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**GUIDELINES  
FOR DECOMMISSIONING OF  
FACILITIES CONTAMINATED  
WITH RADIOACTIVE  
MATERIALS**



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## **PREFACE**

There is a need to have standard guidelines for decommissioning of facilities contaminated with radioactive materials in view of potential radiological hazard caused to workers and members of the public as a result of exposure to such materials. These guidelines were jointly prepared by Atomic Energy Licensing Board (AELB) and Nuclear Malaysia Agency with intention to be used as a supplementary and explanatory document to the existing regulations in force and they were prepared based on current practices of countries, which have accumulated decommissioning experiences and recommendations of the International Atomic Energy Agency (IAEA) Safety Report Series No. 45. Application of the guidelines will facilitate the AELB's licensee and will make for greater consistency to the Atomic Energy Licensing Act, 1984 and its subsidiary legislations. The guidelines may require slight modification and adjustment in order to harmonize them with the rest of the standard guidelines issued by the AELB. AELB wishes to express its appreciation to all those who assisted directly or indirectly in the drafting and review of the guidelines until its publication.

# **GUIDELINES FOR DECOMMISSIONING OF FACILITIES CONTAMINATED WITH RADIOACTIVE MATERIALS**

## **1. INTRODUCTION**

Any facility, which is directly or indirectly involved with use or production of radioactive materials, unless otherwise exempted, would be controlled by AELB as provided for under the provisions of AELA 1984 (ACT 304) and its subsidiary legislations. Operation of the facility shall be done in accordance with the requirements of the Act and its relevant subsidiary legislations.

When such a facility comes to the end of its operational life and/or is no longer useful to the licensee, it has to be decommissioned and disposed of in a proper and safe manner to ensure that it is secured and it can no longer pose any hazard to workers, members of the public and the environment.

Decommissioning operation should be performed on the facility in order to achieve this safety and security goal and to release it from further regulatory control by AELB.

## **2. OBJECTIVE**

2.1 The objective of these guidelines is to present standard guides and procedures, which shall be followed by a licensee when embarking on decommissioning operation on any facility contaminated with radioactive materials. The guidelines ensure that the decommissioning operation would be carried out in a systematic, safe, secured and acceptable manner and with full compliance of the regulatory requirements in force, which would eventually guarantee a permanent release of such facility from further regulatory control by AELB.

## **3. SCOPE**

3.1 These guidelines address safety requirements and procedures that should be followed and complied with when carrying out decommissioning operation on facilities contaminated with radioactive materials and they are not intended to cover the requirements and procedures for the decommissioning of any nuclear facilities. However, the requirements and procedures covered in these guidelines are deemed adequate to cover similar operation performed on certain types of nuclear facilities excluding nuclear reactors.

3.2 The guidelines are intended to address both radiological and non-radiological hazards associated with decommissioning operation that may have direct or indirect safety and security implication to workers, members

of the public and the environment. However, the guidelines give more emphasis on the radiological hazard since its control falls under the purview of AELB. The licensees shall comply to other standards, guidelines and regulatory requirements for more detailed requirements and procedures of non-radiological hazard controls prior to carrying out the decommissioning operation on a facility.

3.3 These guidelines are also not intended to cover standard procedures and requirements pertaining to conditioning, transport and disposal of radioactive waste generated from a decommissioning operation since the necessary standard procedures and requirements to ensure safety of these operations are prescribed in separate guidelines issued by AELB.

#### **4. TERMINOLOGY AND ABBREVIATION**

4.1 In these guidelines, unless otherwise changed by AELB through a special order, the following terms used have the meaning as described below:

- a. characterization – a systematic identification and assessment of the types, quantities, forms and locations of contamination within a facility, its site and wastes arising from its decommissioning operation;
- b. contamination – the presence of radioactive substance in or on a material or the human body or other place where they are undesirable or could be harmful;
- c. decommissioning – to remove safely from service and to reduce residual contamination to a level that permits termination of any applicable licenses and release of the facility from further regulatory control and for unrestricted use;
- d. decommissioning operation – collectively refer to the planning, implementation and management of the entire decommissioning activities.
- e. decommissioning project – refer specifically to the actual decommissioning work without taking into consideration facility characterization and site characterization
- f. decommissioning activities – means activities involved in the decommissioning project as described in para10.29
- g. decommissioning strategy – a systematic assessment made on various options or alternatives of decommissioning available to find the best among them that suits to an intended decommissioning operation of a particular facility;
- h. decontamination – activities employed to remove or reduce the levels of radioactive contamination in or on structures, equipment, materials,

items, buildings, personnel and areas of a contaminated facility and its site;

- i. employees means the facility's personnel, the facility's contract workers and employees of outside contractors and subcontractors
- j. environmental assessment - a systematic evaluation made to assess the potential impact caused on the general public and the environment as a result of carrying out decommissioning operation;
- k. facility – plants, equipments, buildings and structures identified under the characterization process that require decommissioning operation to be performed;
- l. quality assurance - the planned and systematic actions and controls that are undertaken to prove that the entire activities of decommissioning operation will perform satisfactorily;
- m. radioactive material – any material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity;
- n. safety assessment – a systematic evaluation made to assess the potential impact caused on workers and the general public as a result of carrying out decommissioning operation; and
- o. site – the soil around and under the facility identified under the characterization process that requires decommissioning operation to be performed;

4.2 The following abbreviations, which are used throughout the guidelines, have their meanings as stated below, unless otherwise they are described to have a different meaning in a particular section:

AELB – Atomic Energy Licensing Board

AELA – Atomic Energy Licensing Act, 1984

ALARA – As Low As Reasonably Achievable

CIDB – Construction Industry Development Board

DOE – Department of Environment

DOSH – Department of Occupational Safety and Health

MDL – Minimum detectable level

OSHA – Occupational Safety and Health Act

QA – Quality Assurance

QC – Quality Control

RPO – Radiation Protection Officer

SHO – Safety and Health Officer

SSDL – Secondary Standard Dosimetry Laboratory

SSCs – Structures, Systems and Components

## **5. APPROVAL FOR DECOMMISSIONING**

5.1 The licensee shall make an official written request to AELB for an approval to carry out a decommissioning operation of a facility using the application form (LPTA/BP/5) as described in the Fourth Schedule of the Radiation Protection (Licensing) Regulations 1986. The form shall be duly completed, signed and returned with the application fee to AELB. Such an approval shall be obtained prior to commencement of the decommissioning project. The licensee shall ensure that no decommissioning operation is carried out without a license or a written approval from AELB.

5.2 An application for approval shall be submitted to AELB together with a decommissioning plan (Section 10) and other appropriate supporting documents (Section 11). To assist the licensee in making the application, flow charts of the application process are enclosed in Annex I and II.

## **6. APPOINTMENT OF RADIATION PROTECTION OFFICER AND SAFETY AND HEALTH OFFICER**

6.1 Decommissioning operation is a complex nature of operation. It is, therefore, very important for the operation to be closely supervised by a competent person who knows its varied and complex nature to ensure that there is minimum hazard caused to workers, members of the public and the environment resulting from its implementation. There is a need to have an RPO whose responsibilities include supervision of related decommissioning activities, establishment and implementation of a radiation protection programme for the decommissioning operation.

6.2 In view of varied nature of hazard typically involved with the decommissioning operation, especially those of non-radiological nature, there is also a need to have a SHO who shall work closely with the RPO to supervise the overall non-radiological safety aspects of the decommissioning operation.

- 6.3 The licensee shall appoint the RPO and the SHO for the purpose of decommissioning operation and they shall be recognized by AELB and DOSH respectively.
- 6.4 The RPO appointed by the licensee to supervise and implement radiation protection programme during the operating period of the facility can continue to serve as the RPO for the decommissioning operation provided he is approved by AELB and capable of carrying out new and additional responsibilities required for safe implementation of the operation.
- 6.5 In cases where such an RPO is unavailable, the licensee may engage the service of external RPO recognized by AELB to assist him in the supervision and implementation of radiation protection programme for the decommissioning operation.
- 6.6 The RPO and the SHO shall work closely with the licensee and his appointed representative responsible for managing the decommissioning project, such as, decommissioning project manager, to ensure that the radiation protection programme and the non-radiological safety programme are implemented effectively and the occupational and public exposure risk resulting from the decommissioning operation is kept to the minimum.

## **7 RADIATION PROTECTION PROGRAMME AND HEALTH AND SAFETY PROGRAMME**

- 7.1 Health and safety programme should identify the actions that are necessary to ensure continuous safety and security during all phases of decommissioning. The programme required may be different from the programme established during the operating period of the facility, but the latter programme can form the basis for the establishment of more comprehensive programme required to ensure safety and security of more complex nature and situation that may occur during the decommissioning operation. The health and safety programme develop for the decommissioning operation should consist of two components, namely radiation protection programme and industrial health and safety programme.
- 7.2 The licensee or his RPO and SHO shall prepare a radiation protection programme and an industrial health and safety programme for the decommissioning operation. The aim is to minimize occupational and public exposure risk resulting from implementation of the decommissioning operation.
- 7.3 The radiation protection programme shall be prepared to meet the requirements of AELA and its subsidiary legislations pertaining to radiological safety aspects of the decommissioning operation. In similar manner the industrial health and safety programme shall be prepared to

meet the requirements of relevant acts and it should cover all non-radiological safety aspects of the decommissioning operation.

7.4 The programmes shall be comprehensive enough to cover employees involved in the decommissioning operation.

7.5 The information provided in the safety assessment report, environmental assessment report, facility characterization and site characterization process should be considered in the preparation of the radiation protection programme and industrial health and safety programme.

7.6 It is important to note that due to severe physical changes and modifications of the safety systems, which are normally carried out during the decommissioning operation, the earlier radiation protection programme and the industrial health and safety programme established during operating period of the facility may no longer be relevant and adequate to cope with the new situation of decommissioning. Therefore, for the purpose of decommissioning operation, it is required for a completely new radiation protection programme and industrial health and safety programme to be established. However, in cases where only part of the facility is to be decommissioned, the earlier programmes developed during operating period of the facility can still be used provided changes made during decommissioning operation are minimum.

7.7 The radiation protection programme should include the requirements of LEM/TEK 45, in addition to the following items:

- a. establishment of radiation, contamination and security control programme, which should include classification of workplaces, erection of physical barriers, posting up warning signs and notices and establishment of access control and procedures, type and frequency of surveys, procedures to control contaminated materials and wastes, procedures to control airborne contamination, procedures for decontamination and procedures for establishing background levels and the amount of activity from natural sources in areas affected by decommissioning operation;
- b. provision of facilities and instrumentation for radiation and contamination control including protective equipment, air samplers and radiation and contamination measuring instruments used to support the radiation protection programme, their procedures for calibration, maintenance and usage, quality assurance of instruments, description of the method used to estimate the MDL (at the 95% confidence level) for each type of radiation to be detected and methods used to estimate uncertainty bounds for each type of instrumental measurement;
- c. establishment of physical surveillance programme for contaminated materials and wastes and radiological monitoring

programme for employees. These programmes should cover continuous surveillance of the contaminated materials and wastes, exposure of workers during routine operations, special operations, maintenance and clean-up activities and should include medical examination, internal exposure monitoring using the most appropriate approved technique, external exposure monitoring for whole and partial body, workplace monitoring for surface and airborne contamination, environmental monitoring, procedures for dose estimation and analysis from monitoring results and procedures for disseminating radiological hazard information to employees.

- d. establishment of training and retraining programme in radiological safety for employees involved in decommissioning operation as specified in detail in Section 8;
- e. establishment and maintenance of record keeping system for safe keeping of all radiological records generated from implementation of the radiation protection programme. This may include calibration records, dose records, medical examination records, survey records, maintenance records, training records, accident and incident reports and any other records required by AELB to be established and maintained.
- f. provision of procedures for inventory, safe handling, storage and transfer of contaminated items and radioactive wastes; and
- g. emergency planning and preparedness to cater for any radiological accident or incident that can happen during implementation of decommissioning project and the plan should include all possible scenarios of radiological accident, accident reporting and investigation and corrective action taken. Details of the requirements for preparation of the emergency plan are described in Section 10.

