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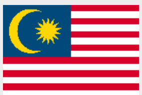
Topics from Participating Countries

*in no particular order



Malaysia

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Public Participation Programme for Borehole Disposal Project: The Malaysia Context

Introduction

Public confidence is essential in the management of radioactive waste. Therefore, in order to build public confidence in the development of borehole disposal facility, there is a need to have a comprehensive programme on public information and involvement. This comprehensive programme should include objectives, target groups, available sources, media information that can be used in the execution of the project, consultation with public on various issues, notably site selection, which involves environmental impact studies as well as the safety case for the borehole disposal facility. Figure 1 shows basic principles for successful application of public information and involvement techniques.

Figure 1: Basic principles for successful application of public involvement techniques

Malaysian Programmes on Public Participation in the Borehole Disposal Facility Project

Malaysia is studying the possibility for disposing of disused sealed radioactive sources into borehole. Borehole disposal concept has been introduced by the International Atomic Energy Agency for country who has small nuclear programme. In order to ensure the borehole disposal project successful, public involvement is essential. Therefore, Malaysia has introduced several programmes on public participation on borehole disposal project.

Exhibition Gallery

At Nuklear Malaysia, there is an exhibition gallery which consists of several panels explaining borehole disposal project, management of low, intermediate and high level waste, and also example of available radioactive waste disposal technology from other countries. There are also dummies of un-treated and compacted radioactive waste in barrels and a replica of the borehole disposal facility. This approach has proved to be very effective, since it is not only informative to the members of local community, but it also could attract delegations of different kinds of public such as students, international visitor etc.

Figure 2: Visitors at Exhibition Gallery

Leaflets

Leaflets are designed in the appealing style and will provide the reader with updated information for later reference. Information in the leaflets such as radioactive and radiation, radioactive waste management, borehole disposal project needs to be addressed properly. Different target groups need to have different leaflets. For the scientific community it is necessary to use technical language and provides scientific and technical details, while this should be avoided in leaflets which intended for members of general public. Also the terminology has to be different, as well as the way of writing and the use of illustrations. When publications are produced it is equally important to have them distributed to the right people.

Visit to the Interim Long-Term Storage Facility and Borehole Disposal Project

A pre-treatment storage facility and an interim long-term storage facility are available at Nuklear Malaysia. The construction of the interim long-term storage facility was completed in August 2000. The facility was designed to cater for 400 drums of 200-liter waste package after treatment and immobilization. Lecture, visit to exhibition gallery, visit to storage facility and borehole disposal project are typically merged during a single visit of visitors/students etc. to Nuklear Malaysia. Some of these activities are shown in Table 2.

Table 2: List of the Visiting Programme to Storage Facility and Bore disposal Project

Activities	Date
Visit by International Participant from IAEA/ANSN Regional Workshop On The Development And Implementation Of A Radioactive Waste Management Programme	31 May 2016
Visit by DDG IAEA Mr Dazhu Yang	23 May 2016
IAEA'S Scientific Visitors: Mr. Ismail Ibrahim Hroub	23 May 2016
Institute of Research Management (IRMI), Universiti Teknologi Mara (UiTM	27 April 2016
Ministry of Energy, Green Technology and Water (KeTTHA)	13 April 2016
Asia Metropolitan University	04 March 2015
National University of Singapore	11 March 2015
Cyber University College of Medical Sciences, Cyberjaya	16 – 23 April 2015
University Tun Hussein Onn Malaysia	27April 2015
Visit by University Technology Malaysia (UTM) practical student	15 June 2015
Visit by International Participant from IAEA Technical Meeting on Implementing The Borehole Disposal of Disused Sealed Radioactive Sources	November 2014
Visit by Honourable Dato' Mah Siew Keong, Minister, Prime Minister's Department	12 December 2014
Visit by Mr. Gashaw Gebeyehu Wolde, PMO IAEA	27 August 2014

Figure 3: Visit to the Storage Facility and Borehole Disposal project

Media Relations

In public information programs, the role of journalists is important. With the proper information provided for the subject/topic, it will attract the interest of the journalist. Activities such as press conferences, press releases, media discussions, special tours to places chosen by a group of journalists, are among the proposed activities of the special media information. Table 3 shows the impact of media publicity to Nuclear Malaysia in promoting nuclear technology in Malaysia. In future, the BDF project will be promoted through these methods so that information can be disseminated to the public more effectively.

Seminar/ Conference/ Workshop in Relation To Borehole Disposal Project

Seminar, conference, workshop and forum are some of the ways to make people understand about borehole disposal project and to ensure the people who involve with this project are competent. This is very important because in will create awareness and can increase confidence level. Therefore, Nuklear Malaysia has organized several seminar/conference/workshops related to borehole disposal project as shown in Table 3.

