Subject Area: ***Accelerator Safety***

Contents: Accelerator Safety

Effective Date: **September 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Section	Overview of Content (see section for full process)
Introduction	
1. Establishing the Authorization Path to Achieve Approval for Routine Accelerator Operations	• Establish number and type of modules. • Create Authorization Path Document. • Obtain departmental and Laboratory-level concurrence. • Submit document to BAO for feedback and concurrence.
2. Developing the Safety Assessment Document (SAD)	• Develop SAD. • Establish roles and responsibilities for change control. • Conduct internal review of SAD. • Place SAD in change control.
3. Developing the Accelerator Safety Envelope (ASE)	• Develop ASE. • Place ASE in change control with SAD.
4. Developing the Commissioning Package or Routine Operations Package	• Review ASE and SAD and recommend improvements to ALD (if any). • Recommend that the DDO approve these versions. • Prepare Commissioning Package and Routine Operations Package for DOE approval. • Develop either Commissioning Plan or Routine Operations Plan. • Obtain concurrence. • Send Package to BAO and notify them that an ARR is beginning.
5.Chartering an Accelerator Readiness Review (ARR) Committee and Conducting an ARR	• Develop Accelerator Readiness Review Plan of Action. • Conduct ARR. • Write ARR Report. • Recommend approval to the DDO.
6.Obtaining Approval for Commissioning	• Request approval for commissioning. • Commission within the boundaries defined in Commissioning Package.
7.Obtaining Approval for Routine Operations	• Establish and submit final SAD and ASE for review and approval. • Develop and submit Routine Operations Package for performing ARR for review and approval.

	• Conduct ARR. • Request approval for operations. • Incorporate items from USI Checklist and procedures into work planning and control processes. • Approve commencement of routine operations.
8.Maintaining Operations within the Approved ASE (Unreviewed Safety Issue Process)	• Create a checklist of USIs. • Incorporate checklist items into work review processes. • Review proposed work for items that may be "at risk." • Update and approve SAD and ASE, if necessary.

Definitions

Exhibits
Accelerator Safety Flowchart
Design Practice for Known Beam-Loss Locations
Topics to Guide the Accelerator Readiness Review (ARR) Committee
Unreviewed Safety Issue (USI) Checklist

Forms
Accelerator Readiness Review (ARR) Report Template
Accelerator Safety Assessment Document (SAD) Template
Accelerator Safety Envelope (ASE) Template
Template for Accelerator Readiness Review (ARR) Plan of Action
Template for Commissioning Plan or Routine Operations Plan

Training Requirements and Reporting Obligations

This subject area does not contain training requirements.

This subject area may or may not contain reporting obligations. See the subject area until obligations are listed here.

References

Facility Hazard Categorization Subject Area

Facility Authorization Basis Program Description

Internal Controlled Documents Subject Area

Standards of Performance

Each facility shall have a defined business mission and defined operating boundaries to govern work assignments.

Facility configurations, operating envelopes, and the design basis shall be documented and controlled.

Managers shall analyze work for hazards, authorize work to proceed, and ensure that work is performed within established controls.

All staff and users shall identify, evaluate, and control hazards in order to ensure that work is conducted safely

All staff and users shall identify, evaluate, and control hazards in order to ensure that work is conducted safely and in a manner that protects the environment and the public.

Management System

This subject area belongs to the **Facility Safety** management system.

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Subject Area: ***Accelerator Safety***

Introduction: Accelerator Safety

Effective Date: **April 2000**

Point of Contact: Safety Management Systems Integration Program Manager

This subject area provides the requirements and guidance, and standardizes the processes necessary for BNL accelerator facilities to comply with DOE Order 420.2 "Safety of Accelerator Facilities."

Following this subject area ensures that all facilities categorized as accelerators establish the necessary documentation, such as accelerator safety envelope, operational procedures, and personnel qualifications, which are needed to establish an authorization basis for the facility. See the Facility Hazard Categorization Subject Area for more information on hazard categorization, and see the Facility Authorization Basis Program Description for information on the Laboratory's overall program. This subject area also helps to standardize the content and format of the Safety Assessment Document (SAD), Accelerator Safety Envelope (ASE), and other required submittals to facilitate review at all levels. This subject area provides guidance and templates that meet the requirements of DOE Order 420.2.

