7. Chapter Seven, Decommissioning and Decontamination Plan

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7.1. Introduction

The objective of the Collider-Accelerator decommissioning plan, which will be developed near the end of each accelerator's operating lifetime, will be to determine the hazards and risks associated with decommissioning the facilities and to plan the activities required to complete the decommissioning. Ensuring the safety of the workers, protecting the public and the environment and complying with applicable state, local, and federal regulations are of utmost importance in preparing the plan. Management of the operating wastes, or other hazardous materials that might remain in the facility after shutdown, as well as the wastes generated during the decommissioning activities are key to conducting a safe decommissioning. Therefore, an approach that accurately identifies the types and quantities of these materials, thereby establishing the baseline, is an important aspect of the decommissioning planning.

Another aspect of the decommissioning plan will be the determination of the final site configuration or end-point in which each facility or site will be left. Determining the desired endpoint for each site and the risks present are essential to planning. The

preferred decommissioning alternative is the Greenfield condition but the following four alternatives will be evaluated at final shutdown:

- re-use for a similar function
- safe storage
- Brownfield condition
- Greenfield condition

It is assumed that federal control will remain in place for a number of years after decommissioning of these accelerators is completed.

Once baseline conditions and an understanding of the volumes of waste to be dealt with are estimated and end-points are chosen, then the methods of accomplishing the decommissioning that will meet the end-point goals can be selected. All C-A facilities currently have similar waste streams. Only the volumes of waste materials and the percent activation vary between the accelerators and experimental areas. Beam intensity and predominant species of particles accelerated are the source of the relative differences in activation levels. All accelerator facilities have recyclable steel, recyclable copper cabling, clean concrete wastes, and miscellaneous clean wastes. Many accelerator facilities have activated steel, activated components, activated copper cabling, activated concrete, miscellaneous activated wastes, activated soil, activated water, mixed-waste electronic components, and mixed-waste lead. There are some facilities that have non-radioactive hazardous materials such as asbestos, beryllium, and lead. Asbestos in particular is present in many buildings at C-AD, primarily in pipe insulation, ceiling tiles, gaskets, thermal insulation, cement boards and pipes, flooring material, and in roofing products. The effectiveness of the decommissioning methods; that is, the method's

ability to keep personnel exposures to hazardous and radioactive materials as low as reasonably achievable and to eliminate or significantly reduce the potential impact on the environment are important criteria that are applied in choosing the appropriate method.

Finally, the waste streams to be managed during the decommissioning are to be analyzed in the decommissioning plan, their characteristics and volumes estimated, and treatment and disposal options evaluated. There are multiple waste streams both for non-radioactive waste and radioactive waste to be managed during the decommissioning. Some of the waste streams can be treated and disposed of locally, such as recyclable metals and concrete waste, while some, low-level radioactive waste, mixed waste, liquid low-level radioactive waste, hazardous waste, and industrial waste such as oil, will be shipped off site for disposal.

7.2. Baseline Conditions

Establishing the expected baseline conditions at the end of each facility's operating lifetime can be accomplished by estimating the radioactivity levels and physical conditions based on measurements, calculations, design features, operating procedures, and waste management requirements. The C-A Department Operating Procedures, Environmental Management System, OSH Management System, and BNL SBMS subject areas would provide up to date and current information on the operating history, activation history, environmental impacts, and waste generation and disposal history to help establish the baseline conditions. Design features that help mitigate the impact of potentially high activation levels on the baseline have been incorporated into the C-A facility designs. Examples of such features are beam loss monitors and cutoff

devices interlocked to shut off the beam to ensure that OPM beam loss criteria are met thereby reducing inadvertent activation of materials. Impermeable barriers are placed over the soil wherever there are known beam loss areas, such as beam stops, targets and collimators. These impermeable barriers are installed to minimize infiltration of surface water into the activated soil areas.

Beam-line cooling systems are designed as closed-loop systems to minimize the amount of activated water. Operations procedure limits and ASE limits on beam intensity, integrated beam, and beam-loss are examples of administrative controls that help minimize the inadvertent activation of materials. These administrative controls can have a large impact on the cost of the decommissioning since they help ensure that large volumes of soil and water will not have to be handled as low-level-radioactive waste, and activation of beam-line components and magnets will be minimized.

Additionally, methods described in C-A Department Operating Procedures and BNL SBMS Subject Areas are in place to track spills, spill response actions, inventories of all chemicals and to record information on beam-loss events. These records will aid in establishing the baseline. Records of hazardous and radioactive wastes, personnel dose records, area survey records, RWP records, and work planning packages are maintained and provide additional baseline information. Radiological and operations records are maintained according to SBMS requirements. Site, building, and component drawings are maintained by both C-A Department and the BNL Plant Engineering Division to assist in baseline information.

The decommissioning plan will include requirements for characterizing the facilities after operations are shutdown and before actual decommissioning commences.