Table 3: Seminar/ Conference/ Workshop/ related to borehole disposal project (No. 1)

Activities	Date	Place
Public Forum and Showcase on Borehole Disposal	12 Feb 2016	Nuklear Malaysia
IAEA Fact Finding Mission on Licensing of Borehole Disposal Project in Malaysia	18 - 19 Feb 2016	Nuklear Malaysia
Forum on Borehole Disposal	12 April 2016	Nuklear Malaysia
Technology Preview & Showcase Nuklear Malaysia	26-29 Oct 2015	Nuklear Malaysia
Regional Training Course Malaysia on Cradle to Grave Management of Radioactive Sources 1	8 - 22 Feb 2013	Nuklear Malaysia
Workshop on Borehole Disposal for Disused Sealed Sources	23 – 24 April 2014	Nuklear Malaysia
Safety Assessment of Long Term Performance of Repository and Borehole Disposal Facilities (AMBER)	16 -20 June 2014	Nuklear Malaysia
Scientific Visit on Identifying Suitable Disposal Sites for Low Level Waste (LLW) and Disused Sealed Radioactive Sources (DSRS)	8 – 12 July 2014	Manila

Table 3: Seminar/ Conference/ Workshop/ related to borehole disposal project (No. 2)

IAEA expert mission Technical Cooperation Project: MAL/3/009 - Capacity Building in The Integrated National Radioactive Waste Management Programme.	20 – 22 June 2011	Nuklear Malaysia
Regional Training Course on Disposal of Radioactive Waste: Management of DSRS Using the IAEA Borehole Disposal Concept	30 June – 4 July 2014	Wellampitiya
Workshop of Integrated Safety Assessment for BOSS Using HYDRUS	4 – 8 August 2014	Nuklear Malaysia
Workshop on: Implementing the Borehole Disposal of Disused Sealed Radioactive Sources	3 – 7 Nov 2014	Nuklear Malaysia

Nuklear Malaysia Technology Preview & Showcase 2015

Nuklear Malaysia Technology Preview & Showcase 2015 was held on 26-29 October 2015 at Malaysian Nuclear Agency. The Honourable Datuk Seri Panglima Wilfred Madius Tangau, Minister of Science, Technology and Innovation (MOSTI), launched the Technology Preview & Showcase 2015 organized by the Nuclear Malaysia.

This programme involved various activities such as product launches, exhibition of products and services, a seminar on commercialization, intellectual property seminar, innovation and visit to plants and main laboratory in Nuclear Malaysia. Borehole Disposal project team members were also involved in promoting the borehole disposal technology to the public in this programme.

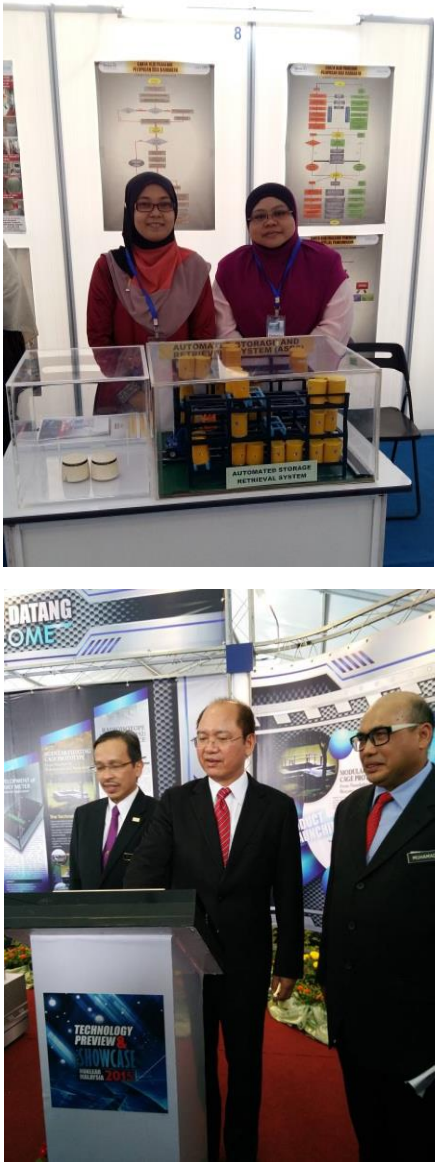

Figure 4: Nuclear Malaysia Technology Preview & Showcase 2015

Public Forum and Showcase on Development of Borehole Disposal Project

Issues of public perception and confidence have been most critical in gaining approval for development of repositories for radioactive waste, which raises the question of how best to achieve confidence regarding the ethical, economic, political and technical aspects of waste management strategy, and disposal in particular.

Based on these, on 12th Feb 2016, a public forum and showcase was held at Malaysian Nuclear Malaysia focusing on the development of the borehole disposal. The Forum, chaired by the Director of Safety and Health Radiation Division, Dr. Wan

Saffiey Bin Hj. Wan Abdullah, has gathered over 100 participants from Nuclear Malaysia and academicians. The aims of this forum are:

a) to help develop better solutions acceptable to all parties, by incorporating public values and concerns into decision making build trust, in both the process and the organizations involved
b) To gain community support for a project
c) To help counter external opposition to the project
d) To canvass their inputs, views and concerns

Figure 5: Speakers and participants of Public Forum on Borehole Disposal Project

The forum has invited experts in radioactive waste management and borehole disposal concept to explain the work involved and recent development of this project in Malaysia. Among the speakers were Dr Mohd Yusof Abd Wahab (Director of Waste and Environment Technology Division), Mr. Marzukee Nik B. Nik Ibrahim (senior officer of Waste Technology Development Centre) and Dr Norasalwa Zakaria (Manager of Waste Technology Development Centre). Question and answer session were held after the presentation.

Briefing by team members on borehole disposal project

Conclusion

The most important aspect of public participation process is the fact that it is a transparent process. It is a stepwise process, and it is important that the individual role and expected products for each step are well defined. It is also important to have flexibility to adapt situations that cannot be foreseen at an early stage.