Requirements of this subject area apply to the entire accelerator facility, which entails the accelerator itself, experimental areas, and associated areas and equipment, using or supporting the production of accelerated particle beams to which access is controlled to protect the safety and health of persons. Uncontrolled office and support spaces are not considered part of the accelerator facility for the purposes of this subject area.

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Subject Area: ***Accelerator Safety***

1. Establishing the Authorization Path to Achieve Approval for Routine Accelerator Operations

Effective Date: **September 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Applicability

This information applies to managers and staff planning to develop, install, and operate accelerators.

Required Procedure

At the completion of the conceptual design report (CDR), or as early as possible in the development or acquisition of the facility, managers and staff develop the Authorization Path Document.

Step 1	Refer to the Accelerator Safety Flowchart for the details on the path to achieving approval for routine accelerator operations.
Step 2	Establish the number and type of modules.
Step 3	Establish an Authorization Path Document for defining roles and responsibilities for • construction, commissioning, and operations • major milestones (sequences and deliverables) for the path for achieving commissioning and routine operations.
Step 4	Obtain concurrence of the Department/Division, Associate Laboratory Director, and Deputy Director of Operations.
Step 5	Submit the the Authorization Path Document to the Brookhaven Group Office (BHG) for feedback and concurrence.

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Subject Area: ***Accelerator Safety***

2. Developing the Safety Assessment Document (SAD)

Effective Date: **September 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Applicability

This information applies to managers and staff planning to develop, install, and operate accelerators.

Required Procedure

Managers and staff develop a Safety Assessment Document (SAD) for non-nuclear accelerator facilities.

Step 1	Gather the appropriate reference documents, e.g., design criteria and specifications; operation characteristics; environmental assessments; documents that may describe the impact on facility staff, staff outside the facility, the public and the environment; prior SADs, and preliminary assessments. Review these to understand the hazards of the facility.
Step 2	Identify appropriate subject matter experts (SME) and assign roles and responsibilities for writing the SAD.
Step 3	Develop the SAD using the exhibit Accelerator Safety Assessment Document (SAD) Template. For accelerators capable of creating soil activation, prepare a section in the SAD that addresses capping to prevent rainwater infiltration. Use the exhibit Design Practice for Known Beam Loss Locations.
Step 4	Establish the roles and responsibilities for change control of the SAD.
Step 5	Perform internal review of the SAD using ES&H SMEs, as appropriate.
Step 6	Place the SAD in change control.

References

Internal Controlled Documents subject area

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Subject Area: ***Accelerator Safety***

3. Developing the Accelerator Safety Envelope (ASE)

Effective Date: **September 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Applicability

This information applies to managers and staff planning to develop, install, and operate accelerators.

Required Procedure

Step 1	Using chapter 4 of the Safety Assessment Document (SAD), its associated risk assessment forms, and results of environmental assessments, develop the Accelerator Safety Envelope (ASE) according to the exhibit Accelerator Safety Envelope (ASE) Template for those hazards dispositioned in the SAD.
Step 2	Place the ASE in change control with the SAD. **Note:** Each version of the ASE must reference the version of the SAD to which it applies.

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Subject Area: ***Accelerator Safety***

4. Developing the Commissioning Package or Routine Operations Package

Effective Date: **April 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Applicability

This information applies to managers and staff planning to develop, install, and operate accelerators.

Required Procedure

The Commissioning Package or Routine Operations Package consists of the following:

- Safety Assessment Document (SAD)
- Accelerator Safety Envelope (ASE)
- the Accelerator Commissioning Plan, or the Routine Operations Plan from the responsible Accelerator Facility.

The Package is submitted to the Deputy Director of Operations (DDO) and Brookhaven Group Office (BHG) to obtain approval from BHG for either commissioning or routine operations of the accelerator. The Package also assists in preparing the Accelerator Readiness Review (ARR) Plan of Action before commissioning or routine operations. Each component of the Package must identify an accelerator facility responsible person.