7.8 The industrial health and safety programme should comply with legal and standard requirements stipulated by relevant authorities including DOSH and DOE and it should address all non-radiological safety aspects that may exist at the decommissioning project site including hoisting and rigging, permanent electrical work, elevated work, construction safety, fire safety, heat-cold stress, power and hand operated tools, motorized vehicles and equipment, work environment, material handling and storage, high pressure safety and laser safety and personnel decontamination facility.

7.9 The industrial health and safety programme should include, but not limited to, the following items:

- a. establishment of physical, mechanical, electrical and chemical hazard control programme, which should include classification of workplaces, erection of physical barriers, posting up warning signs

and notices and establishment of access control and procedures, type and frequency of surveys, procedures to control airborne dust and chemicals, noise and vibration;

- b. provision of facilities and instrumentation for physical, mechanical, electrical and chemical hazard control including protective devices, air samplers, noise measuring instrument and airborne measuring instruments used to support the industrial health and safety programme, their procedures for calibration, maintenance and usage, and quality assurance of instruments;
- c. establishment of monitoring programme for protection of employees. This programme should cover employees exposure to the hazard during routine operations, special operations, maintenance and clean-up activities and should include noise and chemical exposure monitoring using the most appropriate recognized technique, workplace monitoring for surface and airborne non-radiological contamination, environmental monitoring for dust and chemicals, procedures for exposure estimation and analysis from monitoring results and procedures for disseminating hazard information to employees.
- d. establishment of training and retraining programme in non-radiological safety for employees involved in decommissioning operation as specified in detail in Section 8;
- e. hazards communication to employees involved in the decommissioning operation,
- f. establishment and maintenance of record keeping system for safe keeping of all non-radiological records generated from implementation of the industrial health and safety programme. This may include calibration records, exposure records, medical examination records, survey records, maintenance records, training records, accident and incident reports and any other records required by relevant authorities to be established and maintained.
- g. emergency planning and preparedness to cater for any non-radiological accident or incident that can happen during implementation of decommissioning project and the plan should include all possible scenarios of non-radiological accident, accident reporting and investigation and corrective action taken. Details of the requirements for preparation of the emergency plan are described in Section 10. This non-radiological emergency plan can be combined together with and become part of the emergency plan for the decommissioning project.

7.10 The licensee shall establish a safety audit programme in order to assess effectiveness of implementation of radiation protection programme and industrial health and safety programme besides to ensure compliance

with regulatory requirements and safety standards. The audit programme should include unscheduled inspections and it should be able to describe the process used in evaluation of and in dealing with violations of AELB and other regulatory requirements and licence commitments. The RPO, the SHO and their staff should perform the audit.

## **8. TRAINING OF PERSONNEL**

- 8.1 The licensee shall establish a safety-training programme for employees involved in the decommissioning operation. The training programme may include pre-employment training, annual/periodic training and specialized training.
- 8.2 The licensee shall ensure that employees, who are involved with the decommissioning operation, have attended a safety training programme covering both radiological and non-radiological safety.
- 8.3 The level of training programme required may vary depending on responsibilities and tasks assigned to the employees involved in the decommissioning project. Ordinary employees should have knowledge on basic radiation protection, warning signs, radiation measurements and workplace hazards. For safety and supervisory employees the training required should be more thorough and it should be recognized by AELB and other relevant authorities including DOSH and CIDB.
- 8.4 It is the responsibility of the licensee to ensure that 'job site' training or a safety briefing session is provided to employees at the beginning of each working day or job task in order to familiarize them with job-specific procedures and safety requirements besides to inform them of the latest condition and hazards present at the work site.
- 8.5 All forms of trainings provided to employees involved shall be recorded. The records shall be maintained to demonstrate that the necessary trainings have been provided to the employees with satisfaction and when retraining should be scheduled for them if required.
- 8.6 The licensee shall ensure that employees, who are not directly involved in the decommissioning operation are allowed to work only in supervised areas with close supervision of RPO, SHO or other trained personnel.
- 8.7 Access to or performing work in controlled areas and any high radiation or contamination areas should be allowed only to trained employees. In this respect, the licensee can take advantage on the presence of employees who have been working with the facility during its operational time by getting them involved in the decommissioning operation so that some of the facility's problems or complexities encountered during the decommissioning operation can be resolved.

## **9. ESTABLISHMENT OF DECOMMISSIONING CRITERIA**

- 9.1 Decommissioning criteria allow for certain decisions to be made and actions to be taken on certain aspects of decommissioning operation, in particular, waste disposal and release of the contaminated materials and facility's site that have safety implication to workers, general public and the environment. Decommissioning criteria are established to ensure that such disposal and release of the materials are done in acceptable manner and without additional unacceptable calculated risk to workers and the general public.
- 9.2 The decommissioning criteria shall be established by the licensee to be presented to and approved by AELB and other relevant authorities. They should be established based on input data and information generated from facility characterization and site characterization and based on the results of the safety assessment and environmental assessment of the decommissioning operation.
- 9.3 The decommissioning criteria required may consist of, but not limited, to the followings:
- a. clean up criteria for the site;
  - b. release criteria for restricted and unrestricted use of the site;
  - c. release criteria for restricted and unrestricted release of the building materials, facility's equipment and components, soils and rocks;  
and
  - d. disposal of radioactive and non-radioactive wastes.
- 9.4 The identified criteria to be used in the decommissioning operation should be indicated clearly in the decommissioning plan (Section 10).
- 9.5 Depending on nature, magnitude and complexity of the decommissioning operation, AELB may appoint an independent qualified or expert group to do verification of the analysis and tests performed to meet the requirements of the criteria established in this section before any release of the site, facility's equipment, components and materials can be made.

## **10. DECOMMISSIONING PLAN**

- 10.1 A licensee who intends to carry out a decommissioning operation on a facility to which he is licensed to shall develop a decommissioning plan. The plan shall be prepared to include all the components specified in the following sub-sections and shall be submitted together with an application letter and appropriate supporting documents (Section 11) to AELB and other relevant authorities for an approval prior to commencement of the decommissioning project.

- 10.2 The plan should be comprehensive enough to cover the entire scope of decommissioning activities identified in the decommissioning operation. It should be able to identify and describe the components in their approximate chronological order and should be expended to provide descriptive information and details, which are very important to ensure adequate establishment and effective implementation of radiation protection programme and industrial health and safety programme for the decommissioning operation.
- 10.3 In cases where the decommissioning operation is intended to be carried out on part of an operating facility, it has to be clearly indicated in the plan. In developing the plan for such situation, care must be taken not to jeopardize the existing safety and security measures and programmes of the operational facility if new radiation protection and industrial health and safety programmes have to be developed or the existing programmes have to be modified to suit the decommissioning operation.
- 10.4 Any comments or issues raised during the review of the decommissioning plan by AELB shall be resolved before commencement of the decommissioning project.

## **Facility Description**

### ***General Information***

- 10.5 The decommissioning plan should have a general description on particulars of a facility to be decommissioned. The information required includes the name and address of the facility, the licensee's name, address and contact number, identification of the license or authorization and ownership of the facility. If ownership has changed during the life of the facility, all previous owners should be identified and indicated in the description. If ownership or the license has been or will be transferred to another party for the purposes of decommissioning, the new entity should also be identified.

### ***Site Location and Description***

- 10.6 The plan should also have a description on type of the facility and location of the facility, including the geographical location, supported by maps to indicate the overall view of the site in relationship to the surrounding areas and community. A more detailed description in the form of key plan and layout of the site should also be provided, which should clearly indicate the facility, buildings and areas to be included and affected by the decommissioning project.
- 10.7 There should also be a description to indicate other buildings or facilities, which are not part of the decommissioning project, but which could be needed to support the project. This description on the location and

facilities should be supported by appropriate site drawings and building drawings, which allow for better understanding of the size and complexity of the facility to be decommissioned.

### ***Building and System Description***

10.8 There should be a description on buildings, major facility systems and ancillary equipment provided in the plan to indicate areas to be included in the decommissioning project. It should be detailed out in the form of engineering schematics and system layout drawings endorsed by registered professional engineer that can provide indication on components, which require removal or decontamination during decommissioning. The information required by the plan should include, but not limited to the following:

- a. building construction: Detailed description on constructed sub-structures, super structures and surrounding infrastructures of the buildings and facility to be decommissioned, which should also include their finishes and other materials, which are not part of but kept in the buildings or facility.
- b. major components: Detailed description on the equipment associated with the facility operation and major equipment and components operated within the affected buildings, which require decontamination, dismantling or release from control and the construction material of the equipment or systems.
- c. building service systems: Detailed description on all utilities and support systems providing various services to the facility and the affected buildings. There should be clear identification of systems that should remain in operation for the dismantling of facility components and those that can be removed immediately upon commencement of the decommissioning project.

10.9 Where decommissioning operation involves only part of the facility, there should be a detailed description on how the decommissioning project is to be carried out in relation to the facility remaining in operation, and the impact of decommissioning project on on-going activities in the rest of the facility.

### ***Radiological Status***

10.10 It is very important to know the radiological status of the facility to be decommissioned at the end of its operational life in order to establish an effective decommissioning plan. The information should be described in detail in the plan and it should be acquired from operating records of the facility and summarized results of the site characterization and facility characterization.

10.11 The information required by the plan should be able to cover the following subjects:

- a. contamination of structures of the facility and the affected buildings;
- b. contamination of support systems and equipment;
- c. contamination of surface soil;
- d. contamination of subsurface soil;
- e. contamination of surface water;
- f. contamination of groundwater; and
- g. contamination of air

10.12 The information provided should be detail enough to cover, at least, the followings:

- a. description on parts, items, areas, equipment, systems and soils which are contaminated with more specific information on their locations (e.g. floors, walls, wall-floor joints, ceilings, equipment, surface soils etc), size of contamination (in  $m^2$ ,  $cm^2$ , Bq/g) and form of contamination or contaminated items (e.g. concrete, steel bars, liquid, surface soils, etc);
- b. degree of contamination and dose rate levels, which should be indicated as the maximum and the average levels on survey drawings for all of the possible contamination described in para 10.12 a;
- c. identification of radionuclides involved and their chemical forms including those used at the facility and that remain at the end of the operating period of the facility and where they are used during the operating period;
- d. the characteristics of the contaminations, which indicate whether they are on the surface, have penetrated into the surface of the materials or soils, non-fixed or fixed, their distribution in the soils or in the sediment;
- e. identification of drainage paths, discharge points and all surface water bodies at the facility that contain residual radioactive material in excess of site background levels; and
- f. the background levels that were used during the characterization surveys and the procedures used to determine these levels.

### *Facility Operating History*

- 10.13 The decommissioning plan should also have a short description on operational history of the facility. The information required include:
- a. any particular chemical and radiological process that was used during the operating period of the facility;
  - b. any significant events that may have occurred which might have an impact on decommissioning or site restoration. Such significant events may include major modifications or renovations made on the facility and any experimental activities that could have had similar impact on decommissioning;
  - c. a description on uses of the facility before radioactive material was involved on the site or in the facility;
  - d. a brief description on monitoring programs being performed in surrounding buildings, on and off site; and
  - e. Other information to further clarify the operational history of the facility.
- 10.14 If the facility has been subjected to multiple owners, they should be identified and a brief history of each owner is described. Similarly, if the facility has been subjected to different licenses or authorizations throughout the life of the facility, it should also be indicated and the type, chemical form and amount of radioactive and non-radioactive materials that were authorized with each license should be described.
- 10.15 There should also be a description given on spills, incidents and non-standard operations that may have had occurred during the life of the facility and require special consideration and attention during the decontamination and dismantling. The types, forms, amounts and concentrations of radioactive and non-radioactive materials involved in the spill or incidents should be indicated and a map drawn to indicate the location of the spills.
- 10.16 In case the facility has previously gone through partial or full decommissioning operation or remediation activities at its site, it should also be briefly described. The description may include types, forms, amounts and concentrations of radioactive and non-radioactive materials involved, summary of radiological and non-radiological evaluation performed and a map or drawing to show where the affected areas were located.
- 10.17 In case the site of the facility contains radioactive and non-radioactive wastes generated by the facility, which was previously buried on site, but must be managed as part of the decommissioning operation, such situation should also be described. The description may include an

estimate of the quantity of the wastes involved, its configuration and a map to indicate location of their burial.