This characterization will confirm or re-establish the baseline conditions, will be used in performing a risk assessment to support the decommissioning safety assessment, and will help establish surveillance and maintenance required to maintain facilities in a safe standby mode until decommissioning begins.

7.3. End Point Goals

The C-A facilities end-points will be stated early during decommissioning planning because they will form the basis for specific goals and activities that must take place. The goals for the hazard category and safety basis of the deactivated facilities will be established, and determinations will be made of decommissioning safety measures.

Determining the desired product, the final site-configuration and the risks present are essential to planning the decommissioning alternatives for the facilities. The decommissioning plan will address the baseline conditions and consider all the alternatives.

The process of evaluating the best alternative and providing an approach that will result in lowest cost, least amount of exposure of workers to radiation during the decommissioning activities and greatest public acceptance will involve consideration of the pros and cons of each alternative, and rely on the input of all stakeholders including the surrounding community. For example, office, shops, and auxiliary/support facilities will be relatively clean with most items recyclable or clean solid wastes and can be expected to be removed. Accelerator and experimental areas contain many thousands of tons of low-level radioactive shielding and a few tons of highly-activated components. Due to the size and number of buildings and useful components, a combination of re-use,

safe storage, and decommissioning of non-useable buildings and components is the likely future scenario to achieve end points in the safest, most cost effective way.

7.4. Regulatory Requirements

The decommissioning plan will delineate the applicable New York State and federal laws, consensus standards, DOE directives and other requirements applicable to the decommissioning activities, especially those required to meet the end point criteria.

Regulations affecting decommissioning fall into three categories:

- those that directly affect decommissioning, e.g., the removal of radioactive materials as needed to reduce risk
- those that protect the worker and the public during decommissioning operations
- those that apply if hazardous or toxic materials are present in the facility

A number of DOE orders and federal regulations actually cover two or more of these categories, so there may be overlapping requirements across categories. Sound planning for interacting with the regulatory agencies and compliance with these regulatory requirements are critical to timely and successful completion of decommissioning activities and will be an integral part of the initial planning activities.

7.5. Decommissioning Methods

Decommissioning methods will be chosen based on radiological conditions at the accelerator and experimental facilities at the time of the final shutdown and the effectiveness of the methods to achieve the desired end-points. Many C-AD facilities such as shops, offices, auxiliary and support buildings are clean and will require only

standard decommissioning techniques. Based on archival radiological data, all seven accelerators and all external beam lines can be largely contact handled to remove both the components and the activated shielding at final shutdown. A few highly radioactive parts such as beam stops, target caves, and beam interaction areas may require remote non-contact handling, at least for a period of 1 to 5 years post shutdown. Additionally, while there are only a few contamination areas and contaminated parts at C-A Department, these areas and components will require surface decontamination techniques applied before significant disassembly work is attempted. Therefore, a variety of techniques and removal methods will be analyzed to select approaches that accomplish the goals and optimize safety to the workers and protection of the environment as well as efficiency.

The decommissioning plan will describe methods that accommodate these varying conditions while maintaining ALARA principles as the basis for the cost estimate. Design features that will reduce personnel exposure as well as decommissioning costs will be addressed. The plan will address the conditions and hazards in detail and will have the benefit of additional information and technologies not yet available. The activation levels will be known in detail, which will allow determination of protection requirements to prevent unwarranted exposure of the workers to radiation.

7.6. Waste Streams

There will be multiple waste streams to be managed during decommissioning. Some of the clean material will be recycled, treated and/or disposed of locally, while much of the radioactive and hazardous waste will be sent off-site for disposal. All

recyclable materials and wastes anticipated from the decommissioning operation will be identified in the decommissioning plan. Based on the general nature of the decommissioning operations and the applicable requirements, an all-inclusive list of waste categories will be identified as part of the decommissioning plan. The list will include recyclable materials, radioactive components, hazardous chemicals, and industrial wastes and any equipment or materials being saved for reuse even though they might not be classified as wastes under the Resource Conservation and Recovery Act.

The C-A Department has been in operation for many years and has been disposing of approximately 3000 ft^3 of low-level radioactive waste, 30 ft^3 of mixed waste, 1200 gallons of activated water, and 30,000 lbs. of hazardous and industrial waste each year. Based on the advice and assistance of experts in BNL's Environmental and Waste Management Services Division, we have a thorough understanding of the treatment requirements of all our waste streams, the off-site disposal sites' acceptance criteria, and the shipping and packaging criteria. The decommissioning operations will necessitate larger volumes of wastes but will consist of all of the same types of wastes that we currently deal with routinely.

The decommissioning plan will review all waste treatment facilities and required processes at the time of the decommissioning. Several low-level radioactive waste disposal facilities, such as Hanford, are currently used by BNL Environmental and Waste Management Services Division today, and it is assumed that these facilities, or equivalent facilities, will be available in the future. Cost estimates and waste volume estimates will be made at the time of the decommissioning plan development.