4) Indonesia (Dr. Dadong Iskandar, National Nuclear Energy Agency of Indonesia (BATAN))

All minerals and raw materials contain radionuclides of natural origin (decay series of U-238 and Th-232, and K-40). Material giving rise to significantly enhanced exposures has known as naturally occurring radioactive material (NORM). In Indonesia there are two terms of NORM i.e. NORM and TENORM. NORM comes from nature itself without the involvement of technology and TENORM (Technologically Enhanced Naturally Occurring Radioactive Materials) comes from industrial activities. There are some industrial activities that generate TENORM, such as mining of ores other than uranium ore, production of oil and gas, zircon and zirconia industry, phosphate industry, and combustion of coal. The TENORM producer should perform a radiation safety analysis of TENORM including at least: types and processes of activities carried out, TENORM quantity, types and concentration levels of radionuclides, and highest radiation exposure and/or contamination on the TENORM surface. The radiation safety analysis should be

assessed by Regulatory Body (BAPETEN). If the assessment shows the intervention level is being exceeded, the TENORM producer should implements the interventional measures. Interventional level in Indonesia could be expressed in terms of: the amount or quantity of TENORM is at least 2 tons, and contamination level equal to or more than 1 Bq/cm2; and /or activity concentration of 1 Bq/gr for each radionuclide in the uranium and thorium series; or 10 Bq/gr for potassium. Some TENORM characterizations and radiological assessments have been done in some oil and gas production, coal power plants in Java island, Tin industry at Bangka Belitung province, and other industries. Several interventions have been carried out based on the characterizations and radiological assessments, including remediation (clean up) of the contaminated sites, established interim storage at the location; put NORM in field storage with radiation signs, and transferred NORM waste to the center for radioactive waste technology – BATAN. In term of NORM, BATAN has conducted radiation and radioactivity surveys at some locations in Indonesia and found at least 3 areas with high natural radiation, i.e. Mamuju Regency (West Sulawesi province), Biak Island (Papua province), and Tual Island (Maluku Province).

5) Japan (Mr. Tatsuo Saito, Japan Atomic Energy Agency (JAEA))

As this country report of Japan, I will introduce here 2 topics:

1. Disposal Concept of Radioactive Waste in Japan and JAEA's mission
2. Introduction of the outline of guideline for measures in handling NORM in Japan

In summary, I will report as follows;

- JAEA's mission is promoting the disposal project of LLW generated from the nuclear energy research / medical and industrial use of radioisotopes in Japan.
- Japan has two guidelines for NORM. The first is for NORM categorization with its containing minerals or generic streams, into 8 groups to lead to each guideline dose (1 mSv/y or 10 uSv/y) for action/exemption.
- The second guideline is for ensuring safety of NORM with preparing measures by screening with flow chart of guideline radioactivity (1 or 10 Bq/g) to the targeted manufactures and consumer goods for exposure reduction.

6) Kazakhstan (Mr. Yevgeniy Tur, National Nuclear Center (NNC) of the Republic of Kazakhstan)

A large amount of NORM/TENORM radioactive waste has been accumulated in Kazakhstan and there is a tendency to an increase in its volume, which requires ensuring safe management of its, including disposal. NORM/TENORM materials are represented by wastes of uranium mining, oil and gas production, metallurgical industries in the form of dumps, tailings, contaminated soils, pipes, equipment, and so on.

A special state program was realized for restoration of the contaminated territories of former uranium mines and open pits. There are also a large number of operating facilities for the management of waste from the uranium mining and uranium processing industry.

A number of deposits of polymetals, rare earths, and phosphorites in Kazakhstan contain uranium mineralization, which is extracted together with the main one during ore mining. Part of the radioactive mineralization goes to dumps and tailings, part remains in the main product.

At the coal deposits, permanent radiation monitoring are carried out both during the mining and during the shipment of coal. To improve the ecological situation in the oil-producing regions of the country and return pipes and oil and gas equipment to the production cycle, a project to create a chemical-technological mobile complex is being successfully implemented.

Most important aspects of the problem of NORM/TENORM management are:

- shortcoming of the radioactive waste management system;
- incompleteness of the process of implementation of organizational measures for radioactive waste management;
- absence of any effective funding mechanism that would satisfy with internationally recognized principles for the safe management of radioactive waste.