### **Decommissioning Strategy**

10.18 The licensee shall carry out an analysis to select a decommissioning strategy if there is more than one option or alternative available for the decommissioning of the facility. The decommissioning strategy is important to be made known to AELB and other relevant authorities as to why such option is considered as the most suitable and selected for the intended decommissioning of the facility.

10.19 In carrying out the analysis for the selection of the strategy, current regulations, standards, safety, cost, licensee's capability, social impact, condition and operational history of the facility, availability of decommissioning technology and waste disposal facility should be taken into account and incorporated into the decision making process.

10.20 Each strategy should be described in the form it would be applied to the facility. The basic principles, criteria and rationale used and the relevant information considered to select the strategy should be clearly indicated. Any modifications to the strategies that have been considered should be described.

### **Project Management**

#### ***Legal and regulatory requirements***

10.21 The decommissioning plan should describe in detail planning for the decommissioning project and how the project is going to be implemented. In making this planning and implementation, due consideration should be given to all relevant requirements of the local prevailing standards and laws. The standards and laws that can be referred to may include but not limited to the following:

- a. Atomic Energy Licensing Act 1984 (Act 304) and its subsidiary legislations;
- b. Occupational Safety and Health Act 1994 (Act 514) and its subsidiary legislations;
- c. CIDB Act.520, 1994;
- d. Local Councils Act;
- e. Factory and Machinery Act 1967 Revised 1974 (Act 139) and its subsidiary legislations;

- f. Uniform Building By-law Act 143,1994;
- g. Environmental Quality Act 1974 (Act 127) and its subsidiary legislations; and
- h. Registration Of Engineers Act 1997 (Revised 2002) (Act 1158).

10.22 The licensee shall indicate his commitment to facilitate the relevant authorities in ensuring that the requirements of the prevailing standards and laws are complied with.

10.23 In cases where local standards and laws are found to be inadequate or unavailable, the licensee may consider to adopt other international standards but it should be done with prior approval from AELB and other relevant authorities.

### ***Project Management Approach and Organization***

10.24 There should be a clear description given on how the decommissioning project is going to be managed to ensure that the project is done on time, in the most effective and safe manner and with full compliance with the standards and regulatory requirements. The description given should include the following;

- a. the administrative functions that will be in place during implementation of the decommissioning project;
- b. identification of resources that are available or needed to plan, manage and implement the decommissioning project. If there is any shortcoming of resources, it should be made known and explained before the project is engaged;
- c. regular review and monitoring arrangements made to ensure that the decommissioning project is carried out as approved by AELB;
- d. establishment of project schedule with tracking system and agreed holding point, cost tracking system (if required) and change control mechanisms. The schedule should be able to identify major decommissioning phase, start and finish dates, as well as major decommissioning task milestones. It should be able to evaluate the lagging, advancement and float time of decommissioning tasks for the planning and management of the overall decommissioning project. If any software programme is used for the schedule, it should also be described. A detail description on how the schedules are managed during the project should also be documented and included and it can be supplemented by a figure, a chart or a logic diagram to depict the sequence of decommissioning activities;

- e. record and report keeping system that will be implemented during the planning and implementation of the decommissioning project including an identification of which records and reports will be maintained. It is important to note that documents approved by AELB should be recorded and updated regularly by the licensee;
- f. the project management organizational structure, including an organization chart that indicates how the decommissioning organization relates to the rest of the licensee's organization and any safety oversight committees supporting the implementation of the project. This chart should indicate all units involved in the project, such as, management, health and safety, operations, quality assurance, administration with clear definition of roles, responsibilities, duties and authorities and the key personnel involved; and
- g. a specimen of signatory for authorization at all levels and changes made during the course of decommissioning, which shall be recorded.

***Task programme management***

10.25 There should be a clear description given on how individual tasks, work packages and reporting requirements are going to be managed throughout the decommissioning project to ensure that the project is implemented effectively. The description given should include the following:

- a. way of implementing organizational structure for carrying out individual tasks, work packages, reporting requirements to the representative responsible for managing the decommissioning (e.g. project manager);
- b. the procedures for managing the tasks through strategic plan and the use of work packages, such as, Work Plan, Work Method Statement, Job Hazard Statement, permits and written procedures;
- c. procedures for evaluating the task programmes and developing the work packages for each task programme. The works packages should contain information on employees' performances, tools used, machines, plant performance and technical aspects related to the radiological and non-radiological safety. Some of the work tasks and all work packages should be subjected to a review and approval by AELB and other relevant authorities;
- d. procedures on how the work packages are managed during the project and how they are issued, maintained, revised and terminated; and

- e. procedures on how employees performing the tasks are informed of the procedures in the work packages, including initial briefing and when changes occur.

### ***Safety Culture and Training***

10.26 There should be a description given on actions taken by the licensee on how to maintain and improve safety culture among employees after the transition of the condition of the facility from normal operation to decommissioning operation. There should also be a description given on how to monitor the state of the safety culture during implementation of the decommissioning operation. Maintenance and improvement of the safety culture should be done by the RPO and SHO.

10.27 The proposed training of employees involved in the decommissioning operation as stipulated in Section 8 should be described. The description should include the following information:

- a. a description of the radiological and non-radiological safety training that the licensee will provide to each employee including pre-employment, annual/periodic training and specialized training;
- b. a description of any daily worker “jobsite” training that will be provided at the beginning of each workday or job task to familiarize employees with job-specific procedures or safety requirements; and
- c. a description of the documentation that will be maintained to demonstrate that training commitments stipulated in Section 8 are being met.

### ***Contractor support***

10.28 Implementation of the decommissioning operation is often involved with a significant number of outside contractors and sub-contractors. Therefore, the decommissioning plan should also contain a description on the following:

- a. a listing of work tasks or work breakdown structure that will be performed by contractors;
- b. the management interfaces between various management set-ups;
- c. the boundary between the responsibility of the contractor and the responsibility of the licensee;
- d. contractor’s project organizational structure and chart, and duty and responsibility of contractor key personnel involved. The minimum

qualification for contractor's key personnel should follow CIDB regulations and endorsed by the licensee;

- e. a clear definition of the roles of the implementing organization and of the project management organization; and
- f. the oversight responsibilities and authority that the licensee will exercise over the contractors' personnel.

### **Decommissioning Activities**

10.29 The decommissioning operation may consist of the following activities, which are listed down according to their proper sequence that can facilitate the licensee in carrying out the operation. The decommissioning plan shall take into consideration each of these activities and shall clearly describe how they are going to be carried out:

- a. characterization of the facility;
- b. characterization of the facility's site;
- c. removal of the residual process materials;
- d. decontamination of buildings and facility's equipment and components;
- e. dismantling of facility's equipment and components;
- f. demolition of the buildings and the facility;
- g. segregate, package and store of the waste generated prior to be transported to the disposal site;
- h. clean up of the facility's site; and
- i. final radiation survey of the site.

10.30 Characterization of the facility and facility's site should be carried out prior to the decommissioning project and they should be done according to the details given in Section 11.

### ***Tasks and Procedures***

10.31 There should be a clear description given on tasks planned for carrying out the decommissioning activities and those who (the licensee's personnel or contractors) will perform the tasks.

- 10.32 The decommissioning activities should be carried out according to standard procedures, which should be established prior to carrying out the decommissioning operation. The standard procedures may include the following:
- a. radiation protection and control procedures that will be used in carrying out decommissioning activities including control of airborne contamination and dust escaping to the environment and control of ground and underground water contamination during facility and site decontamination;
  - b. procedures already authorized under the existing license and those for which approval is being requested as part of the decommissioning plan; and
  - c. any other unique safety or decontamination procedures associated with the facility, buildings and soil decontamination activities.
- 10.33 The licensee should also indicate in the plan of his commitment that the decommissioning activities will be conducted in accordance with written and approved procedures.

#### ***Residual material removal***

- 10.34 All residual process materials and removable radioactive materials including sealed sources should be removed for reuse, storage in an approved location or disposal before commencement of the decommissioning project in order to minimize radiological and non radiological hazard to personnel involved in the project. Such material removal and disposal should be clearly identified and described in the plan.

#### ***Decontamination***

- 10.35 Decontamination is able to reduce radiation doses to employees and other persons in the vicinity of the contaminated materials and to minimize volume of radioactive waste generated.
- 10.36 The licensee should describe in the plan the overall decontamination strategy taking into account the benefits which results from reduced public exposures, the additional exposures to employees engaged in decontamination operation and the costs saved by minimizing the amount of waste generated.
- 10.37 There should also be a description given on evaluation of its effectiveness, which should be performed before any decontamination strategy is undertaken or a decontamination technique is selected. This evaluation should include:

- a. estimated doses to employees;
- b. consideration of the possible generation of aerosols;
- c. target decontamination level;
- d. consideration of the likelihood that available techniques will achieve the target decontamination level on particular components;
- e. an ability to demonstrate by measurement that the target decontamination level has been reached;
- f. availability of facilities required for decontamination and their eventual decommissioning;
- g. cost of the technique compared with the expected benefit;
- h. size and geometry of components, systems or structures;
- i. type and characteristics of the contamination;
- j. estimation of the volume, nature, category and activity of any liquid or solid wastes;
- k. consideration of compatibility of these wastes with existing treatment, conditioning, storage and disposal systems and discharge limits;
- l. any possible deleterious effect of decontamination on equipment and system integrity;
- m. any possible on site and off site consequences as a result of decommissioning activities; and
- n. non-radiological hazards (e.g. the toxicity of solvent used).

10.38 The decontamination technique selected should also be described. The decontamination of facility's equipment and components and remediation or clean up of the facility's site should be carried out with due consideration given on ALARA and the decommissioning criteria stipulated in Section 9.

### ***Dismantling***

10.39 Dismantling should be carried out with due consideration given on the followings. Dismantling techniques used should be described in the plan:

- a. reduction in size of objects/components to facilitate decontamination, handling, etc.;
- b. facilitating access to radiation sources or other radioactive material for further management;
- c. segregation of contaminated equipment, structures and materials from those which are less contaminated or not contaminated, in order to reduce radiation hazards to employees in subsequent handling and also to reduce the quantity of waste requiring final disposal; and
- d. Security of the dismantled contaminated materials and wastes.

### **Surveillance and Maintenance**

10.40 In view of such a long period of time usually involved with a decommissioning project, all major pieces of equipment and systems (fixed and non-fixed) used during the implementation of the decommissioning project would, therefore, require establishment of scheduled maintenance. This requirement should be identified and described in the decommissioning plan. The maintenance may require additional special consideration in cases where the decommissioning strategy chosen is deferred decommissioning. There should also be a description given on surveillance requirements for systems and buildings, which may include surveillance methods, frequencies and specifications for acceptance and periodic review and modification of the schedule for maintenance and surveillance.

### **Waste Management**

10.41 Decommissioning operation invariably involves with generation of radioactive waste. The waste generated is usually of different nature and form than the waste generated and handled during the operating period of the facility. Therefore waste management should be properly addressed in the decommissioning plan. Effort must be taken by the licensee to choose the right decontamination strategy and technique that can minimize the generation of waste.

10.42 Adequate and appropriate waste facilities should be provided to cater for the wastes generated from the decommissioning activities. The facilities should have adequate capacity to handle the secondary waste generated as a result of carrying out the decommissioning activities and the waste that may be generated from accident.

10.43 The waste should be segregated and packaged to facilitate in handling during temporary storage. Packaging of the waste material should comply with the standard and procedures recognized by AELB.

10.44 Appropriate waste tracking system and quality assurance record should be established and implemented and it should also be described in the plan.

