DEVELOPMENT OF A COMPREHENSIVE SECURITY PLAN FOR RADIOACTIVE WASTE DISPOSAL FACILITIES IN MALAYSIA (BOREHOLE DISPOSAL FACILITY)

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Abstract

Any criminal or intentional unauthorized acts to critical infrastructures such as radioactive waste disposal facilities would undermine efforts to protect people, property, society and the environment either directly or indirectly through exposure to ionising radiation. With the aim of preventing a malicious act, a security measures should be design to deter malicious acts, detect and delay any unauthorized access or unauthorized removal of the radioactive sources. A security plan document sets out the security measures that the facility implements to prevent the loss, sabotage, illegal use, illegal possession or illegal removal of sealed sources throughout their entire lifecycle, including while they are in storage or during transportation. The preparation of security plan document is adequately in line with the Nuclear Security Series Recommendation On Radioactive Material and Associated Facilities (NSS 14) to implement one of the basic security function which is a security management. Over the years the Malaysian Nuclear Agency (Nuclear Malaysia) has grown to become a leader for Research & Development on waste technology activities including radioactive waste management, processing and disposal, which includes sitting for a national repository. The Radioactive Waste Disposal Facility operates in accordance with the Atomic Energy Licensing Act (Act 304) 1984 and related subsidiary regulation, enforced by the Atomic Energy Licensing Board (AELB) as a national regulatory body. The development of a comprehensive security plan is one of the license conditions that Nuclear Malaysia needs to be complied with when decided to build a Borehole Disposal Facility as the ultimate solution to the increasing number of category 3 – 5 of Disused Spent Radioactive Sources (DSRS). The development of the document is based on the latest guideline document provided by the AELB, 'Security Plan Preparation Guide for Radioactive Sources' (LEM/TEK 62 Sem.2). The preparation of this comprehensive document has proved to be a big challenge for Malaysia, that chose to be the first country to implement the disposal technology through the Borehole Disposal Facility, especially in describing best practises on security management that includes measures for both technical and administrative physical security, for facility not yet built. This document also completely described the overall nuclear security system to protect the radioactive sources and related measure to threat level, response to any possible nuclear security event and the protection of sensitive information. This paper provides thoughts on how these challenges can be overcome and suggest improvements that can be made in the future to ensure the sustainability of nuclear security control in this facility is well established and guaranteed

1. INTRODUCTION

Over the years the Malaysian Nuclear Agency (Nuclear Malaysia) has grown to become a leader for Research & Development in nuclear technology and its application. The ability of agency proved by establishment and development of the important nuclear application facilities comprising category 1 to category 5 such as the gamma irradiator processing facilities (Sinagama, Raymintex, Gamma Green House, Gamma Cell), the radiography industry as Non-destructive testing facility (NDT), the Secondary Standard Dosimetry Laboratory (SSDL), the Radioisotope Production Laboratory facility, and the Waste Management Centre for radioactive waste management, processing and disposal, which includes sitting for a national repository. The management and operational of the facilities in accordance with the Atomic Energy Licensing Act (Act 304) 1984 and related subsidiary regulation, enforced by the Atomic Energy Licensing Board (AELB) as a national regulatory body.

The development of a comprehensive security plan is one of the license conditions that Nuclear Malaysia needs to be complied with when decided to build a Borehole Disposal Facility as the ultimate solution to the increasing number of category 3 – 5 of Disused Spent Radioactive Sources (DSRS). The development of the document is based on the latest guideline document provided by the AELB, 'Security Plan Preparation Guide for Radioactive Sources' (LEM/TEK 62 Sem.2). The preparation of this comprehensive document has proved to be a big challenge for Malaysia, that chose to be the first country to implement the disposal technology through the Borehole Disposal Facility, especially in describing best practises on security management that includes measures for both technical and administrative physical security, for facility not yet built.

2. BASIC SECURITY FUNCTION

Any facility that been use of any radioactive sources must established the security system to protect the radioactive sources from any criminal or intentional unauthorized act. The designed to perform basic security functions must be based on 5 elements that is been suggested by the International Atomic Energy Licensing Agency in Nuclear Security Series No. 11: Security of Radioactive Sources (Implementing Guides) NSS 11 which is Deterrence, Detection, Delay, Response and Security Management.