7) Malaysia (Dr. Norasalwa Binti Zakaria, Malaysian Nuclear Agency)

Presence of NORM in Malaysia dates back from a long history when Malaysia was a tin-mining country. The tin-mining activity produced tin tailings, monazite, ilmenite and xenotime, which contains NORM. Later, the discovery of oil and gas further introduced more NORM waste in the national inventory. Ultimately, these wastes need to be permanently disposed of. Malaysia embraces the graded approach when planning for a disposal facility. A low level radioactive waste repository was constructed to dispose thorium waste. This repository accommodates 196,700 tons of thorium waste where 6% of this waste contains 670 Bq/g Th-232, 3% contains 119 Bq/g Th-232 and the majority 62% contains 7.4 Bq/g U-238. A permanent disposal facility equivalent to landfill disposal is also planned to be constructed to dispose very low level NORM waste containing 6 Bq/g thorium.

8) Mongolia (Mr. Oyunbolor Galnemekh, Radiation protection society NGO)

The huge volume of naturally occurring radioactive materials (NORM) wastes produced annually by NORM related industries in Mongolia and it deserves to come to the attention of national environmental protection agencies and regulatory bodies. NORM wastes constitute, by and large, unwanted byproducts of industrial activities as diverse as coal, copper, zinc, lead and rare earth mines, oil and gas wells. In many of these branches of industry, the problem of naturally occurring radioactive materials is present. The main source of risk for workers and public is the short-lived radon daughter products present in air. This source of risk is present in Mongolia, due to its geological condition. Most of the territory of the country is presented by granite with enhanced concentration of uranium. These granites are the main source of the uranium in radioactive mineral deposits and NORM in other non-uranium mining sites and lakes.

Currently, the NORM regulation is on final stage of approving by the Government of Mongolia. Most concepts (graded approach, exemption, notification, authorisation etc.) are already included in the Mongolian regulatory framework. As of March 2020, there are 69 coal mines, 23 mines of other mineral resources, 4 rare earth mining, 2 oil exploiting company has a valid exploitation licenses and 13 TPPs, 144 building material factories under the sampling program for control of NORM by the regulatory body. NORM generating industries have not been identified in the country completely.

Radon issue is not yet explicitly mentioned in the Mongolian regulatory framework apart from some

articles in different documents. Radon Action Plan is not approved and Radon Survey was not carried out in Mongolia. Regulatory limits for workplaces, mining sites. Indoors (1110 Bq/m³ for workplaces, 200 and 100 Bq/m³ for existing and new buildings, respectively) specified in national BSS(2015). General agency for specialized inspection /GASI/ and and its branch Metropolitan inspection agency /MIA/ started to carry out some Rn measurement campaigns in public buildings such as schools, kindergartens in Ulaanbaatar during last several years.

Lack of laboratory capacity, human resources and absence of National radon action plan are the main challenges for NORM regulation in Mongolia. However, a limited number of instruments from various manufacturers is currently in use, but unable to ensure the required Quality Control of radon measurements in the country. The large distances need to be travelled to carry out a nation-wide radon survey in Mongolia is also challenging task. Therefore, international cooperation (e.g. with the bilateral or the regional) is important for strengtheining of regulatory control of NORM residues and also establishment of nation wide radon survey in Mongolia.

9) The Philippines (Ms. Kristine Marie Dacallo Romallosa, Philippine Nuclear Research Institute (PNRI))

The Philippines is a mineral-rich country and many other natural resources. Sources of naturally occurring radioactive materials are from its a) coal mining and power industry, b) mineral mining, c) oil and gas exploration, d) radon and e) the fertilizer industry particularly phosphate. The overview of these sources are discussed in this report.

However, there is no existing policy and legislation on the management of NORM in the Philippines. There are also no regulations yet on its proper storage and disposal. Although there are some regulations with regards to radioactive waste management which covers the requirements for the disposal of wastes arising from NORM processing, these industries are currently not regulated.

Majority of the ongoing activities for NORM in the country is research and development. Spearheaded by PNRI, research is focused on the a) radiological assessment of NORMs in the Philippine terrestrial environment and b) determination of radon levels in dwelling places in the Philippines and its possible implications to human health. The goals of these studies are for policy recommendations on NORM management. The studies also aim to generate a database of activity concentrations of natural radionuclides (226Ra, 232Th/228Ra and 40K) in industries. This will also be discussed in the report.

Lastly, the report will also present the updates on the radioactive waste management in the Philippines. Most of the activities have been delayed due to the COVID-19 pandemic, however, there are some progress which will be discussed.