***Waste Identification, Estimation and Characterization***

10.45 All the waste streams generated during implementation of the decommissioning activities should be identified and specified according to waste classification which include radioactive waste, hazardous waste, mixed waste, other types of non-hazardous waste, recyclable material and cleared material.

10.46 The licensee shall estimate and indicate clearly in the plan the volume of each type of waste generated based on the information and input data generated from facility and site characterization, decommissioning criteria established, the decommissioning method chosen and the amount of radioactivity by radionuclide. There should also be an indication when the waste is expected to be generated. Estimation of volume of waste generated should be done by a qualified quantity surveyor.

10.47 The decommissioning wastes should be characterized and segregated according to type of radionuclides (alpha and beta-gamma emitters) or according to half-life: short (< 1 year), medium (1 - 30 years) and long (>30 years) and this should be indicated in the plan.

10.48 There should be a description on the commitment of the licensee towards a goal of waste minimization by recycling some of the material or other methods that fall within the release criteria.

***Solid Radioactive Waste***

10.49 The licensee should indicate in the plan a summary of the types of solid radioactive waste that are expected to be generated from decommissioning activities including soil, structural and component metal, concrete, contaminated components and piping, wood and plastic. The licensee should ensure that a temporary storage is provided and adequate to cater for the amount of solid waste generated.

10.50 The wastes should be segregated and packaged immediately after they are generated. The waste package should immediately be transported to an approved disposal site upon completion of packaging process. In cases where the waste has to be stored on site due to unavailability of an approved disposal site or for other reasons, a safe and secured storage place has to be made available prior to commencement of the decommissioning activities.

- 10.51 The plan should also contain a description on how the contaminated soils or other loose solid radioactive waste will be handled from being re-disbursed after exhumation and collection.

### ***Liquid Radioactive Waste***

- 10.52 The plan should contain a description on measures taken to reduce the volume of liquid wastes that will be generated by decommissioning activities.
- 10.53 The liquid wastes should be collected and placed in appropriate and adequately shielded containers immediately after they are generated. It is recommended for the liquid waste to be converted into a stable form by treatment and conditioning and packaged immediately after they are collected. The waste package should immediately be transported to an approved disposal site upon completion of conditioning and packaging process. In cases where the waste package has to be stored on site due to unavailability of an approved disposal site or for other reasons, a temporary safe storage place has to be made available prior to commencement of the decommissioning activities and it has to be adequate to cater for the amount of liquid waste generated from decommissioning activities.
- 10.54 In cases where any radioactive discharge to the environment has to be made during decommissioning operation, the licensee shall ensure that the amount discharged over a stipulated period of time does not exceed the release limit established as part of the release criteria described in Section 9. The licensee shall comply with the directives given by AELB as to how the discharging of radioactive waste should be carried out.

### ***Mixed Waste***

- 10.55 There should be a description on types of solid and liquid waste that contains both radionuclides and other hazardous material and when they are expected to be generated during decommissioning activities. There should also be a description on measures taken to reduce the volume of mixed waste generated from the decommissioning activities.
- 10.56 The mixed wastes should be collected and placed in appropriate and adequately shielded containers immediately after they are generated. It is recommended for the mixed waste to be converted into a stable form by treatment and conditioning and packaged immediately after they are collected. The waste package should immediately be transported to an approved disposal site upon completion of waste packaging process. In cases where the waste package has to be stored on site due to unavailability of an approved disposal site or for other reasons, a temporary safe storage place has to be made available prior to

commencement of the decommissioning activities and it has to be adequate to cater for the amount of mixed waste generated from decommissioning activities.

10.57 The licensee shall coordinate with other relevant authorities that have jurisdiction over non-radiological hazardous components contained in the waste and this should be described in the plan.

### **Cost Estimate and Funding Mechanisms**

10.58 Cost estimate should be calculated and included in the decommissioning plan. It can be calculated based on information provided in the decommissioning plan, such as, facility description, decommissioning activities and waste management. The estimate can be used to assist in preparing the project schedule, workforce requirement and phased funding.

#### ***Cost estimate***

10.59 The specific approach and process that have been used to generate a cost estimate for the full implementation of the decommissioning plan and for decommissioning of the facility should be identified and briefly described in the plan. The description should include the following information:

- a. process to generate a cost estimate (a logic diagram may be included to depict the sequence of activities);
- b. basic description on the extent of the facility covered by the cost estimate;
- c. all assumptions used in the cost estimate including labour costs, disposal costs, working hours, and on-site transportation;
- d. a summary of the costs by phase or major task, labour constant, man-hours by task and estimated cost of wastes generated; and
- e. contingency allowance and uncertainties of the cost estimate

10.60 Details on costing made should be provided in the appendix of the decommissioning plan as backup details information for an independent review of the entire cost estimate.

#### ***Funding mechanisms***

10.61 The plan should have description on funding mechanism, which are already present or will be in place for the completion of the

decommissioning activities on a time scale as commensurate in the decommissioning plan. The description should also include a summary of measures that will be used to manage project risks and prevent or mitigate cost escalation.

### **Safety Assessment**

- 10.62 A new safety assessment is normally required when a facility moves from an operational to a decommissioning mode. The licensee shall ensure that this assessment is carried out for the intended decommissioning operation and it should be included in the decommissioning plan. A detailed safety assessment report can be prepared separately, but it should be submitted together with the decommissioning plan to AELB when applying for an approval.
- 10.63 The extent and detail of the safety assessment should commensurate with the complexity and the hazard associated with the facility. It should be able to identify and evaluate both radiological and non-radiological hazard associated with the decommissioning operation. It should be able to assess adequacy of protection and safety to employees involved, public and the environment resulting from physical and mechanical changes, deteriorating condition of the facility and the possibility of accident happened while carrying out decommissioning activities.
- 10.64 The assessment should, as far as possible, be made based on site-specific data and information, which include data and information generated from facility and site characterization (Section 11).

### ***Identification of relevant safety criteria***

- 10.65 The safety criteria, which provide basis for evaluation of the safety assessment, should be identified and established by the licensee and they should be described in the plan. The criteria should be applicable to all decommissioning activities and established based on dose to employees, dose to the public, discharges to the environment, and exposure to chemical and non-radiological hazards.

### ***Operational limits and conditions***

- 10.66 The operational limits and conditions, which apply to the operating facility, should be identified and it should be reviewed to determine their applicability to the decommissioning operation, in particular, with regard to release limits for discharges of gases and liquid effluents. There should be justification for the continued use of existing limits and conditions of the facility. Any new applicable criteria and relevant limits and conditions concerning non-radioactive materials should also be considered, if applicable.

### ***Hazard analysis of normal decommissioning activities***

- 10.67 The hazards of radiological and non-radiological nature should be analysed for individual decommissioning activities taking into account the decommissioning strategy, anticipated activities and results of the characterization survey. Where applicable, the analysis should include:
- a. standard external events and hazards specific to the decommissioning activities;
  - b. doses to the workforce, other impacts on them and the environment from known radioactive contamination in the components and the facility;
  - c. evaluation of situations where the radioactivity content may turn out to be higher than expected; and
  - d. identification and evaluation of relevant hazards due to demolishing of buildings and facilities.

### ***Hazard analysis of abnormal events and incidents***

- 10.68 There should be a description on identification of abnormal events, incidents and methods and assumptions that were used to identify and analyse these events and incidents, and presents the results of the analysis. The description may include loss of contaminated materials and wastes and list of all the hazards and fault/accident conditions applicable to the decommissioning activities and reasons for selecting certain scenarios for further analysis and for excluding some identified events. Radiological and non-radiological hazards should be listed separately. Types of consequences arising from each event and incident shall be identified and list of preventive measures both engineered and administrative for mitigation.

### ***Assessment of potential consequences***

- 10.69 There should also be a description on potential consequences and estimated doses to employees, the public and the environment from normal decommissioning activities as well as the potential consequences from the scenarios selected for abnormal situations. The description should also include methods used for assessing non-radiological consequences, identification of potential physical injuries to employees as a result of abnormal situations, a list of reference to

any data sources used and assumptions that have been made in the assessment.

### ***Preventive and mitigating measures***

10.70 The SSCs and the administrative preventive measures, which are essential for safety, should be identified and described. Such identification and description may include how the performance requirements of the SSCs will continue to be met during the decommissioning phases, the examination, maintenance, inspection and testing requirements for each SSC and the administrative preventive measures and actions that will be taken to mitigate the effects of identified hazards and reduce their impacts on employees, the public and the environment.

### ***Risk assessment***

10.71 The safety assessment should include an appropriate risk assessment that commensurate with the degree of hazard involved, and it should be able, after taking into account the likelihood and consequences of the selected scenarios, to demonstrate that the resulting risks have been minimized. The hierarchy of preventive and control measures employed, both engineered and administrative, should be described with sufficient evidence to indicate defence in depth exists. If at this stage this preventive and control measures cannot be demonstrated, the preventive and mitigating measures (and possibly the planned decommissioning activities) shall be reconsidered. Appropriate analyses should be undertaken, including a cost–benefit analysis, to ensure that the principle of optimisation has been fully satisfied and that no further reasonably practicable measures shall be available to further reduce the risks.

### ***Comparison of analysis results with relevant safety criteria***

10.72 The safety assessment should include a comparison of the safety analysis results with the established safety criteria. It should be described in the form of a summary of the assessment of routine doses and discharges and the risk assessments for radiological and non-radiological hazards from the decommissioning activities and it should be able to show that the doses and discharges meet all the established relevant operational limits and conditions. The total radiological risks to both employees and members of the public should be evaluated and their comparison with the relevant dose limits should also be described. The environmental impacts from the decommissioning activities should also be described in summarized form and it should be able to show that these impacts have been optimised.

10.73 The results of safety assessment should be concluded and a statement should be made on the acceptability of the decommissioning plan from a safety and environmental impact point of view.

### **Environmental Assessment**

10.74 The decommissioning plan should include a section on environmental assessment, which normally describes summary of the assessment. The licensee should ensure that this assessment is carried out for the intended decommissioning operation. Detailed environmental assessment can be prepared as a separate report, which should be submitted together with the decommissioning plan to AELB when applying for an approval. The summary of the assessment included in the decommissioning plan should have a brief description on the following:

- a. background information, which include the objective and scope of the decommissioning project and any applicable environmental protection laws, regulations or other requirements that need to be complied by the decommissioning project;
- b. description of project, which should include:
  - identification of the decommissioning activities that could result in an environmental release from the facility and impact on the local environment;
  - description of the potential pathways that could be involved with these releases;
  - evaluation of the potential discharge for each activity; and
  - description of the form (i.e. airborne, liquid, solid or gaseous) for potential release with regard to radionuclide and chemical form.
- c. Environmental protection programme, which should include:
  - description of the environmental monitoring programme that can verify the environmental protection programme is being properly implemented;
  - a map or site plan that identifies the locations on-site and off-site monitoring stations and sampling locations which includes monitoring for all pathways;
  - description of the equipment that will be used at each location, along with its capabilities and limits of detection;

- frequency for performing the monitoring, i.e. replacement of filters, dosimeters and sample collections;
- types of samples that will be collected and the analytical procedures; and
- procedures to determine the background and baseline concentrations of radionuclides in environmental media. The average background values for the site or areas of the site and the surrounding area should be provided.

d. effluent monitoring programme, which should include:

- background and baseline concentrations of radionuclides in environmental media;
- identification of all radionuclides in the effluents that will be generated from decommissioning activities;
- description of the physical and chemical characteristics of radionuclides in effluents;
- map, drawing or description of all effluent discharge points;
- sample collection and analytical procedures that are collected at the discharge points to ensure that the samples are representative of what is being released;
- representative samples of liquid effluents shall be taken at each release point for the determination of concentrations and quantities of radionuclides released to an unrestricted area;
- minimum detectable activity for the effluent monitoring equipment;
- frequencies of effluent sample collection.; and
- recording and reporting procedures for effluent monitoring.

e. effluent control programme, which should include:

- description of the controls to minimize releases of radioactive materials to the environment based on well-recognized industry practices and procedures;
- summary of the action levels and description of the actions to be taken, should a limit be exceeded;

- description of the leak detection systems for ponds, lagoons, and tanks based on well-recognized engineering practices;
- description of the procedures to ensure that releases to sewer systems are controlled and maintained to meet the requirements of regulations; and
- description of the method and estimation of doses to the public from expected effluents.