2.1 Security management

Includes ensuring adequate resources (personnel and funding) for the security of sources. It also includes developing procedures, policies, records, and plans for the security of sources and for a more effective security culture, in general. This term also includes developing procedures for the proper handling of sensitive information and protecting it against unauthorized disclosure.

It is being recommended that the category 3 facility shall provide security plan as a security objective and the documentation of security arrangement and reference procedure as a security measure.

A security plan should include all information necessary to describe the security approach and system being used for protection of the source. Generally the typical information need to be gathered in the security plan such as a description of the source, its categorization, and its use, a description of the environment, building and/or facility where the source is used or stored, and if appropriate a diagram of the facility layout and security system, the location of the building or facility relative to areas accessible to the public., local security procedures, the objectives of the security plan for the specific building or facility, The security measures, the administrative measures to be used and etc.

3. MALAYSIA LEGISLATIVE REQUIREMENT

3.1 Atomic Energy Licensing Board (AELB)

The security and the protection of the radioactive sources in Malaysia as clearly stated in Atomic Energy Licensing Act 1984 Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010 under clause No. 70, The licensee shall take all measure to ensure the security and protection of all radiation sources in his possession or under his control to prevent theft, loss or sabotage.

The Atomic Energy Licensing Board as a regulatory body has determined that any activity that involve of radioactive sources shall provide a set of document that called Security Plan. The development of the document is based on the latest guideline document provided by the AELB, 'Security Plan Preparation Guide for Radioactive Sources' (LEM/TEK 62 Sem.2). The execution of this requirement been enforced by Atomic Energy Licensing Board through license conditions.

3.2 Chief Government Security Officer (CGSO).

The consideration of security control for this facility also take into account of other related legal requirement such as Protected Areas and Protected Places Act 1959 that enforced by the Chief Government Security Officer (CGSO).

3.3 Security Plan Preparation Guide for Radioactive Sources (LEM/TEK 62 Sem.2).

Security Plan Preparation Guide for Radioactive Sources (LEM/TEK 62 Sem.2) is a sets out the minimum security measures that licensees must implement to prevent the loss, sabotage, illegal use, illegal possession or illegal removal of sealed sources during their entire lifecycle, including while they are in storage or transport, or being stored during transportation. This document sets out guidance to help the licensee to prepare the security plan document for any activities that been licensed under Atomic Energy Licensing Act 1984 (Act 304)

This describes the minimum security measures required for the use, storage and transport of sealed sources, and includes measures for both technical and administrative security for the purpose of providing a security controls in accordance within the level of threat at the related facility.

The Security Plan Preparation Guide for Radioactive Sources (LEM/TEK 62 Sem.2) is only applies to sealed radioactive sources (encapsulated or solid) and does not apply to unsealed radioactive substances. This document applies to Category 1, 2, and 3 sources and provides "prudent management practices" for Category 4 and 5 sources.

The definition of category based on these 3 documents below:

1. International Atomic Energy Agency's (IAEA) *Code of Conduct on the Safety and Security of Radioactive Sources.*
2. IAEA Safety Guide RS-G-1.9, *Categorization of Radioactive Sources*
3. IAEA/TECDOC-1344, *Categorization of Radioactive Sources.*

3.4 Categorization methodology

The Atomic Energy Licensing Board (AELB) bases its categorization of sources on the IAEA source categorization, defined in IAEA TECDOC-1344. This document recognizes that not all radioactive sources could (or should) be treated alike, and has established five source categories as below:

1. Category 1 as personally extremely dangerous.
2. Category 2 as personally very dangerous.
3. Category 3 as Personally dangerous.
4. Category 4 as unlikely to be dangerous.
5. Category 5 as to not dangerous.

The IAEA categorization methodology has found worldwide acceptance, and provides a uniform means of classifying the risk associated with the most commonly used sealed sources and radiation devices.

Category 1 sources are the most risk significant sealed sources licensed by the AELB. Because they pose the greatest risk to the health and safety of persons and to the environment, Category 1 sources are always used in a well-shielded and well-controlled location. Examples include cobalt-60 teletherapy sources used for cancer treatment and cobalt-60 sources used in pool-type irradiators to sterilize medical products. Such sources must be shielded and secured safely.