Whilst taking the budgetary constraints into consideration, it is important for Nuklear Malaysia to optimize this public participation process. Nuklear Malaysia needs to gather as much information as possible from this approach, so that it can be used as lessons learned in near future for public participation processes.

Thailand

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Thailand Institute of Nuclear Technology (TINT)

Development on Radiation Safety and Radioactive Waste Management at the Rare Earth R&D Center, Pathumthani, Thailand

Summary: The rare-earth extraction and the U-Th extraction pilot plants of the Rare-earth Research and Development Center (RE R&D Center), at Pathum Thani province, were operated during 1995-2005. After that the activities and the facilities were no longer in operation. After the heavy floods occurring in 2011, the pilot plants and surrounding areas were contaminated with naturally occurring radioactive material (NORM) residues. The survey procedures were conducted for checking contamination of the Monazite processing and the U-Th extraction plants for the radiation safety and radioactive waste management and for the future remediation. The environmental samples such as sludge, and water around the site were investigated. The objective of this study is to prepare all technical and administrative actions leading to the release of those radiological facilities from regulatory control and safe management of radioactive waste. The first phase study shows that several areas such as the U/Th extraction, monazite and the NORM residues storage of the TINT Rare Earth Research & Development Center are contaminated.

Introduction

Rare-earth mineral concentrates are chemically processed to extract intermediate groups of mixed rare earth compounds. Chemical treatment of mineral concentrates derived from hard rock deposits may start with roasting in air (calcining) to drive off carbon dioxide and oxidize cerium to the tetravalent state. This is in many situations followed by treatment with hydrochloric acid to dissolve non-cerium rare earths, yielding a marketable cerium concentrate which can be used directly as a low value product or further separated into high purity individual rare earths as shown in Figure 1.

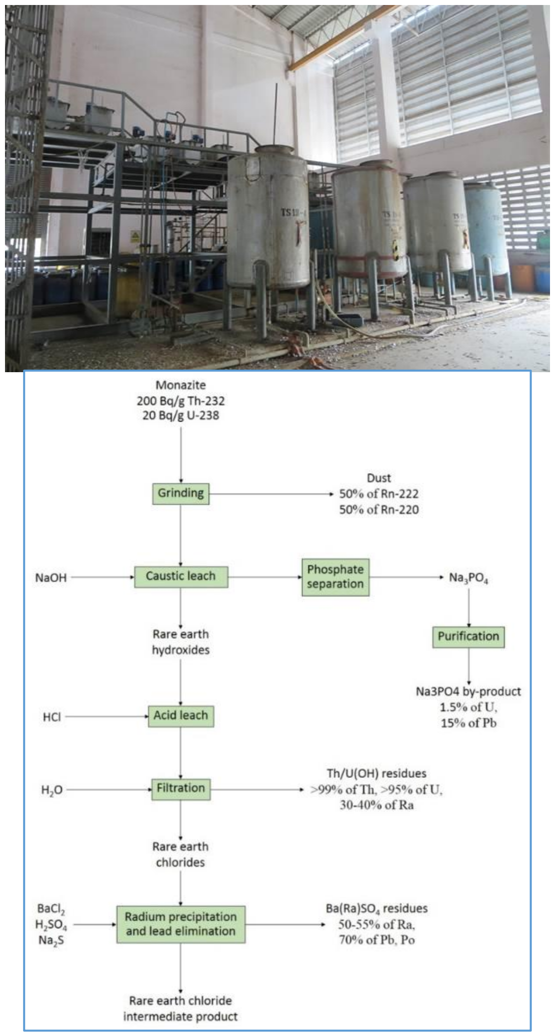

Figure 1 Monazite processing plant and diagram

Methods:

Monitoring contamination and exposure dose rate at the U-Th extraction and monazite processing plant- Direct dose rate measurement (Figure.2)-Collecting environmental samples for analyzing the radioactivity in samples (Figures 3).

Figure 2.Survey on Dose rate and Contamination

Figure 3.Sampling of water and sluges on site

Exposure dose and contamination

Building No. 8 was separated to 2 sections: the uranium and thorium processing and the monazite processing sections. The grid is applied to each section to estimate dose rate and contamination, in each square. The results of dose rates and contamination at the uranium and thorium processing and the monazite processing plants, are shown in Figure 4 and Figure 5 respectively. Wide areas of contamination cause high dose rates in the building No. 8, mainly in the uranium and thorium processing section. The highest dose rate and contamination is 300 μSv/hr, 100,000 cpm at the area A1 in the map.

Monitoring environmental sample

Radionuclides and activity concentration in surface water from the environment shown in Table1.

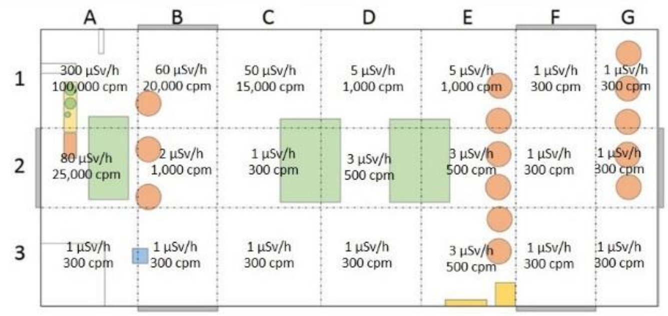

Figure 4. Dose rates and contamination at U/Th plant

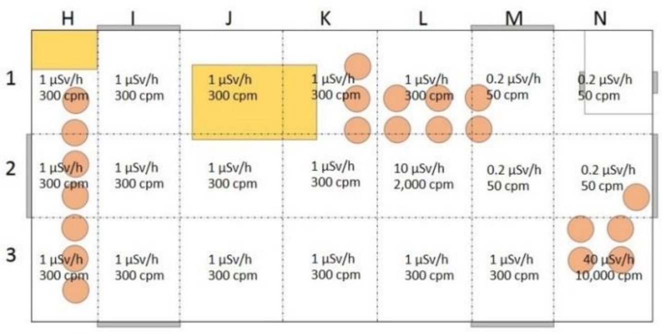

Figure 5. Dose rates and contamination at monazite processing plant

Table 1. Radioactivity in water samples on-site.