## **Health and Safety**

10.75 The decommissioning plan should have a description of health and safety programme developed according to the requirements stipulated in Section 7 for the decommissioning operation. It should be able to cover the details of both radiation protection programme and industrial health and safety programme. There should also be a description on safety audit planned to be carried out on the decommissioning operation, its type and frequency.

### ***Optimisation analyses and programme***

10.76 There should be a description given on the administrative system used for evaluation of the work performed to determine optimisation of safety and minimization of doses and occupational hazards. This include the procedures for documenting significant findings and the procedure for communicating these findings through a lessons learned programme, the procedures for performing a detailed dose estimate incorporating ALARA principles for all major tasks and the engineering and administrative controls that will be implemented to limit the dose to employees (e.g. incorporation of shielding, limitation of stay time and rotation of employees).

### ***Decommissioning criteria***

10.77 The decommissioning plan should also include a description on the decommissioning criteria used and the procedure to be followed to ensure that the release criteria have been met for the release of building materials, facility's equipment and components, soils and rocks from regulatory control and for reuse of the materials, equipment and components during and after decommissioning. The decommissioning criteria should be established according to the requirements stipulated in Section 9.

10.78 The procedure to ensure compliance with the decommissioning criteria for building materials, facility's equipment and components, soils and

rocks should be made based on the following evidence and it should also be included in the plan:

- a. records of usage;
- b. certificates;
- c. approval documents;
- d. as-built drawings; and
- e. decontamination survey report.

### ***Final release criteria***

10.79 The decommissioning plan should also have a description on the site release criteria to be achieved at the end point of the decommissioning project and an explanation on how the optimisation process was considered during the development of these criteria. There should also be a description on procedures for verifying that the criteria have been met.

### **Quality Assurance**

10.80 QA provides adequate confidence in the validity and integrity of the reported data, information, methods and procedures generated, established or used during the decommissioning operation, as well as in the protection, retrievability and replicability of the data and information. The QA is important to ensure that appropriate controls are in place so that identified objectives and all requirements of the decommissioning plan are achieved.

### ***Quality Assurance Programme***

10.81 The QA programme should be established and described in the decommissioning plan. The QA programme should be able to cover the whole decommissioning operation process including the facility characterization process and the site characterization process to ensure that all activities involved, including those performed by contractors and sub-contractors, are subject to the applicable controls of the QA programme. The programme should be approved by AELB and implemented during and throughout the decommissioning operation to ensure that these activities are of acceptable quality and implemented as planned.

10.82 The QA programme should contain a brief summary of corporate QA policies of the licensee or contractor.

10.83 There should also be a procedure for notifying AELB about changes of the approved QA programme and QA organization within 30 days after the confirmation of the changes.

10.84 The QA programme should include, but not limited to, the following items:

a. Organization

- There should be a QA organization established to give an overview of how the QA system works and to prescribe the authority, duties and responsibilities of persons/units responsible for performing activities covered by the QA programme. It should be described in relation to the decommissioning organization with special attention given to the relationship between the implementing and project management structure. There should also be a clear explanation given on the procedures for managing the delegation of responsibilities within the decommissioning project.
- The organizational responsibilities for ensuring activities which are affecting quality should be prescribed in the form of documented instructions, procedures and drawings; and the way they are accomplished through implementation of these documents should be described.

b. Training of Personnel

- Personnel play very important role in ensuring successful implementation of QA programme. Therefore, training in related fields should be provided to employees who are responsible for performing activities affecting quality and its records should be kept. This training need should be considered in addition to the training requirements stipulated in Section 8 to ensure health and safety. For formal training and qualification programmes, documentation should include the objectives and content of the programme, attendees, and date of attendance.

c. Document Control

- The QA programme should have a summary of types of document that are included in the programme and a description on the procedure for developing, issuing, distributing, revising and retiring these documents to ensure that the directions are understandable and they reach those responsible for the activities.

- d. Control of Material, Design and Measuring and Test Equipment
- It is the responsibility of the licensee to establish and implement a system for identification and control of materials, parts, components, field and laboratory samples and for control, verification, validation and maintenance of standard of all design works and software and this responsibility should be indicated in the plan.
  - The QA programme should also include establishment and implementation of a system to ensure that all testing are performed according to written procedures and all measurements and test equipment are controlled, calibrated and maintained accordingly. All radiological and non-radiological tests should be carried out by an accredited laboratory and approved by AELB and other relevant authorities and the test results should be documented and retained.
- e. Instructions, procedures and drawings
- The QA programme also requires description on establishment and implementation of the standard procedures to be followed during the decommissioning operation and standard procedures to be performed in the preparation, review, approval and control of instructions, procedures and drawings.
- f. Non-conformance
- Measures should be established to ensure that conditions adverse to quality e.g. failures, malfunctions, defects and non-conformance are promptly identified and corrected. Any corrective action and follow-up activities by the QA organization should be documented and maintained after the corrective action has been implemented.
- g. Quality Assurance Records
- QA records which consist of results of review, inspections, tests, audits and material analyses, monitoring records of work performance; and records on the qualification of employees, procedures, and equipment should be identified, established and maintained to indicate that activities affecting quality have been performed properly.
  - The QA organizations and other organisations involved in the establishment and maintenance of QA records and procedures for storing the records should be identified and described.

- h. Audits and Surveillance
  - Management reviews should be performed to ensure that quality is maintained during the decommissioning activities.
  - The QA program also requires an audit and surveillance programme to be established and implemented for the purpose of inspecting the results of activities affecting quality and to verify decision for acceptance or rejection. There should be an audit group formed to carry out these tasks and to prepare a report. The follow-up activities associated with audits and surveillance should be described.
  - In addition to audit, the QA programme also identify the need to establish the self-assessment programme which allows for self-assessment to be carried out to confirm that activities affecting quality comply with the QA programme. The licensee shall ensure that persons performing self-assessment activities are not to have direct responsibilities in the area they are assessing.
  
- i. Lessons Learned Programme
  - The lesson learned programme should be established and described in the QA programme. It should consist of the followings:
    - o description of the lessons learned from the decommissioning operation;
    - o procedures for capturing and recording the lessons learned during the decommissioning operation;
    - o description on method for making the information available to others within and outside the organization; and
    - o description of the feedback mechanism for this information in the overall decommissioning operation.

### **Emergency Planning and Preparedness**

10.85 The licensee is required by the Radiation Protection (Basic Safety Standard) Regulations 1989 to establish emergency planning and preparedness to cater for any accident or incident that may occur during implementation of the decommissioning operation. It is one of the components required to be included in the radiation protection programme and industrial health and safety programme and it should be described as part of the programmes in the decommissioning plan. The content of the emergency plan should consist of, but not limited to, the following items:

a. Emergency Sources and Emergency Organization

- The emergency plan should be able to identify and capture all eventualities and accident scenarios that can lead to emergency situation during implementation of the decommissioning project. The emergency plan should have an emergency organization and chart, which identifies key personnel and groups involved in response action and their roles and responsibilities to be carried out during an emergency. It outlines details of the necessary response actions and lines of communication between various personnel and groups involved.
- The organization should identify the roles and responsibilities of outside support groups, such as, fire departments, medical personnel, police and utility companies, if they are required and description of the arrangements made with these groups in case of on-site and off-site actions. There should also be a description on modifications and their justification in operational arrangements concerning emergency response due to specific decommissioning activities.

b. Emergency situations

- The emergency plan should also contain description on:
  - procedures for responding to emergency situations and how to carry out countermeasures;
  - maintenance of the above procedures throughout the decommissioning period;
  - mitigation of the consequences of an accident at its source;
  - prevention or minimization of radiation exposures to prevent adverse health; and
  - recovery from an accident or incident and to ensure that the facility is in a safe condition.

c. Maintaining Preparedness

- The emergency plan should always be maintained and kept in the state of preparedness to ensure that it is always ready and can be implemented effectively when an emergency occurs during decommissioning. It is, therefore, very important for the plan to be made known to employees involved and for them to familiarize

with the standard operating procedures in the event of an emergency, for the emergency personnel to have appropriate training and retraining on the subjects involved besides to update them with the latest information and procedures that need to be implemented, and for the plan itself to have regular scheduled or unscheduled drill and exercise to ensure that emergency equipment, emergency personnel and their response capabilities are always in the state of readiness for emergency.

d. Emergency Equipment and Supplies

- The plan should have a list of emergency equipment available to respond to radiological and non-radiological emergencies during decommissioning and indication about locations where they are being kept at the decommissioning project site. There should also be a description on procedures for carrying out periodic checking of the equipment to ensure its operational status.

e. Reports and Records

- The plan should indicate the requirement for all accidents and incidents happened during implementation of the decommissioning project to be investigated and their report prepared. It should have a description on procedures for performing investigations, procedures for ensuring corrective actions are implemented and verified, procedures for recording emergency events and reporting procedures to AELB and other relevant authorities.

### **Validation and Final Radiation Survey**

10.86 The licensee should describe in the decommissioning plan an overview of a plan for conducting the final radiation survey. The detail of the final radiation survey plan is described in Section 11 and it should be submitted as a supplementary document together with the decommissioning plan when applying for an approval for the decommissioning operation.

10.87 The overview of the final radiation survey plan should describe how the facility and site would be surveyed to demonstrate compliance with the release criteria. The description should include, but not limited to the following information:

- a. methods to ensure that sufficient data about pertinent structures, systems, components, equipment, the site, and the environments are included in the survey (including maps, diagrams, and plant layout drawings);

- b. types, calibrations and operating conditions of instruments to be used;
- c. methods to obtain and analyse data, including the methodology selected to translate instruments or sample analysis results into appropriate units for inclusion in a report;
- d. comparison with pre-operational radiation survey results and other data on background radiation;
- e. methods for auditing and verifying data;
- f. quantitative error analyses of the results; and
- g. basis and methods for making statistical inferences from the data selected to ensure that all significant residual sources of radiation are found and quantified.

10.88 The final radiation survey shall be carried out by the licensee. A report should be prepared once the final radiation survey finished and it should form the basis for verifying that the facility and the site meet decommissioning criteria that permit release of the property by AELB for restricted or unrestricted use.

10.89 An expert group or an independent consultant may be appointed to assist AELB in verification and validation of the actual survey and its report.

10.90 The results of the final radiation survey should be included in the final decommissioning report.

### **Restoration and release of Site**

10.91 The site shall be restored to the condition approved by AELB upon completion of the validation and prior to its release. Care must be taken to minimize the impact of soil erosion, flood and slope instability under the influence of normal environmental condition using recognised engineering methods.

10.92 As-built drawings of the site should be endorsed by registered professional engineer and made available to the relevant local authorities by the licensee prior to release of the site.

### **Completion of Decommissioning**

10.93 A final report on decommissioning operation shall be prepared by the licensee once the decommissioning project is completed. It should provide the confirmation of completion of decommissioning operation

and should be reviewed and approved by AELB. In cases where decommissioning operation was not planned for the whole facility or site, the non-decommissioned or partially decommissioned part of the facility or site that remain after completion of the decommissioning operation should continue to be placed under the regulatory control of AELB.

10.94 The final decommissioning report should be prepared according, but not limited, to the followings:

- a. the decommissioning objective;
- b. a description of the facility and site;
- c. the decommissioning criteria used;
- d. a description of the decommissioning activities;
- e. a description of any remaining buildings or equipment not decommissioned or partially decommissioned;
- f. the final radiation survey report;
- g. an inventory of radioactive wastes generated including indication of their storage and/or disposal;
- h. an inventory of non-radioactive waste generated including indication of their storage and/or disposal;
- i. an inventory of materials and equipment released from regulatory control;
- j. a list of structures, areas or equipment designated for restricted use;
- k. a comparison of actual volumes of waste generated during decommissioning works with the amounts projected in the plan;
- l. a summary of abnormal events and incidents that occurred during decommissioning;
- m. a summary of occupational and public doses received during decommissioning;
- n. site release report and
- o. the lesson learned during the decommissioning process.