Category 2 sources are most often industrial radiography exposure devices. These devices are portable, and are widely used in pipeline work and in pressure vessel fabrication shops (particularly in the oil and gas industry).

Category 3 sources are often fixed gauges that are bolted to pipes, vessels and assembly lines where they operate reliably in harsh industrial environments, often for decades.

Category 4 sources are less risk significant than Category 3 sources, and are classified as low risk to persons, security and the environment. An example of a Category 4 source is a portable soil moisture density gauge used in road construction.

Category 5 sources and their use are considered to be the least risk significant. Examples include electron capture detectors used to measure pesticide residues in food, x-ray fluorescence analyzers, and low-dose brachytherapy implant sources.

To assign a category, the total activity of all sources in one facility (storage or use) where sources are in close proximity must be equal to, or greater than, the number identified in the category as below.

Radionuclide	Category 1 source		Category 2 source		Category 3 source	
	Terabecquerels (TBq)	Curies (Ci)	Terabecquerels (TBq)	Curies (Ci)	Terabecquerels (TBq)	Curies (Ci)
Americium-241 (^{241}Am)	60	1,620	0.6	16	0.06	1.6
Americium-241 / Beryllium (^{241}Am/Be)	60	1,620	0.6	16	0.06	1.6
Californium-252 (^{252}Cf)	20	540	0.2	5.4	0.02	0.5
Cesium-137 (^{137}Cs)	100	2,700		27	0.1	2.7
Cobalt-60 (^{60}Co)	30	810	0.3	8.1	0.03	0.8
Curium-244 (^{244}Cm)	50	1,350	0.5	13	0.05	1.3
Gadolinium-153 (^{153}Gd)	1,000	27,000				
Iridium-192 (^{192}Ir)	80	2,160	0.8	22	0.08	2.1
Plutonium-238 (^{238}Pu)	60	1,620	0.6	16	0.06	1.6
Plutonium-239 / Beryllium (^{239}Pu/Be)	60	1,620	0.6	16	0.06	1.6
Promethium-147 (^{147}Pm)	40,000	1,081,000	400	11,000		1,100
Radium-226 (^{226}Ra)	40	1,080	0.4	11	0.04	1.1
Selenium-75 (^{75}Se)	200	5,400		54	0.2	5.4
Strontium-90 (^{90}Sr) / Yttrium-90 (^{90}Y)	1,000	27,000				
Thulium-170 (^{170}Tm)	20,000	540,540	200	5,400		540
Ytterbium-169 (^{169}Yb)	300	8,100		81	0.3	8.1

TABLE 1: Activities corresponding to threshold of Category 1, 2 and 3 sources.

For security control purposes, the aggregation of sources in a single storage (or use) facility can be used to determine a security category. This is done by adding the actual sealed source activities of the sources and determining the category from Table 1. For example, one industrial level gauge containing a sealed source with 0.19 TBq of cesium-137 is a Category 3 source (1.0 > 0.19 > 0.1). However, when there are six of these sealed sources at a single licensed location, for security reasons they may be treated as a Category 2 source (6 x 0.19 = 1.1 > 1.0).

The A/D ratio for a single radionuclide is the activity (A) of the source compared to the activity determined to define a threshold of danger (D). For the aggregation of various radionuclides, the sum of the A/D ratios is used

to determine a final category as described in RS-G-1.9, *Categorization of Radioactive Sources* and TECDOC-1344, *Categorization of Radioactive Sources*.

If multiple sources from different categories are stored, the highest category should suffice (e.g., storage of Category 2, 3 and 4 sources would meet the security requirements for Category 2).

3.2 Categorization of Borehole Disposal Facility for Security Control.

Basically, there are two main types of radioactive waste in Malaysia:

a) Waste generated from usage of radioactive materials from industry, medical, agricultural, research and educational purposes.

b) Waste resulting from activities related to the enhancement of NORM in the environment and the decommissioning of the contaminated facility;

Based on this categorization methodology that has been implemented, the development of the Borehole Disposal Facility may be treated as a category 3 sources.