Step 1	The Associate Laboratory Director (ALD) approves the versions of the SAD and ASE to be used for commissioning and/or operations and submits them to the Laboratory ES&H Committee Chair.
Step 2	The Laboratory ES&H Committee reviews the ASE and SAD and recommends to the ALD improvements (if any) to satisfy concerns that they may have regarding the versions of the SAD and ASE.
Step 3	The changes in the versions of the SAD and ASE are managed in formal change control.
Step 4	When the Laboratory ES&H Committee is satisfied that the quality and comprehensiveness of the versions of the SAD and ASE meet BNL requirements and form an adequate basis supporting the commissioning and operations of the facility, they formally recommend that the DDO approve these versions.
Step 5	Staff prepare the documents for DOE approval. They consist of **A. The Commissioning Package** • the Accelerator Commissioning Plan • the change-controlled versions of the SAD and ASE that support the Commissioning Plan, reviewed and recommended for approval by the Laboratory ES&H Committee.

	Note: For small machines, the Commissioning Plan will be a brief document. **B. Routine Operations Package** • the Routine Operations Plan • the change-controlled versions of the SAD and ASE that support the Routine Operations Plan, reviewed and recommended for approval by the Laboratory ES&H Committee, if different from commissioning documents. Note: For small machines, many of the documents developed for commissioning will be similar.
Step 6	Staff develop the Plan using the exhibit Template for Commissioning Plan or Routine Operations Plan. Collaboration with the Radiological Control Division staff is required for fault studies.
Step 7	Staff obtain concurrence of the Department/Division, ALD, and DDO.
Step 8	The DDO sends the Package to the BHG for information and notifies them that an ARR is beginning.

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Subject Area: ***Accelerator Safety***

5. Chartering an Accelerator Readiness Review Committee (ARR) and Conducting an ARR

Effective Date: **April 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Applicability

This information applies to managers and staff conducting a commissioning or routine operations Accelerator Readiness Review.

Required Procedure

Step 1	The Department Chair/Division Manager declares readiness.
Step 2	The Deputy Director of Operations (DDO) appoints the Accelerator Readiness Review (ARR) Committee and invites a member of the Brookhaven Group Office (BHG) staff to participate on the committee.
Step 3	The ARR Committee develops the Plan of Action using the exhibit on the Template for the Accelerator Readiness Review Plan of Action to guide the ARR.
Step 4	The ARR Committee conducts the review.
Step 5	The ARR Committee writes the ARR Report using the exhibit on the Accelerator Readiness Review (ARR) Report Template. The Committee also uses the exhibit on Topics to Guide the ARR Committee as guidance in preparing the ARR Report.
Step 6	The ARR Committee recommends approval to the DDO.

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Subject Area: ***Accelerator Safety***

6. Obtaining Approval for Commissioning

Effective Date: **April 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Applicability

This information applies to managers and staff planning to commission an accelerator.

Required Procedure

Step 1	The Deputy Director of Operations (DDO) forwards the Accelerator Readiness Review (ARR) Report and the Commissioning Package to the Brookhaven Group Office (BHG) and requests approval for commissioning.
Step 2	BHG sends approval of the Commissioning Package to the DDO.
Step 3	The DDO sends the approval to the Associate Laboratory Director and the Department Chair/Division Manager.
Step 4	The Department/Division commissions within the boundaries defined in the fully changed-controlled Commissioning Package. Appropriate commissioning boundaries are incorporated into the unreviewed safety issue (USI) process or equivalent. **Note:** If the accelerator is being commissioned by module, the procedures in the sections on Developing the Safety Assessment Document (SAD), Developing the Accelerator Safety Envelope (ASE), and Developing the Commissioning Package or Routine Operations Package are repeated for each module.

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Subject Area: ***Accelerator Safety***

7. Obtaining Approval for Routine Operations

Effective Date: **September 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Applicability

This information applies to managers and staff planning to develop, install, and operate accelerators.