## **11. RELATED DOCUMENTS**

### **Characterization Survey Plan**

- 11.1 Facility characterization and site characterization are a critical aspect of the decommissioning process, which should be carried out by the licensee prior to development of the decommissioning plan. It is aimed at identifying the nature, extent and location of radioactive contaminations; their concentrations or levels of surface contamination and their distribution throughout the facility and the site to be decommissioned.
- 11.2 The information generated from this characterization process is important to estimate volumes for various types of waste generated, to plan work to keep radiation exposure ALARA, to choose the optimum methods for decommissioning, to prepare a decommissioning plan (Section 10), safety assessment report, environmental assessment report and to establish decommissioning criteria (Section 9) if required.
- 11.3 The licensee shall establish a characterization plan, which covers both the facility and the site, to ensure that the necessary information is adequately captured and the process of acquiring the information can be done effectively. The characterization plan shall be prepared to include all the components specified in the following sub-sections and shall be submitted to AELB for an approval prior to submission of an application letter and the decommissioning plan (Section 10).

### ***General Information***

- 11.4 The characterization plan should have a general description on background of the facility to be decommissioned. The information provided should include:
  - a. the name and address of the facility, the licensees' name, address and contact number, identification of the licence or authorization;
  - b. type of the facility and the process and activities which were previously involved;
  - c. location of the facility and the site in relation to the surrounding community and their sizes;
  - d. detailed building and site layouts which indicate existence of other facilities and buildings on the site, which are and are not involved in the decommissioning operation, buildings which are affected by the operation and those which are required to support the operation;
  - e. appropriate drawings, which indicate boundaries, reduced level or formation level and control point of the survey required and other

information to allow for better understanding of the size and complexity of the facility involved; and

- f. a general description of all buildings, major facility systems and ancillary equipment, which include schematic engineering and system layout drawings that can provide additional information about the systems and major components required to be removed or decontaminated during decommissioning.

### ***Document and Historical Review***

11.5 The characterization plan should also have a short description on past activities and radiological conditions of the facility and its support structures and buildings, means to classify different radiological areas and clean areas and possibility of existence of residual contamination on and off the site. Such information required for this description may be acquired from the following sources:

- a. historical documentation accumulated and kept over an operational period of the facility;
- b. the site licence, licence conditions and amendment applications, inspection records, disposal records, facility operation records, routine survey reports, accident reports, site maps and drawings and process flow diagrams; and
- c. unofficial sources, which may include senior or former employees at the facility, old photographs of construction or modifications and newspaper articles.

### ***Identification of Potential Contaminant Sources and Locations***

11.6 The licensee should be able to identify all possible sources of contaminants, their type, amount or concentration and locations. This may include known radionuclides used at the facility and those, which may present as a result of contamination, transfer from other areas or unplanned accumulation of the material that has taken place over a period of time.

11.7 The identification of sources should be given more emphasis on the known locations of radiological contamination at the site, which may include areas where radioactive material was handled and processed, where waste was managed and where spills, fires and other operational incidents had occurred. Confirmation of the presence of these sources could easily be made with detailed review of operational records of the facility.

- 11.8 If radioactive material originally present has decayed to background levels and no further characterization activities are necessary, a justification together with explanation on the method used should be made to show that the release criteria have been met.
- 11.9 Maps and tabular data of various areas of identified sources should be included and presented to display the radiological conditions at the facility as currently known.

### ***Characterization Surveys and Background Surveys***

- 11.10 There should be a description given on how to carry out sampling, sample preparation, radioactivity measurements and radiation measurements for the purpose of meeting the characterization plan. The description provided should include the following requirements:
- a. the standard procedures used to perform sampling, sample preparation and detailed analyses and measurements;
  - b. the types of survey (e.g. surface gamma radiation, , fixed contamination, non-fixed contamination, airborne contamination, waterborne contamination, Radon and Thoron);
  - c. the areas of survey (all areas of the facility and site, scraping inside of piping, pumps, and other equipment, surface wipes for non-fixed contamination, coring samples from concrete surfaces, and soil samples);
  - d. type of instrument used in the survey, its MDL, conversion factors and characteristics;
  - e. measurement locations in each area of the facility to obtain a complete radiological snapshot of the facility;
  - f. explanation of a grid system if it is used during the survey and the rationale behind the design of the system;
  - g. maps, drawings or other visual representations of the areas and systems that will be surveyed or sampled with clear indication of measurement or sample locations;
  - h. a list of types of samples that will be collected, the number of each type of sample involved, the size and location of each sample and the analyses that will be performed;
  - i. the process used to verify the presence of any buried material on site or areas with sub-surface contamination;
  - j. procedures to record field data and analytical results;

- k. the process that will be used to track smears and samples from the time they are taken to their final disposition.; and
- l. the process used to establish the natural background levels in the facility for background correction.

11.11 QA is very important in sampling and measurement to ensure that the results produced are reliable, accurate and acceptable for the purpose of meeting characterization plan. The QA provisions as described in Section 10 for the samplings and measurements should, therefore, be established and described in the characterization plan.

11.12 Accuracy and reliability of measurement results are also affected by knowledge and experience of employees involved in carrying out the work. It is, therefore, also important for the training and qualifications of the employees involved to be considered and indicated in the plan.

### ***Health and Safety Provisions***

11.13 Safety hazards and any special safety concerns that might be encountered during the survey and sampling activities should be identified and described in the characterization plan. This may include provisions to be taken by survey teams to protect employees and the public during the characterization effort and procedures taken to prevent releases of radioactive materials into the environment from implementation of characterization activities.

11.14 Implementation of characterization activities must include consideration of ALARA of employee exposure received from radiation and contamination present at the facility and the site. In cases of high radiation fields or excessive contamination levels, accurate measurement and/or extensive sampling for laboratory analysis may not warrant the health risks associated with radiation dose to employees or possible contact with hazardous materials. In these cases, it is acceptable to estimate the required information by calculations or extrapolations utilizing conservative methods.

### ***Data Interpretation and Results***

11.15 The method for presenting the data in the characterization report should be identified and described in the characterization plan. The description should include the following:

- a. the process which is used to convert the collected field measurements into units comparable to those of the decommissioning criteria;

- b. the procedures for determining the average values and standard deviation for the survey units and their comparison with the decommissioning criteria;
- c. the methodology used to calculate the MDL of the instrument or analytical technique and the measurement uncertainty;
- d. the procedure for statistically validating the collected data against the desired confidence level objective;
- e. the method for determining areas that have contamination above the release criteria; and
- f. the disposition of the records containing raw data and the storage requirements for the records.

### ***Comparison with Decommissioning Criteria***

11.16 The plan should also have a description on the process used to compare the collected data with the decommissioning criteria for releasing equipment, components, areas or to identify areas not requiring any further action. The description should also include means to identify any newly identified contaminants or locations of contaminants that were discovered during the characterization survey.

### ***Report***

11.17 There should be a brief description given on the contents of the characterization survey report that will be prepared after the characterization survey has been completed. The report can be prepared as one report or separately for the facility characterization and the site characterization and this should be indicated in the plan.

### **Characterization Survey Report**

11.18 This report shall be prepared by the licensee according to the description given in para 11.17. It should represent a summary of all the radiological data and information that were collected after implementing the characterization activities. It represents a final status report about the facility and the site before commencement of the decommissioning operation. The information contained in the report is also used to finalize the decommissioning plan. The report also provides the basis for nearly all of the remaining planning work for implementation of the decommissioning operation of the facility and the site.

### ***General Information***

- 11.19 The characterization survey report(s) should practically contain the information described earlier on in the characterization survey plan. It should have a general description on background of the facility and the site to be decommissioned. The information provided should include:
- a. the name and address of the facility, the licensees' name, address and contact number, identification of the licence or authorization;
  - b. type of the facility and the process and activities which were previously involved;
  - c. location of the facility and the site in relation to the surrounding community and their sizes;
  - d. detailed building and site layouts which indicate existence of other facilities and buildings on the site, which are and are not involved in the decommissioning operation, buildings which are affected by the operation and those which are required to support the operation;
  - e. appropriate drawings, which indicate boundaries, reduced level or formation level and control point of the survey required and other information to allow for better understanding of the size and complexity of the facility involved; and
  - f. a general description of all buildings, major facility systems and ancillary equipment, which include schematic engineering and system layout drawings that can provide additional information about the systems and major components required to be removed or decontaminated during decommissioning.

### ***Review of Historical Documentation***

- 11.20 The report(s) should include results of historical documentation review from the operational period of the facility that were pertinent and useful for the implementation of the characterization plan. It should also contain information concerning spills, fires or other operational occurrences that could have an impact on the decommissioning operation. The report(s) should be able to highlight past onsite waste disposal or other activities that were found during the review of records and verified by the characterization survey.

### ***Identification of Contaminant Sources and Locations***

- 11.21 The report(s) should be able to indicate all possible sources of contaminants, their type, amount or concentration, chemical

composition, physical form and locations. It should also contain a description on ratios of the radionuclides and reason for differences of the radionuclides or ratios of the radionuclide found in different locations of the facility and the site.

### ***Measurements Made and Analyses Performed***

- 11.22 There should be a description on procedures used to perform detailed measurements in the facility and types of survey involved. This includes QA provisions and procedures to determine general area background radiation and the process used to track smears and samples from the time they were taken. All locations of measurements and samplings should be indicated on maps of the facility and the site, which should also be attached together in the report(s).
- 11.23 The survey and sampling results obtained from the characterization activities including those of background determination should be summarized in the report(s) and the detailed data are provided in an appendix of the report(s). Maps and drawings can be used to portray this information and provide clear overview of the radiological conditions at the facility.
- 11.24 Any buried structures, equipment or disposal remains that were found during the characterization should be described and their radiological status summarized in the report(s).

### **Final Radiation Survey Plan**

- 11.25 The final radiation survey plan provides all the necessary information planned to be carried out in the final radiation survey of the facility and the site to be decommissioned. It shall be submitted together, as a supplementary document, with the decommissioning plan (Section 10) for review and approval by AELB.
- 11.26 The final radiation survey is required to ensure that the release criteria have been met and the site is safe to be released from further regulatory control by AELB.
- 11.27. The general content of the final radiation survey plan prepared by the licensee shall include, but not limited to the following information:
- a introduction and general description of the facility and the site, which include:
    - name, address, geographical location of the facility;
    - activities performed and process description, historical documentation from operational period of facility;

- site description including a site layout, building drawings; and
  - building description including schematic engineering system layout drawings.
- b. identification of potential contaminant sources and locations, which includes:
- description on types and location of radionuclides during characterization survey; and
  - maps and tabular data.
- c. information on surveys, which includes:
- description of the procedures used to perform sampling, sample preparation and detailed analyses and measurements;
  - description of the types of survey (e.g. fixed contamination, non-fixed contamination) that will be performed.;
  - identification of the survey area;
  - identification of the types of instrumentation that will be used to perform these surveys and their MDL as well as any conversion factors and their characteristics.;
  - description of measurements taken in each area;
  - description of and rationale grid system to be used;
  - description of maps, drawings, locations and samples points indicated on these representations;
  - list of types of samples collected, numbers of each type of samples, the size and location of each samples and the analyses will be performed;
  - identification and justification of area that has not been decontaminated to the release criteria standard as to why they remain;
  - description of techniques for scanning including presenting the results (e.g. non-intrusive system);
  - establishment of naturally occurring background level to allow background correction.;
  - description of QA provisions for the work to be performed;

- description of the required training of the employees who are performing the survey work;
  - description of the procedure that will be used to record field data and analytical results; and
  - description of the process that will be used to track smears and samples from the time they are taken to the final disposition.
- d. health and safety provisions, which include:
- description of the provisions that will be taken to protect employees and the public during the final survey;
  - identification of radiological and non-radiological safety hazards or special safety concern that might be encountered during the survey and sampling activities; and
  - description and provision of any special precautions or training that will be required.
- e. data interpretation and results, which include:
- description of the presentation format in the final radiation survey report for the collected data;
  - description of the process that will be used to convert the collected field measurements results into units comparable to the values used in the release criteria;
  - description of procedures for determining the average values for the survey units;
  - description of the methodology that will be used to calculate the MDL of the instrument or analytical technique and the standard deviation;
  - description of the procedures that will be used to show that the collected values are statistically validated against the desired confidence level objective; and
  - description of the disposition of the records once data interpretation is completed along with the procedures for storing the collected data.
- f. comparison with the decommissioning criteria, which includes:

- description of the process used to compare the collected data with the release criteria for releasing areas or to identify areas not requiring any further action;
- identification of any areas that were not decommissioned to these levels and reason should be given; and
- description of the method for annotating areas that are above the release criteria.