No	Sample	Activity Concentration (Bq/L)		
		Ra-226	Th-232	K-40
E1	Pond 7	10.41 ± 2.84	1.66 ± 0.64	65.19 ± 5.31
E2	Channel beside the pond 7	4.15 ± 0.33	1.72 ± 1.22	66.69 ± 3.12
E3	Pond filter sediment suspensions	15.49 ± 2.95	1.15 ± 0.46	66.11 ± 3.23
E4	Environmental monitoring point 1	8.84 ± 2.39	1.63 ± 0.64	66.92 ± 3.12
E5	Pond 1	7.87 ± 2.34	2.36 ± 0.67	63.91 ± 3.12
E6	Environmental monitoring point 2	8.94 ± 2.34	1.28 ± 0.67	63.92 ± 3.12
Baseline Surface water before operation (1991) [2]		0.00126		

Worker awareness and training are particularly important for supporting the introduction of radiation safety rules and for creating an understanding of the precautions embodied in such rules. Individual employee work practices may exacerbate dust generation. The general standard of housekeeping and spillage control also needs to be kept under regular review. Even when low activity concentration materials are handled, a reasonable standard of housekeeping may be necessary to ensure that dust and dirty from bird sham resuspension are adequately controlled. Very high standards would generally be required in the processing areas and storage areas where highly active material such as monazite sand, U cake/ Th cake are stored.

Advised Measures

1. The comprehensive plan should be draw up to balance of prevent contamination with workers (RWM staff and etc.)
2. Regulatory controls should be strengthened, e.g. management of NORM residues, residues disposal, environment monitoring, and effluent (processing water, gas) discharge to environment
3. Contamination zone should be clean up or remediated
4. Survey the whole site and take remediation measurements
5. Reuse of slag for building material should be seriously controlled to ensure the radiation level below limitations

Conclusion

This study is aimed to survey the NORM residue/ NORM waste located at the Rare-earth Research and Development Center. The contamination in water samples from ponds and high contamination in liquid waste stored at Building8 were found. The regulatory controls of NORM should be strengthened, e.g. management of NORM residues, residues disposal, environment monitoring, and effluent discharge to environment. The comprehensive plan should be draw up to balance of prevent contamination with workers. The survey of the whole site should be conducted. The contamination zone found should be clean up or remediated.

References

[1] International Atomic Energy Agency, Safety Report Series No.68, Radiation Protection and NORM Residue in the Production of Rare Earths from Thorium Containing Materials

[2] Srisuksawat, K, et al. "Pre-operational Survey of a Rare-earth Research and Development Center", Proceeding of the 6th Nuclear Science and Technology Conference, Office of Atoms for Peace, Bangkok, Thailand (1996)

Indonesia
Moch Romli
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National Nuclear Energy Agency (BATAN)

Self-Assessment Survey for Safety Culture Implementation in Center for Radioactive Waste Technology

Introduction

Center for Radioactive Waste Technology (CRWT) is part of National Nuclear Energy Agency (BATAN) organization that has a role in radioactive waste management. In the operation of waste treatment facilities (such as incinerator, evaporator, and boiler), there is great hazard potential.

Safety in the operation of the facility is the contribution of employees' awareness to behave safely. Consistent Safety behaviour of the employees will build a strong safety culture in organizations. Annually, CRWT management organizes the activities as efforts in the safety culture development. To evaluate the safety culture development efforts, annually conducted the self-assessment survey to examine implementation of safety culture. In the implementation on self-assessment survey is based on Regulation of BATAN Head No. 200 year 2012.

Methodology

Conducted the self-assessment survey with filling out the questionnaire that has been attached on Regulation of BATAN Head Number 200 year 2012. The questionnaire is an adaptation of the IAEA document Scart Guidelines. The questionnaire contained 5 (five) safety culture characteristics that become the object of assessment (Figure 1). These characteristics consist of 37 (thirty seven) attributes in more detail.

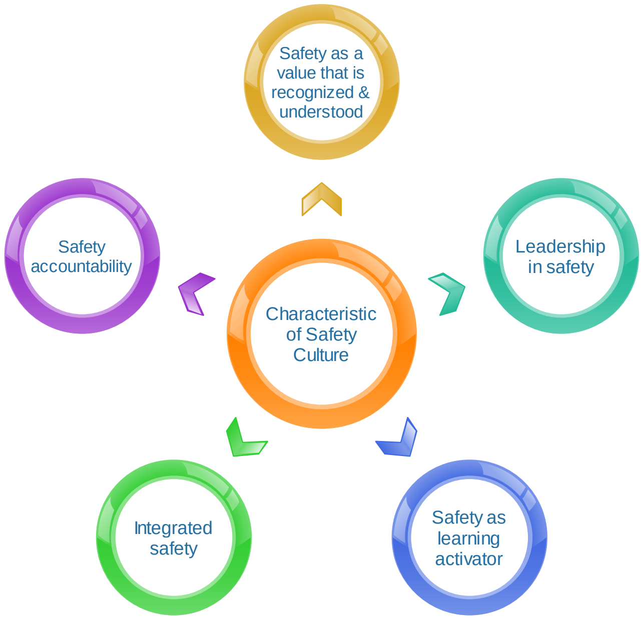

Figure 1. Safety Culture Characteristics

The attributes of each characteristics are as follows:

Characteristic 1: Safety as a value that is recognized & understood

1. Safety is the highest priority, as shown in the documentation, communication, and decision-making;
2. Safety is a major consideration in resource allocation;
3. Safety strategy is reflected in the organization's work plan;
4. Individual believe that the safety and activity results in line;
5. Long-term approach to proactive and safety issues indicated in decision-making;
6. Social behaviour aware of the safety and received/ supported (both formally and informally);

Characteristic 2: Leadership in Safety

7. The manager is committed to safety clearly;
8. Commitment to safety is clear at all levels of management;
9. Leadership are safety-related activities involving the management level;
10. Leadership skills are systematically developed/ improved;
11. Managements ensures that there is sufficient individual competence;

12. Management tried to involve individual in safety improvement;
13. In the change management process, the safety implications to be considered;
14. Management indicates continuous efforts in transparency and communicating to all levels as well;
15. Management has the ability to resolve conflicts;
16. The relationship between managers and individuals are based on trust;

Characteristic 3: Safety Accountability

17. There is relationship which is in accordance with the regulatory body, which ensure that the safety accountability remains with the license;
18. Roles and responsibilities are clearly defined and understood;
19. There are high levels of compliance to the rules and procedures;
20. Management delegate responsibilities appropriate authority to build clear accountability;
21. Safety ownership at all levels organizations and individuals is clear;

Characteristic 4: Integrated Safety

22. Organization based on trust;
23. Consideration for all kinds of safety, including the industrial and environmental safety;
24. A good quality of documentation and procedures;
25. good quality of the process, from planning to implementation and review;
26. individuals have the necessary knowledge and understanding of the work process;
27. there is a presumption against the factors that influence motivation and job satisfaction;
28. There are good working conditions on the conditions of time pressure, workload and stress;
29. There interdisciplinary and cross-functional collaboration, and teamwork;
30. Housekeeping and material conditions reflects the high commitment;

Characteristic 5: Safety as Learning Activator

31. questioned the prevailing attitude at all levels of the organization;
32. Conformity report system is available;
33. Do internal and external assessment, including self-assessment;
34. Learn from the organization and operation experience (both internal and external facility);
35. Learning is facilitated through the ability to recognize and diagnose deviations, to formulate and implement solutions and monitor the results of corrective action;
36. Safety performance indicators are continually monitored, evaluated, and acted upon;
37. There is a systematic development of individual competencies.

Each of these attributes has a value of its own weight ranging from responses excellent, good, adequate, less, and bad. Scoring on attributes of safety culture is determined by the weight of importance with a weight score 9 to 65, where a score of 65 is considered the most important. The total value for all of the characteristics obtained by the formula:

Total value = C1 + C2 + C3 + C4 + C5

where each C1 up to C5 are the sum of the average values for each attribute in one characteristics group.

The total value of these attributes determine the status of the safety culture of the organization's rank. There are five ratings status of implementation of safety culture in an organization as follows in Figure 2.

Results and Discussion

Self-assessment respondents are active employees CRWT of the Waste Management Division, Occupational and Operations Safety Division, Waste Facility Development Division, Waste Management and Storage Technology Division, Administration

Division, Quality Assurance Unit, and Nuclear Security Unit.

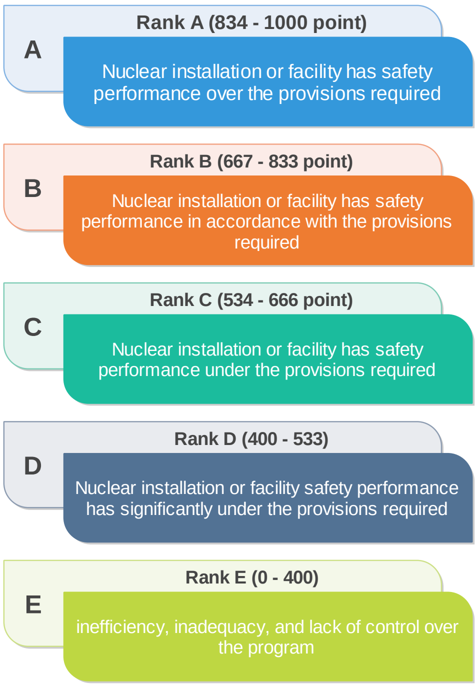

Figure 2. Ranking Status of Implementation of Safety Culture

The number of employees who participate in the survey as many as 111 peoples from all employees CRWT 125 person. After data processing, some of the data coming out of the trend (outliers) were excluded from the calculation so that the respondents were included in the final calculation of only 99 people (79, 2 % of the total employees).

Figure 3. Questionnaires by CRWT Employees

Based on the results of data processing, the total value obtained was 792, 59. This value is entered in the B rating, which means a nuclear facility or installation have safety performance in accordance with the provisions required and deviations that occurred only a minor deviation from the requirements or expectations of the design or program implementation, but the deviation is not a risk to health, safety, security, environmental, or compliance with the safety requirements.