Required Procedure

Step 1	The Department/Division establishes the final Safety Assessment Document (SAD) and Accelerator Safety Envelope (ASE) for operating the Accelerator Facility, incorporating the appropriate information obtained during commissioning.
Step 2	The Associate Laboratory Director (ALD) submits the final SAD and ASE to the Laboratory ES&H Committee.
Step 3	The Laboratory ES&H Committee reviews the SAD and ASE for routine operations and recommends approval to the Deputy Director of Operations (DDO).
Step 4	The Department/Division develops the Routine Operations Package and provides it to the DDO.
Step 5	The DDO reviews and approves the Routine Operations Package for performing an Accelerator Readiness Review (ARR).
Step 6	The DDO submits advance copies of the Routine Operations Package to the Brookhaven Group Office (BHG), and notifies BHG of beginning the ARR process.
Step 7	The DDO instructs an Accelerator Readiness Review Committee to conduct the ARR per the section Chartering an Accelerator Readiness Review (ARR) Committee and Conducting an ARR.
Step 8	The DDO approves the Routine Operations Package on the basis of the ARR Committee's recommendation.
Step 9	The DDO forwards the Routine Operations Package to BHG and requests approval for operations.
Step 10	BHG sends approval of the final ASE to the DDO.
Step 11	BHG sends approval for the commencement of routine operation activities for an accelerator facility or module.
Step 12	The DDO sends the approval to the Associate Laboratory Director and the Department Chair/Division Manager.

Step 13	The Department Chair/Division Manager completes and obtains approval of any Facility Use Agreement modifications that may be necessary
Step 14	The Department Chair/Division Manager formally incorporates items from the Unreviewed Safety Issue (USI) Checklist and procedures into the organizational work planning and control processes. See Section 8, Maintaining Operations with the Approved ASE (Unreviewed Safety Issue Process).
Step 15	The Department Chair/Division Manager approves commencement of routine operations.

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Subject Area: ***Accelerator Safety***

8. Maintaining Operations with the Approved ASE (Unreviewed Safety Issue Process)

Effective Date: **April 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Applicability

This information applies to managers and staff who operate accelerator.

Required Procedure

Note: No activity or facility modification may compromise the Safety Analysis Document (SAD) or the Accelerator Safety Envelope (ASE). Proposed changes are to be screened for hazards that lie outside the bounds of those considered in the SAD and in the development of the ASE, by implementing this section.

Change control must be clearly identified in facility procedures and must consider items in the exhibit Unreviewed Safety Issue (USI) Checklist in this subject area. The USI process may result in rewriting portions of the SAD and modifying the ASE. Such revisions require applicable review and approval. Reportable events may also cause the USI process to be initiated.

Step 1	Using the ASE and Chapter 4 of the SAD, establish a checklist of considerations that should be used as part of the work planning and control or operational event review processes to ensure that the planned work does not impact the ASE. See the exhibit Unreviewed Safety Issue (USI) Checklist for examples of items that may be appropriate.
Step 2	Incorporate the checklist items into the organizational work review process checklists used to support ES&H 1.3.6 and ES&H 1.3.5 work review processes.
Step 3	If a work review indicates that one of the USI checklist items may be "at risk," the proposed work must be reviewed by the Department/Division ES&H Committee.
Step 4	If the Department/Division ES&H Committee review indicates that the proposed work is covered within the existing SAD, then the Committee will document its approval to proceed with the proposed work. **Note:** These approvals are maintained as controlled records appended to the SAD until they are subsequently incorporated into a SAD revision.
Step 5	If the Department/Division ES&H Committee determines that the hazards associated with the proposed work are not appropriately included in the SAD, then the SAD must be updated and approved per the section Developing the Safety Assessment Document (SAD) of this subject area.
Step 6	If the Laboratory ES&H Committee determines that the SAD revision does not require a revision

	to the ASE, the proposed work can proceed after placing the SAD revision into change control.
Step 7	If the Laboratory ES&H Committee determines that the SAD revision requires the ASE to be updated, Steps 3 - 7 must be followed to obtain an approved ASE revision before the proposed work can begin.