### **Final Radiation Survey Report**

11.28 The final radiation survey report presents the final conditions of the facility and the site at the conclusion of the decommissioning operation. The report shall be prepared by the licensee taking into consideration all of the data generated in the decommissioning process.

11.29 The report shall be submitted to AELB as evidence to verify and conform that the release criteria have been met and the site is clean and ready for release from further regulatory control by AELB.

11.30 The general content of the final radiation survey report prepared by the licensee shall include, but not limited to the following information as summarized in Annex III:

- a. introduction and general description, which include:
  - name, address, geographical location of the facility identified on maps;
  - description on activities performed, processes involved and historical documentation during operational period of facility;
  - site description including a site layout, sites and building drawings;
  - identification of the area within the building(s) and the boundaries that were included in the survey;
  - provision of general description of the building(s), major facility systems and ancillary equipment that still remain; and
  - identification and discussion on other buildings or facilities on the site that were not part of decommissioning effort, but on which the decommissioning operation could have had an impact or that were needed to support these operation.

- b. identification of contaminant sources and locations, which includes:
- identification of the radioactive contaminants;
  - description of their chemical composition and physical form;
  - description of the significant ratios between radionuclides that were used during the final survey; and
  - description if the radionuclides or ratios of radionuclides varied between different locations of the facility, there is an indication of different mixtures occurred and it should be indicated in site layout, building maps and drawings.
- c. measurements made and analyses performed, which include:
- description of the procedures that were used to perform the detail measurements in the facility and of the site;
  - identification of the types of survey (e.g. , fixed contamination, non-fixed contamination) and the locations where they were performed on site layout, building maps and drawings;
  - identification of the instrumentations that were used to perform these surveys;
  - summary of the survey results provided using site layout, building maps and drawings to portray this information in order to provide clear overview of the final radiation conditions at the facility and of the site;
  - summary of the results of sampling that was performed and show the location of the sample collection sites;
  - identification and description of any buried structures, equipment or disposed materials that were found during characterization and decommissioning activities;
  - description of the radiological status of these items after decontamination or dismantling activities;
  - explanation of the procedures and the results in determining general area background;
  - summary of the background levels for various materials (e.g. concrete);
  - description of QA provisions for the work that was performed;

- description of the disposition of all smears, filters or samples that were generated during the characterization survey; and
  - description of the process that was used to track smears and samples from the time they are taken to their final disposition.
- d comparison with the decommissioning criteria, which includes:
- description in the form of maps and drawings of the areas that exceed the release criteria for the facility after the final survey has been conducted;
  - identification of systems and equipment that have activity levels greater than the clearance criteria and indication of general levels of radiation and contamination for these items;
  - identification of all areas, systems and components that can be released for unrestricted use; and
  - description of any institutional controls that will be required for any areas that have not been released.
- e. conclusions and summary, which include:
- description, as concisely as possible, of the final radiological situation at the facility and site;
  - identification of any areas that were not surveyed due to physical constraints but that might contain radioactive material and will need additional attention or require institutional control; and
  - summary and an overview of drawings and maps of the areas that will require institutional controls.
- f. appendices, which include
- provision of maps and drawings of all areas of the site and building, systems, equipment and components that were surveyed;
  - description of the grid system that was used;
  - maps and drawings that show the location of the survey and sample collection points. Indicate also the type of survey that was performed or the type of material that was collected at each point;
  - detailed radiation and contamination data, which include:

- provision in tabular form, the survey point number and/or grid location, type of survey performed, gross count per minute (for screening purpose) or dose rate, activity per unit area (for contamination), MDL and uncertainty value (on the basis of 95 % confidence level);
  - indication of the project title, survey unit location, data collection date and instrument used;
  - record of individuals who collected and reviewed the data and calculations;
  - record for each instrument and type of survey, the model number, type of probe used (if applicable), serial number of the meter and probe, calibration, efficiency and MDL;
  - explain of the method used to calculate the MDL;
  - correlation between the instrument used to collect the data and the survey point; and
  - provision of correlation if automatic counting systems were used for smears.
- sample data, which include:
- Summary, in tabular form, of the sample collection location, sample number, type of material sampled, size of sample, depth of collection (for soil and concrete), gross count per minute (for screening purpose), radionuclide (if identified), activity per unit weight (in Bq/g), MDL and uncertainty value (on the basis of 95 % confidence level);
  - flow rate of air sampler and the collection time for air samples;
  - indication of the measurement title, collection location, sample collection date and type of analysis conducted;
  - identification of the individuals who collected and prepared the sample and those who reviewed the results and calculations;
  - description of each instrument and type of sample, the model number, equipment serial number, efficiency and MDL;
  - description of the procedure for calculating the MDL; and

- description of the procedures used to prepare the samples for analysis.

### **Public Relation Plan**

11.31 The licensee should prepare a public relation plan to highlight activities that are planned to be carried out for enhancing public understanding and acceptance of the issues related to decommissioning operation.

11.32 Information which should include where appropriate, the following items:

- a. record of all stakeholders in the decommissioning project, including regulators, technical organizations, public and non government organizations;
- b. designated person in the department within the decommissioning organization who will be appointed as the point of contact with stakeholders;
- c. list of types of information that will be routinely distributed or other items available on an irregular and unscheduled basis;
- d. methods of communication that will be used to provide information to each group of stakeholders;
- e. web sites available with information for use by interested stakeholders on the status of the project;
- f. procedures for issuing press releases on significant accomplishment or upcoming activities;
- g. information from various sources for use by the various stakeholders on the status of the project;
- h. methods of independent verification that can be used by stakeholders for appropriate evaluation and updates;
- i. procedures for relaying emergency information to the public;
- j. description of plans for public meeting and updates on project to be routinely held;
- k. additional information on any regular basis in newsletters, open houses, tour of facility;
- l. procedures for requesting speakers from project to talk with various stakeholders about various aspects of the work; and

- m. plans, any activities, or any environmental monitoring program ongoing or to be implemented during decommissioning.

### **Site Policies and Procedures**

11.33 The licensee should prepare a report containing compilation of site policies and procedures, which should be submitted as an additional document together with the decommissioning plan (Section 10) and other related documents described in this Section 11.

11.34 The licensee should provide information on but not limited to:

- a. existing policies and procedures that are applicable during decommissioning activities;
- b. lists of all policies and procedures that are obsolete or have been superseded;
- c. new procedures and policies that will be required to support the decommissioning activities;
- d. procedure for preparing and approving new procedures;
- e. organizations that must review and/or approve the new policies and procedures;
- f. process to ensure each party (including workers) understands their role in the implementation of these procedures (i.e. worker briefings);
- g. process in the formulation of updates to these procedures and how these updates will be distributed to ensure that everyone has the latest copy of the authorized procedures; and
- h. organization responsible for maintenance and maintaining the master copy of the policies and procedures.

### **Final Decommissioning Report**

11.35 The Licensee shall prepare a final decommissioning report according to para 10.94. which is summarized in Annex IV and submit to AELB as evidence that the decommissioning operation has been completed in accordance with license and other legal requirements.

## **12. REFERENCES DOCUMENTS**

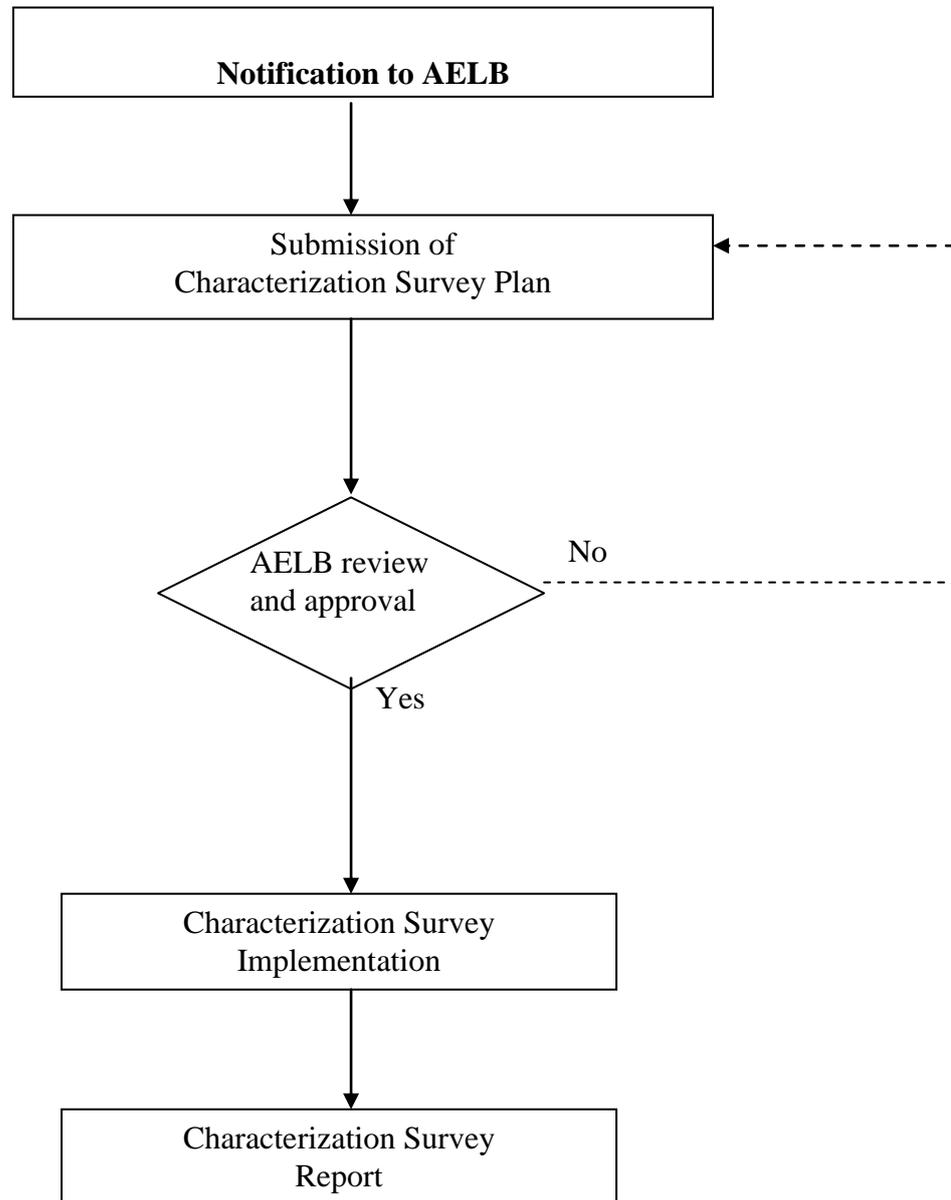
- 12.1 In preparing these guidelines, significant reference has been made to the Act 304 and its subsidiary legislation. The licensee is required to refer to the documents for more details and specific explanation on certain aspects of regulatory requirements and radiation safety pertaining to decommissioning operation:

## **13. BIBLIOGRAPHY**

- a. Atomic Energy Licensing Act, 1984 (Act 304);
- b. Radiation Protection (Licensing) Regulations 1986 [P.U(A) 149];
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- d. Radiation Protection (Transport) Regulations 1989 [P.U(A) 456];
- e. IAEA; Standard Format and Content for Safety Related Decommissioning Documents, Safety Reports Series No.45, 2005;
- f. IAEA; Decommissioning of Nuclear Fuel Cycle Facilities, Safety Standards Series, Safety Guide No. WS-G-2.4, 2000;
- g. IAEA; Decommissioning of Medical, Industrial and Research Facilities, Safety Standards Series, Safety Guide No. WS-G-2.2, 1999
- h. IAEA; Decommissioning of Nuclear Facilities Other Than Reactors, Technical Report Series No. 386, 1998;
- i. IAEA; Decommissioning of Facilities for Mining and Milling of Radioactive Ores and Closeout of Residues, Technical Report Series No. 362, 1994.
- j. AMERICAN SOCIETY FOR TESTING AND MATERIALS; Standard Guide for Preparing Characterization Plans for Decommissioning Nuclear Facilities, ASTM E 1982 – 97, 1997

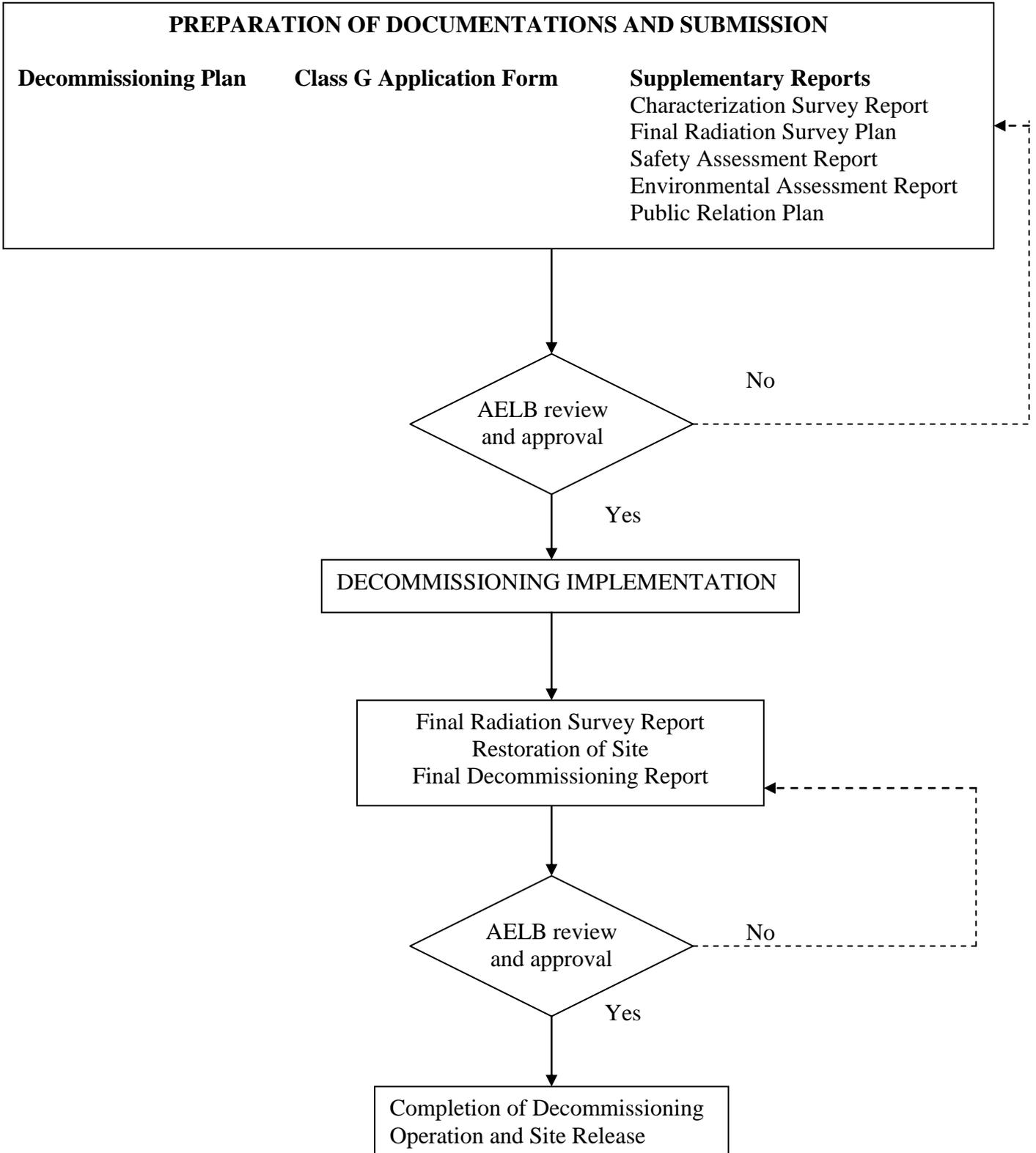
**ANNEX I**

**FLOW CHART OF DECOMMISSIONING OPERATION  
PRE-LICENSING**



**ANNEX II**

**FLOW CHART OF DECOMMISSIONING OPERATION IMPLEMENTATION**



**ANNEX III**  
**CONTENTS OF FINAL RADIATION SURVEY REPORT**

**EXECUTIVE SUMMARY**

**INTRODUCTION AND GENERAL DESCRIPTION**

Name, address, geographical location of the facility identified on maps;

Reason for decommissioning, management approach, licensing and operations

Description on activities performed, processes involved and historical documentation during operational period of facility;

Site description including a site layout, sites and building drawings;

Identification of the area within the building(s) and the boundaries that were included in the survey;

General description of the building(s), major facility systems and ancillary equipment that still remain; and

Identification and discussion on other buildings or facilities on the site that were not part of decommissioning effort, but on which the decommissioning operation could have had an impact or that were needed to support these operation.

**IDENTIFICATION OF POTENTIAL CONTAMINANT SOURCES AND LOCATION**

Identification of the radioactive contaminants;

Description of their chemical composition and physical form;

Description of the significant ratios between radionuclides that were used during the final survey; and

Description if the radionuclides or ratios of radionuclides varied between different locations of the facility, there is an indication of different mixtures occurred and it should be indicated in site layout, building maps and drawings.

**MEASUREMENT MADE AND ANALYSES PERFORMED**

Description of the procedures that were used to perform the detail measurements in the facility and of the site;

Identification of the types of survey (e.g. , fixed contamination, non-fixed contamination) and the locations where they were performed on site layout, building maps and drawings;

Identification of the instrumentations that were used to perform these surveys;

Summarization of the survey results provided using site layout, building maps and drawings to portray this information in order to provide clear overview of the final radiation conditions at the facility and of the site;

Summarization of the results of sampling that was performed and show the location of the sample collection sites;

Identification and description of any buried structures, equipment or disposed materials that were found during characterization and decommissioning activities;

Description of the radiological status of these items after decontamination or dismantling activities;

Explanation the procedures and the results in determining general area background;

Background levels for various materials (e.g. concrete);

Description of QA provisions for the work that was performed;

Description of the disposition of all smears, filters or samples that were generated during the characterization survey; and

Description of the process that was used to track smears and samples from the time they are taken to their final disposition.

## COMPARISON WITH DECOMMISSIONING CRITERIA

Description in the form of maps and drawings the areas that exceed the release criteria for the facility after the final survey has been conducted;

Identification systems and equipment that have activity levels greater than the clearance criteria and indicate general levels of radiation and contamination for these items;

Identification of all areas, systems and components that can be released for unrestricted use; and

Description of any institutional controls that will be required for any areas that have not been released.

## CONCLUSION AND SUMMARY

Description as concisely as possible the final radiological situation at the facility and site;

Identification of any areas that were not surveyed due to physical constraints but that might contain radioactive material and will need additional attention or require institutional control; and

Summary of an overview drawings and maps of the areas that will require institutional controls.

## APPENDICES

Maps and drawings of all areas of the site and building, systems, equipment and components that were surveyed;

Description of the grid system that was used;

Maps and drawings that show the location of the survey and sample collection points. Indicate also the type of survey that was performed or the type of material that was collected at each point;

Detailed radiation and contamination data:

- In tabular form, the survey point number and/or grid location, type of survey performed, gross count per minute (for screening purpose) or dose rate, activity per unit area (for contamination), MDL and uncertainty value (on the basis of 95 % confidence level);
- Indication of the project title, survey unit location, data collection date and instrument used;
- Record of individuals who collected and reviewed the data and calculations;
- Record for each instrument and type of survey, the model number, type of probe used (if applicable), serial number of the meter and probe, calibration, efficiency and MDL;
- Explain of the method used to calculate the MDL;
- Correlation between the instrument used to collect the data and the survey point; and

- Correlation if automatic counting systems were used for smears.

Sample data,

- In tabular form, the sample collection location, sample number, type of material sampled, size of sample, depth of collection (for soil and concrete), gross count per minute (for screening purpose), radionuclide (if identified), activity per unit weight (in Bq/g), MDL and uncertainty value (on the basis of 95 % confidence level);
- Flow rate of air sampler and the collection time for air samples;
- Indication of the measurement title, collection location, sample collection date and type of analysis conducted;
- Identification of the individuals who collected and prepared the sample and those who reviewed the results and calculations;
- For each instrument and type of sample, the model number, equipment serial number, efficiency and MDL;
- Description of the procedure for calculating the MDL; and
- Description of the procedures used to prepare the samples for analysis.

## **ANNEX IV**

### **CONTENTS OF THE FINAL DECOMMISSIONING REPORT**

#### **EXECUTIVE SUMMARY**

#### **DECOMMISSIONING OBJECTIVE**

#### **DESCRIPTION OF FACILITY AND SITE**

#### **DECOMMISSIONING CRITERIA**

Basis for the removal of regulatory controls from the equipment, building or site, or for any other control regime approved by the regulatory body

#### **DECOMMISSIONING ACTIVITIES**

Decontamination, dismantling, demolition, packaging and transporting of the waste generated to the disposal site.

#### **FINAL RADIATION SURVEY REPORT**

Final conditions at the facility and the site at the conclusion of the physical decommissioning operation using data generated in the decommissioning process

#### **INVENTORY**

Radioactive and non-radioactive wastes generated including indication of their storage and/or disposal;  
Materials and equipment released from regulatory control;  
List of structures, areas or equipment designated for restricted use;  
Comparison of actual volumes of waste generated during decommissioning works with the amounts projected in the plan

#### **SUMMARY**

Abnormal events and incidents that occurred during decommissioning;  
Occupational and public doses received from decommissioning work;

#### **DESCRIPTION OF FINAL FACILITY/SITE CONDITION**

Description of any remaining buildings or equipment not decommissioned or partially decommissioned;

#### **SITE RELEASE**

Description of the either for restricted or unrestricted release

#### **LESSON LEARNED**

Summary of abnormal events that occurred during decommissioning process and action taken

## ANNEX V

### TIMELINE FOR DECOMMISSIONING OPERATION

ACTIVITY		DURATION (YEAR)																							
		YEAR1												YEAR2											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
<b>1</b>	<b>PRE-LICENSING</b>																								
	<i>Notification to AELB</i>																								
	<i>Characterization Survey Plan Submission</i>																								
	<i>Characterization Survey Implementation</i>																								
	<i>Characterization Survey Report</i>																								
<b>2.</b>	<b>DOCUMENTATION SUBMISSION</b>																								
	i) Decommissioning Plan ii) Class G Application Form iii) Supplementary Reports - <i>Characterization Survey Report</i> - <i>Final Radiation Survey Plan</i> - <i>Safety Assessment Report</i> - <i>Environmental Assessment Report</i> - <i>Public Relation Plan</i>																								
<b>3.</b>	<b>DECOMMISSIONING IMPLEMENTATION</b>																								
	<i>Final Radiation Survey Report</i>																								
	<i>Restoration of Site</i>																								
	<i>Final Decommissioning Report</i>																								
<b>4</b>	<b>SITE RELEASE</b>																								