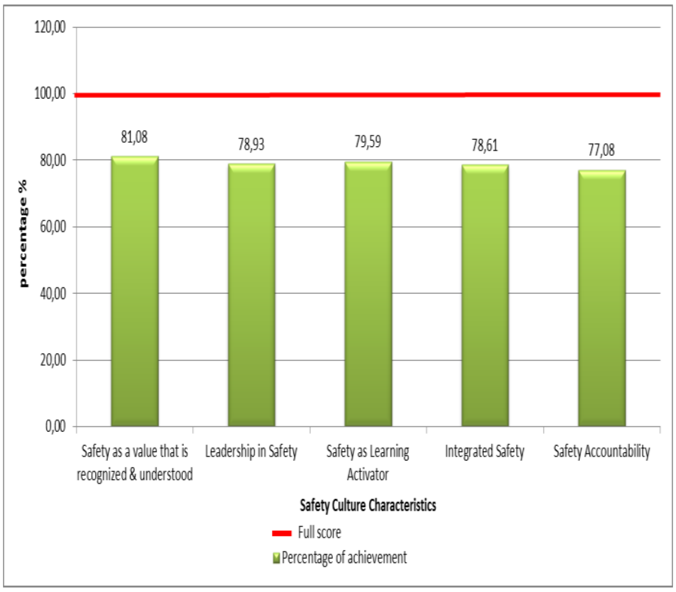

Figure 4. Diagram Percentage per Performance Safety Culture Characteristics

From the diagram above, it can be seen that the highest score in safety culture characteristics is safety as a value that is recognized & understood. While the lowest score is safety as learning activator.

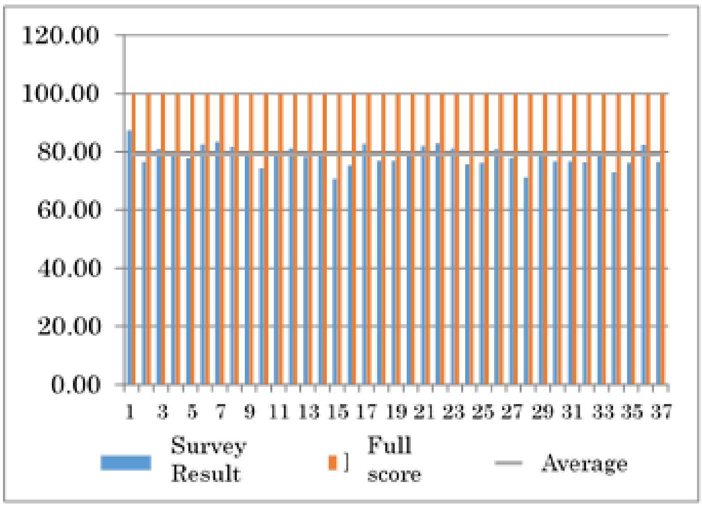

Figure 5. Achievement Percentage per Attribute of Safety Culture

Based on the analysis of the attributes, the highest average score in safety is highest priority, as shown in the documentation, communication, and decision-making. While the lowest performance, there is management has the ability to resolve conflict.

From results of attributes, the average score is 78, 97.

After a average value obtained, some attributes with value below average performance, can be categorized as a weak attribute. There is 5 (five) weakest attribute is as follows:

1. Leadership skills are systematically developed/ improved;
2. Management has the ability to resolve existing conflicts;
3. The relationship between managers and individuals are based on trust;
4. There is a good working condition on the conditions of time pressure, workload, and stress;
5. Learn from organization and operation experience (both internal and external facility).

Conclusion and Recommendation

Processed questionnaire data derived from 99 employees, where the results show the value of 792, 59, which means CRWT is ranked B (safety performance in accordance with the regulations as required).

Based on 5 (five) characteristics, the strongest is the safety as value recognized and understood (81.08% of the full score) and the weakest is the safety characteristics as the learning activator (77.08% of the full score). While the 37 attributes, which is the strongest one is safety the highest priority and there are 5 (five) attributes that are weakest.

To strengthen the five attributes that efforts should be made:

- Workload distribution based on competence and position;
- improving two-way communication between managers and employees;
- planning and implementation of corrective actions from the evaluation of events should be better;
- the need for more adequate means to facilitate employee learning from incidents that have occurred. The means of communication are open to evaluate the cause of the incident and provide space for employees to provide feedback.

References

International Atomic Energy Agency, Self-assesment of Safety Culture in Nuclear Installation, Tegdoc No.1321, Vienna, 2002.

International Atomic Energy Agency, Scart Guidelines, Vienna, 2008.

BATAN, Regulation of BATAN Head No. 200 year 2012 on Guidelines for Safety Culture Implementation, Jakarta, 2012.

Bangladesh

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Bangladesh Atomic Energy Commission (BAEC)

Management of Disused Sealed Radioactive Sources

Introduction

In Bangladesh both sealed (spent radioactive sources, SRS) and unsealed radioactive wastes are generated from the use of radioactive sources (RSs) in various activities which include nuclear techniques in medicine, agriculture, industry, research and education etc. The Central Radioactive Waste Processing and Storage Facility (CWPSF) is the unique facility of Bangladesh working for the safe management of radioactive wastes (RWs) arising from the different stakeholders throughout the country. The amount of wastes generated from different users in the country during the period of 1993 to 2016 shown in Fig1. Sealed radioactive sources which are generated from industry, medicine, various research fields in the country are safely stored in the Central Waste Processing and Storage facility after it becomes unfit for the intended application.