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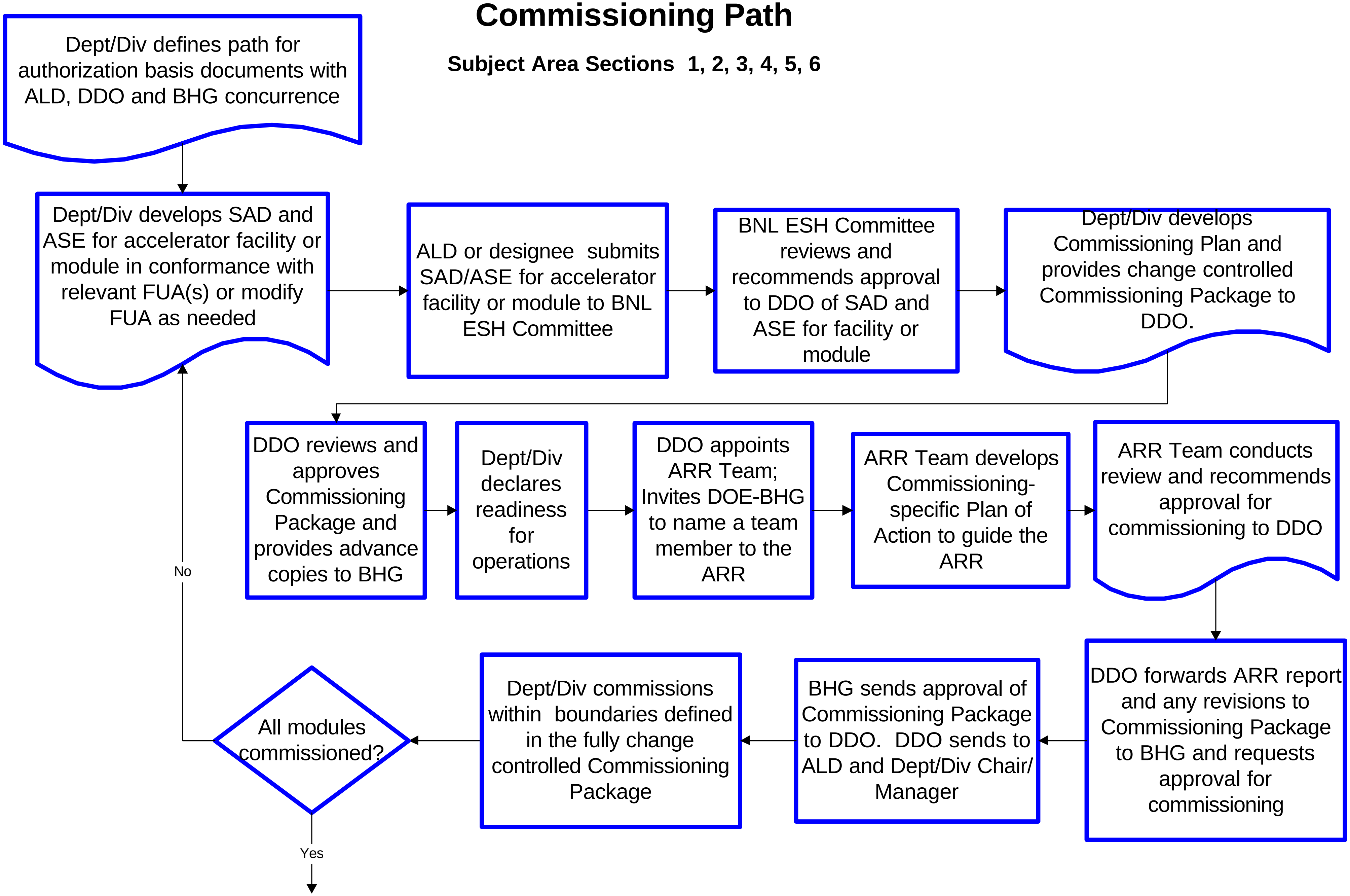
Commissioning Path