10) Thailand (Dr. Klitsadee Yubonmhat, Thailand Institute of Nuclear Technology (TINT))

In Thailand, NORM and technologically enhanced NORM (TENORM) have been being mostly generated by groups of industries. By the last study in 2005, the production capacity of nine industrial sectors concerning the TENORM waste creation was reported (i.e. oil and gas exploration and production, tantalum and niobium extraction, tin production, rare earth processing, cement production, steel refinery,

water treatment, coal and coal power production as well as chemical fertilizer.). Nowadays, more detailed information in regarding to where the existing TENORM sites are, what kind of NORM waste is and what exact waste amount in each industry is generated, remains scarce. Thailand by Office of Atoms for Peace (OAP), the regulatory body, recently established the Ministerial Regulation: Radiation safety B.E. 2561 (2018) to control the radiation dose for both worker and the public. The safety criteria for NORM waste has been also set up and notified in the Announcement of the Nuclear Energy for Peace Commission: Safety criteria B.E. 2562 (2019). However, there is no any specific regulations to guide or enforce the industrial facilities generating NORM and TENORM. This is the country crucial problem that the regulatory body have to get involved and resolve to attain the required information on this waste type, and this could be the efficient way to protect the public and the environment.

11) Vietnam (Prof. Le Thi Mai Huong, Institute for Technology of Radioactive & Rare Elements (Vietnam Atomic Energy Institute))

Radioactive waste in Vietnam is generated by research, industry, medical applications, research reactor operation and radiopharmaceutical production. Naturally occurring radionuclides (NORM) and technologically enhanced naturally occurring radioactive materials (TENORM) are produced in Vietnam by the mining, mineral sands processing and other resources sectors. Monitor the radioactive elements of these wastes, and their burial and management still proceed like those of ordinary production wastes (may take into account the dangers of chemicals...) but not much attention about radioactivity.

The current situation at mining and processing facilities containing radioactive elements in Vietnam. Specifically, the issue of managing tailings wastes in uranium processing experiments, in mining and processing beach sand minerals, in exploiting and processing rare earth ores and in ZOC production. For the waste produced from the mining industry, oil refining and processing of phosphates, produce acid phosphoric, processing bauxite: The waste generator and state management agencies have not yet inspected them. Monitor the radioactive elements of these wastes, and their burial and management still proceed like those of ordinary production wastes (may take into account the dangers of chemicals...)

In 2020, The Ministry of Science and Technology of Vietnam has drafted a new regulation on NORM waste management and is preparing to issue it.

This presentation includes the following main contents: The Radioactive waste Management Policy; Legislation Framework; Current management of NORM in Vietnam and Orientation, Challenges, Plans and Proposals in Radioactive Waste Management in Vietnam.

Session 5：Topical presentation on NORM/TENORM

1) Issues and Challenges in NORM management (Dr. Norasalwa Binti Zakaria, Malaysia)

NORM is present everywhere in the environment primarily from activities in the oil and gas industry, ore processing, and mineral extraction. Developments are taking place in many countries with regards to sustainably managing NORM waste, however, according to IAEA, there is yet issues and challenges particularly in establishing national inventories and defining strategies to manage NORM wastes and residues. A recent IAEA International Conference on NORM in Industry highlighted these challenges.

Minimizing the volume of NORM wastes in general could be achieved by following the circular economy approach. In order for this model to be a success, concerted effort between the regulator, industry player and public community at large is needed. On the aspect of NORM disposal, graded approach helps determining the best disposal option for NORM waste by selecting a disposal method suiting the radioactivity level and associated risk of the waste. Another main challenge in NORM management is sampling and characterization. One identified problem in this area is the lack of consensus with regards to sampling and analysis protocols.

2) NORM Management Challenges in Australia (Mr. Duncan Kemp, Australia)

Naturally Occurring Radioactive Materials (NORM) are a part of many industries in Australia, principally in the extractive industries. The management of these industries comes under many regulators. As an example, because they are extractive industries they will have the relevant regulator (mining regulator, oil exploration regulator, industrial regulator) as well as the environmental regulator, safety regulator and the radiation protection regulator. All of these regulators have to interact and work together to minimise the regulatory burden on the organisation. The regulators need to work together to make sure that they are being consistent in approach and not asking for the same information.

When in operation one of the main challenges is dose to workers. The dose is often not assessed comprehensively as not all pathways are always included in the assessment. The external dose and radon are always assessed, however the surface water and dust may not be assessed for radiation impacts on workers. All workers are monitored for dose, however the national dose register is based on company records, so if a worker moves from one company to another, they will be given a different number to be recorded in the national dose register. This may lead to people being exposed to more than is acceptable within a year at multiple sites.

All of Australia belongs to somebody, with Traditional Owners being important stakeholders. This makes negotiating a mine site, disposal facility, or extraction point involve the land title holder, government bodies (including regulators) and also the Traditional Owners. There may be more than one Traditional Owner covering the site.

Completing works is also a challenge, with the Rum Jungle uranium mine rehabilitation being an example. The mine was closed in 1971, but required multiple attempts to remediate the site. The issues are around copper leaching into local waterways, and the failure of the tailings facility built in the 1980s. The main cause was using average water flows and not monsoonal water flows in the design calculations. This flooded the site regularly washing leached heavy metals into the river.