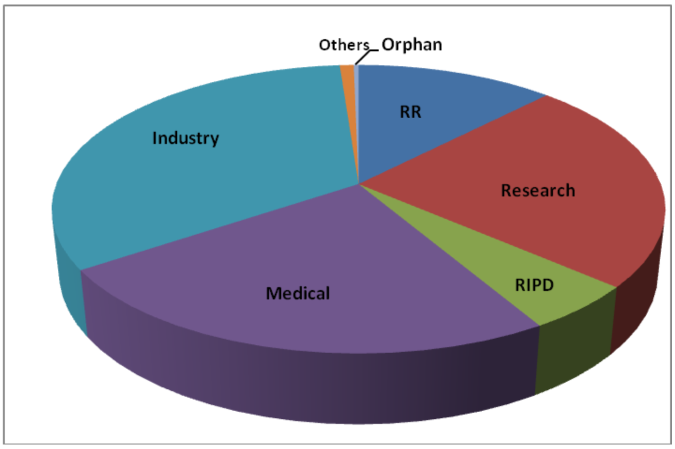

Fig1. Wastes arising from different users (1993- 2016)

The spent sealed radioactive sources which are received from different end users containing radionuclides e.g., ^{60} Co, ^{137}Cs, ^{90}Sr, ^{192} Ir, ^{55}Fe and ^{241}Am-Be neutron sources. The disused sealed radioactive sources ^{60}Co collected from research, oil and fertilizer industry, ^{90}Sr source from tobacco company, ^{137}Cs source from research, cancer hospital and fertilizer industry, ^{252}Cf, ^{241}Am-Be sources from university and research institutes, ^{192} Ir from gas industry and ^{55}Fe from tissue industry, all the disused sealed radioactive sources are safely stored inside the shielding containers at CWPSF prior to conditioning work. The immediate objective of these SRS is to facilitate interim storage. To keep the sources with low surface dose rate low and to protect human, workers, environment from any unnecessary exposure or accidents from Sealed Radioactive Sources the most important thing is to produce a package likely to be suitable and acceptable to disposal route. The conditioning of radioactive waste involves those operations that transform radioactive waste into a form suitable for handling, transportation, storage and disposal. The conditioning process involves the production of a package type that is recognized and in conforms to IAEA transport regulations and the use of immobilization matrix that is already widely accepted in many countries for interim storage.

Methods and Materials:

With a view to manage SRS stored at central waste processing storage facility into a suitable and acceptable for interim storage a number of SRS have been conditioned by adopting a systematic standard procedure. The conditioning of the sources which has been based on the preparation of working area covered with plastic and appropriate lead shielding , characterization, dismantling of source and transfer of the sources to the working enclosure, drum preparation, contamination check by using appropriate survey instruments, dose rate measurement, placement of source inside the capsule, closing of capsule and drum.

Fig 2. Preparation of working enclosure

Using appropriate radiation protection handling procedures, sources removed from their shields and place them in the prefabricated lead shielding area. The recovered sources put inside the IAEA-standard capsules. The sources encased within a special lead container are placed in the center of a 200L Stainless Steel (SS) drum. Gravels grout and Portland cement was mixed with water and the mixer was poured into the 200L SS drum up to ~75 cm from the bottom of the drum and kept for 24 hours to get settled. The prefabricated shield was placed into the cavity in the drum having the thickness of the immobilization matrix approximately 21cm including iron pipe. Four separate standard capsules used in this conditioning work. Three capsules for gamma emitting radionuclide and one for neutron sources. The gamma sources are stored in two cemented drums and the neutron sources placed into 0.034 m^3 lead container with 0.04 m thickness of lead. Outside of the cemented drum checked to ensure that no concrete has been spilled on the outside surface of the drum. The drum integrity and wipe tests performed to determine the contamination on the drum. Appropriate radiation labels posted on the drum to ensure proper identification for storage.

Fig 3. Dismantling of DSRS Container

Fig 4. Radiation Dose Rate Measurement

Fig 5. Placement of SRS inside the capsule

Fig 6. Drum Preparation and source immobilization in cement matrix

Fig7. Released Materials

Conclusion:

Conditioning in this way prevents unauthorized removal of the sources. The bulk weight and robust nature of the package also provide a barrier against the loss of containment of the radioactive material.

A number of category 3-5 sources having activity concentration 1.96 Ci of ^{137}Cs, 0.0742 Ci of ^{90}Sr, 0.002 Ci of ^{60} Co, 0.00022 Ci of ^{252}Cf and 0.1443 Ci of ^{241}Am/Be safely conditioned in IAEA standard capsules.

The empty containers which were left behind after the conditioning work of the above mentioned radionuclides, have been measured for radiation dose level and surface activity in order to clear these empty containers as per regulatory clearance regime. Radiation dose level and surface activity of all empty containers were measured by using the appropriate survey equipments. The measured radiation dose level and surface activity at the surface of the containers are ranging from 0.11 to 0.61μSvhr^{-1} and 0.20 to 0.69 Bqcm^{-2} respectively. The immobilized waste packages are safely stored in the waste interim storage facility with an appropriate radiation level.