4. SECURITY LEVEL AND SECURITY OBJECTIVE FOR BOREHOLE DISPOSAL FACILITY.

The development of the Borehole Disposal Facility in Malaysia is to overcoming the management of category 3 disused radioactive sources issues. Base on the Security Plan Preparation Guide for Radioactive Sources (LEM/TEK 62 Sem.2.

The security level and the security objective for Borehole Disposal Facility as below:

Security program sub sections	Category 3 - Medium risk
Access control	• Restrict access to authorized user • The access based on two-man access
Intrusion detection system	To install detection and be linked to a control alarm system (CAS) that monitored by an auxiliary police 24/7.
Perimeter and/or physical barrier	• The location of the Borehole Disposal Facility will build with double layer fence. The outer layer fence with anti-climb specification. • Intruder alarm system within the inner layer fencing of perimeter installed. • To install high security metal cage with high security padlock to secure the BDS topside.
Security of storage	• To install high security metal cage. • Secured with high security padlock • Equipped with a minimum of one intrusion detection system or equivalent
Response protocol	• Generic response protocol and contingency plan by the auxiliary police. • Contingency plan based on auxiliary police procedure (Protected Areas and Protected Places act 1959) • Direct communication within the AELB and districts police office
Maintenance and testing	The preventive maintenance of physical protection system will

	implement base on quarterly basis (4 times a year)
Facility security plan	• The security plan based on specific facility • Reviewed on a regular basis at least one a year or when important changes are done at the facility • Communicated on a need to know basis
Personal trustworthiness or background	• Background checking for every staff based on federal government procedure that in charge by the Chief Government Security Officer (CGSO). • Background checking for other such as student, cleaner personnel, contractor go through internal check and need to apply permit for every each of admission.
Information security	All prescribed information must be protected and be shared on a need to know basis
Security awareness program	The security training shall include at least once a year for every each personnel that been given authorized access
Vehicle security	• No direct access of vehicle to BDS specific location • The main exit equipped with security barrier • The Ground Retractable Automobile Barrier that controlled by auxiliary police
Transportation security plan	Prudent management practices

TABLE 2: Security Level and The Security Objective for Borehole Disposal Facility.

Based on the guideline, it is mandatory for the management of Borehole Disposal facility as a category 3 facility to provide the security plan document that fulfill the minimum requirement for security measure that has been set by the Atomic Energy Licensing Board (AELB) as one of the license conditions.

As stated on the security Plan Preparation Guide for Radioactive Sources' (LEM/TEK 62 Sem.2), the development of the security plan suggested 15 main list that need to put into account and consideration as below:

No	Item	No	Item
1	Introduction	9	Perimeter
2	Security Management	10	Access Control
3	Internal Security	11	Thrustworthiness
4	Storage	12	Physical Protection System
5	Security Policy	13	Contingency Plan
6	Site Plan	14	Security Awareness
7	Transportation	15	Security Procedure
8	Information Security		

TABLE 2: Content of Comprehensive Security Plan

4. CONCLUSIONS

The development of a comprehensive security plan is one of the license conditions that Nuclear Malaysia needs to be complied with when decided to build a Borehole Disposal Facility as the ultimate solution to the increasing number of category 3 – 5 of Disused Spent Radioactive Sources (DSRS). The development of the document is based on the latest guideline document provided by the AELB, 'Security Plan Preparation Guide for Radioactive Sources' (LEM/TEK 62 Sem.2).

The preparation of this comprehensive document has proved to be a big challenge for Malaysia, that chose to be the first country to implement the disposal technology through the Borehole Disposal Facility, especially in describing best practises on security management that includes measures for both technical and administrative physical security, for facility not yet built.

Most of the challenges encountered while developing this document have been successfully resolved because of good cooperation within all the parties involved especially Atomic Energy Licensing Board (AELB) as a regulator. It is a big challenge to the facility management to make sure that all the commitment been written in the document need to be implement accordingly and also to review at least one a year to make sure that sustainability of nuclear security control in this facility will always well established and guaranteed over the time.

6. REFERENCES

1. Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010
2. IAEA, Safety Guide No. RS-G-1.9, Categorization of Radioactive Sources, Vienna, 2005
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7. Security Plan Preparation Guide for Radioactive Sources (LEM/TEK 62 Sem.2).