The disposal options for NORM wastes in the Oil and Gas; Alumina; and Phosphate industries are discussed, including all the recycling and reuse options.

The long term safety case for the disposal needs to cover the dose pathways which may come from the external field dose rate; dust suspension and inhalation; radon inhalation; surface water (including oceans) and ground waters. Different options will have different considerations and different dose profiles.

Session 8 and 9 : Summary of Group Discussion on NORM/TENORM and review of LLRWR Consolidated Report

Group A ((Japan/ Mongolia/Philippines)

General discussions:

The following possible items regarding NORM to be compared among the FNCA countries were identified and categorized.

1. Characteristics
   - Survey and analysis of geological data related to NORM (incl. radon-prone rocks close to, or at the surface) and resources
   - Major construction and building materials
   - Major natural sources and radioactive concentration
   - Identification of NORM workplaces and radon prone area

2. Current operations for NORM sources

2.1 Mining/minerals/gas and oil
   - Regulation and/or guideline
   - Measurement and assessment
   - Clean-up/disposal (and/or reused/recycle)

2.2 Radon
   - Regulation and/or guideline
   - Measurement and assessment
   - Measures for reducing radon exposure

3. Experiences of risk communications (if any)
   - Public understandings for reused/recycle
   - Public information about the combined risk due to causes other than radiation, chemical toxicity, etc.

Specific discussions:

- Measurement in “Bq/g” is still effective in practical operations, while assessment in “mSv/y” would be too complicated and additional on-site trainings and calculations will be required. Nevertheless, information related to radiation dose would be essential both for safe assessments in planning any enterprises handling NORM and for risk communications for public understandings.
- There could be several differences in the reference data of working conditions among Asian and other countries. As being a key factor for dose assessments, information on these differences could be added as an item to be shared for understanding the situation of worker doses in each country.
- Public information regarding consumer products containing NORM and disposal method seems to be not implemented well and this should be done by the relevant business operators.

Group B (Australia/China/Thailand/Vietnam)

Characterisation:

Who should do it?

There was a mix of responses with some indicating that it should be the regulator and others saying private industry. All agreed that it was very important.

How much material needs to be characterised?

We had a discussion about the extent of the characterisation, which it be all the country; only the known areas; all construction material; or only known industries?

For those countries with limited resources the focus should be on the industries which are known to produce waste. Gain understanding of what can produce radioactive waste from the FNCA and other international forums.

Clean up of legacy sites? This happens in Australia, not elsewhere. At the moment.

Regulatory Aspects:

Is it suitable to use radiation protection measures for artificial for NORM?

The difference is the volume of material which needs to be addressed, amount of radiation found in most areas. It should be separated.

Should there be a graded approach?

Yes, Based on the annual dose that people get, max of 1 mSv/y.

Disposal sites:

No-one is responsible for NORM sites or NORM in general, so we don't know how to answer this question specifically.

The consensus was it should be in landfill, with a long term dose assessment describing how people can get exposed, dose rate based to someone living on the site (Environmental Safety Case and assessment).

Stakeholders:

Need to sell how NORM can be recycled, and what can be made from them, emphasising the circular economy. Need to be very clear about the hazard and the risks. Radioactivity and natural sources are difficult to communicate to the general public as the level of fear is high. Industry is easier to communicate with as you can provide something that they want and trade. Much more risk focussed.

Group C (Kazakhstan/Malaysia/Bangladesh/Indonesia)

Characterization:

Indonesia: At first, we need to identify all industry that produce NORM and to implement selected sampling ONLY because it is expensive to do for all, plus distributed locations in Indonesia the characterization is needed to help perform decontamination, transport, packaging, storage and finally disposal. Indonesia will also consider valorization of NORM.

Bangladesh - need to identify sources of NORM in Bangladesh, also radionuclides and activity

Regulatory Aspects:

Indonesia agree to revise the regulation. 1 Bq/g is too low. Implement graded approach in the regulation (amendment is needed).

Bangladesh also think 1 Bq/g is too low. Current Bangladesh exempt level for U-238, Ra-226 is 10 Bq/g.

Kazakhstan need special regulations and guidelines to manage NORM/TENORM

Disposal site:

Bangladesh there is no special disposal site for NORM/TENORM. Waste is disposed on the site of mining/milling Indonesia - disposal is based on economical factor and site condition.

Indonesia proposes surface mine, landfill disposal. Regional centralize disposal site is on the bigger Island in Indonesia but will not be possible at the smaller islands.

The current practice in Kazakhstan is long term storage for NORM/TENORM.

There is no disposal facility yet for NORM.