Republic of Korea

Hyuncheol Kim

Korea Atomic Energy Research Institute (KAERI)

I'll involved in the Radiation Safety & Radioactive Waste Management Project of FNCA as a Project Leader for Republic of Korea from Jan, 2017. Now, I'm working in Environmental Radioactivity Assessment Team as senior researcher in KAERI (Korea Atomic Energy Research Institute). In this writing, I'll introduce to RS&RWM members on my team and what I'll do for the future of RS&RWM project.

KAERI has operated the research reactor, called "HANARO" with power of 30 MW, and other nuclear facilities for production of nuclear fuel for the reactor (Fig 1). According to nuclear safety act in Korea, KAERI have to monitor the environmental radioactivity around KAERI site. My team is responsible for this environmental radioactivity monitoring (ERM) program. We have collected 1334 samples yearly, and analyzed 3H, 90Sr, U isotopes, gamma isotopes and so on (Fig 2, Fig 3). Then, the annual report on the analytical results is published. In addition, the analytical method for the analysis of above radionuclides and radiation have been developed by ourselves.

Figure 1 HANARO, research reactor operating by KAERI

Media	Nuclide	Sampling frequency	Sampling point	
			In-site	Off-site
Airborne dust	Gross alpha/beta, gamma isotopes	Monthly(cont.)	5	1
	I-131	Weekly(cont.)	5	1
Moisture	H-3	Monthly(cont.)	4	1
Fallout	Gross beta, gamma isotopes	Quarterly(cont.)	2	1
River sediment	Gamma isotopes, U isotopes	Quarterly	2	2
Soil	U isotopes	Biannually	2	-
	Sr-90		7	5
	Gamma isotopes		9	5
Pine leaf	Gamma isotopes	Biannually	2	1
Rainfall	H-3, Gross beta, gamma isotopes	Monthly(cont.)	4	1
Surface water	H-3, Gross beta, gamma isotopes	Monthly	4	2
Ground water	U isotopes	Quarterly	1	-
	H-3, gamma isotopes		1	2
Rice	Gamma isotopes	Annually	-	4
Cabbage	H-3, Sr-90, gamma isotopes	Annually	-	4
Fowl	Gamma isotopes	Biannually	-	2
Milk	Gamma isotopes	Biannually	-	1
Ambient dose	Ambient dose rate	Continuous	6	1
	Accumulated dose(TLD)	Quarterly	37	19

Figure 2 Environmental radioactivity monitoring program (ERM)

Figure 3 ERM post (upper), and instrumental facilities (lower)

The principle of analytical techniques that are applied both in emergency and normal situation is the same, but the minimum detectable activity (MDA) to require by the regulatory is higher in emergency than in normal siutuation. Based on the experiences of above environmental radioactivity program, we have developed the rapid method to identify radionuclides and determine its concentration level for emergency preparedness. For example, the individual dose rate could be estimated for the detected gamma nuclides using environmental radiation monitor, shown in Fig 4. For rapid analysis of alpha/beta radionuclides, the automated radionuclide separation technique has been developed, shown in Fig 5. These automated separation technique could save the analytical time and the labor intensity. My laboratory is a member of IAEA-ALMERA (Analytical Laboratories for the Measurement of Environmental Radioactivity) network, and has participated to develop or validate the analytical method for alpha/beta radionuclide.

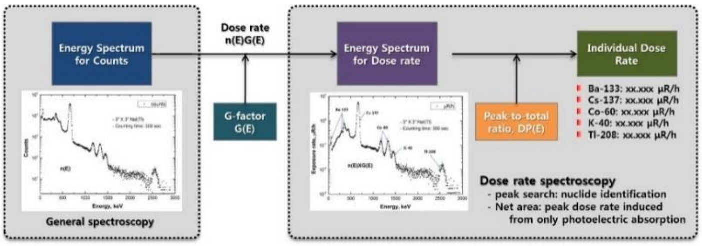

Figure 4 Dose rate spectroscopy

Figure 5 Automated radionuclide separation system (left: for small volume of sample, right: for large volume of sample)

The environmental radioactivity is a hot issue to public in Korea since FDNPP (Fukushima Dai-ichi Nuclear Power Plant) accident, and NORM (naturally occurring radioactive material) has been one of issues, also. We have developed the analytical procedures and validated the method for quantification of natural radionuclides in raw materials or by-products using ICP-MS, alpha spectrometer, gamma spectrometer, and liquid scintillation counter.

In Korea, the first research reactors, being TRIGA MARK-II and MARK-III, were built in 1960s to 1970s. These reactors were decommissioned from 1997 to 2015, which is the first experience of decommissioning of nuclear facilities in Korea. According to the law, some radioactive wastes produced in decommissioning of above nuclear facilities should transfer to the low and intermediate radioactive waste repository which is placed in Gyung-ju. We participated the characterization of radioactivity of decommissioning wastes including soil and concrete, which covered gamma isotopes, 3H, 14C, 90Sr, 99Tc and so on.

Scientists and national regulatory should make reliable technologies and policies for the general public, not to worry about their environment. So, this project has enough scientific and social value to implement by Asian countries planning or operating nuclear facilities. Riadoactive waste management is the biggest issue in public in terms of nuclear safety. How to manage the radioactive waste will directly continue to affect the environment. Now, general public do not allow new nuclear program without a solid implementation plan on radiation safety and radioactive waste management. So, this project could be very helpful and valuable to develop the implementation plan or policy. I'll collaborate with FNCA members on radiation safety and radioactive waste management.

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