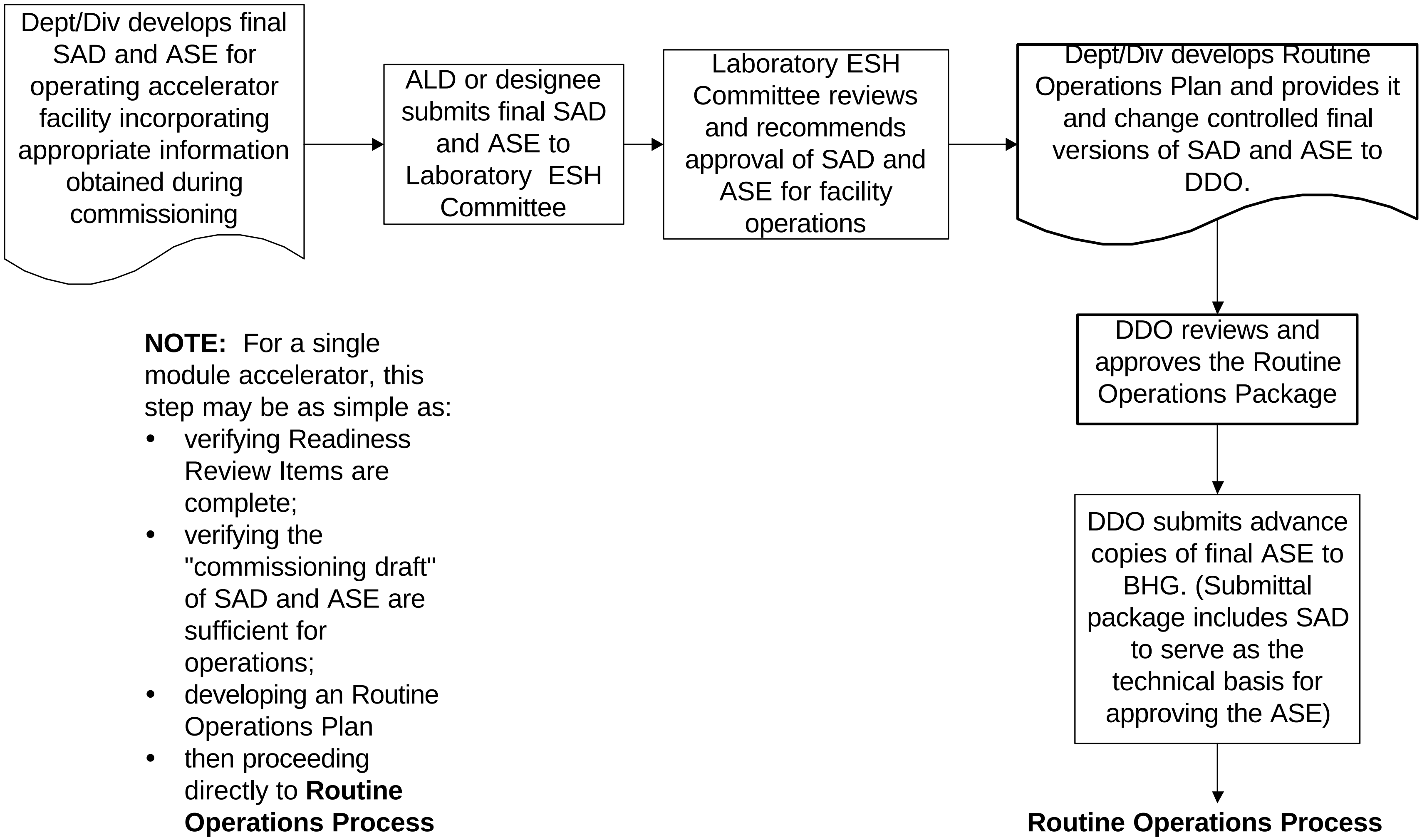
Subject Area Sections 1, 2, 3, 4, 5, 6



Final SAD/ASE Documentation Process

Final SAD/ASE Documentation Process

Subject Area Section 7

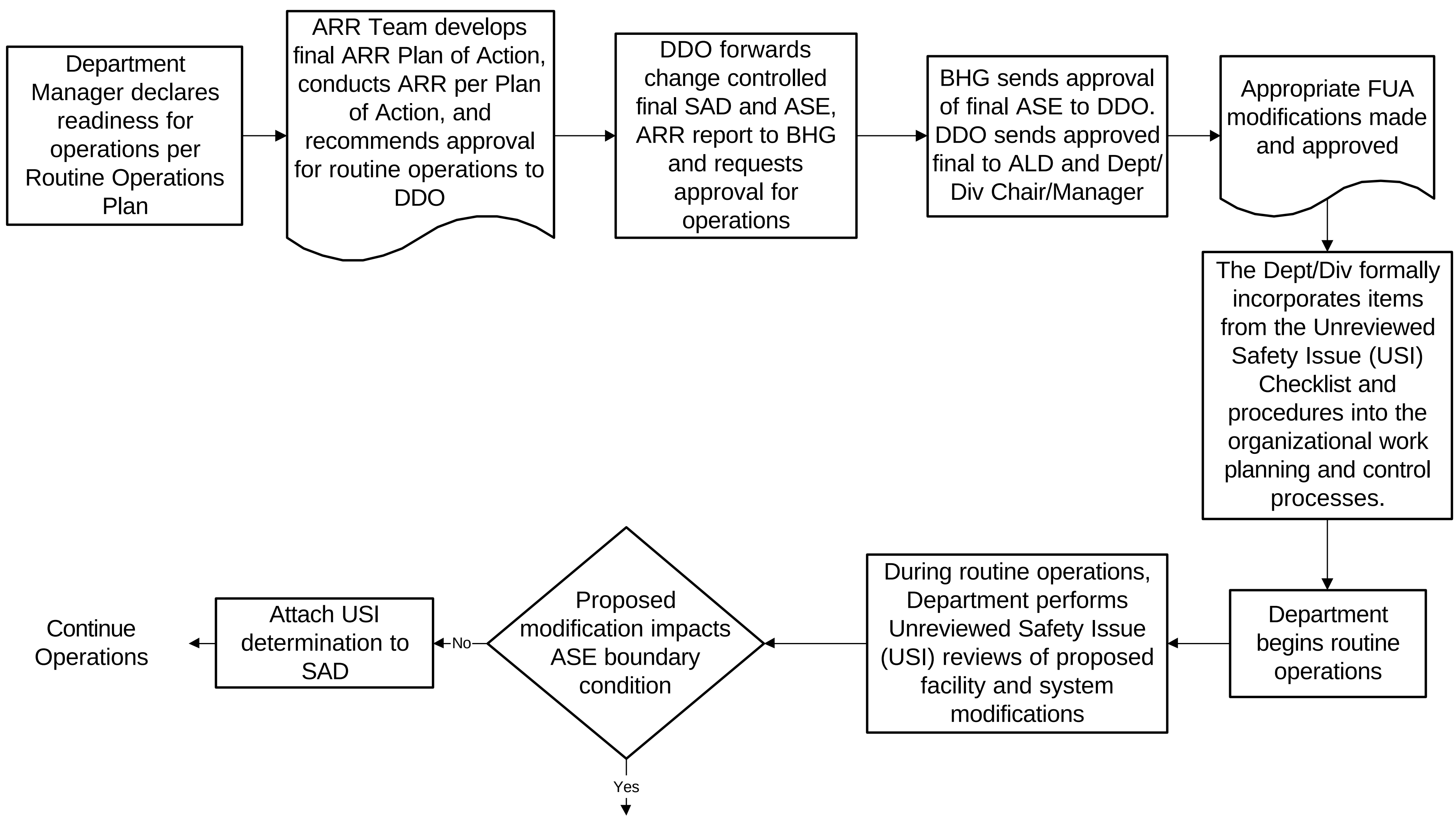


NOTE: For a single module accelerator, this step may be as simple as:

- verifying Readiness Review Items are complete;
- verifying the "commissioning draft" of SAD and ASE are sufficient for operations;
- developing an Routine Operations Plan
- then proceeding directly to **Routine Operations Process**

Routine Operations Process

Subject Area Sections 7, 5, and 8



Introduction

When a high-energy charged particle, such as a proton, leaves the vacuum confine of an accelerator, it encounters various materials along its flight path. These materials, which are used in the magnetic transport components, vacuum pipes, cooling system, tunnel environment and radiation protection shielding, are various metals such as aluminum, copper and steel, as well as air, water, concrete and soil.

Particles such as neutrons, other protons and other nuclear fragments may be produced along the path of the high-energy particle. That happens when a nucleus is struck by a high-energy particle, it may be broken into smaller pieces. At high-energy accelerator energies (e.g., AGS and RHIC), tens to hundreds of nuclei may be broken-up by these "spallation reactions" when dissipating the energy carried by a single high-energy particle. The kinds and quantities of fragments produced depend upon various factors such as the type and energy of the incident particles, the composition of the material struck, the species and energy spectrum of the fragments arising out of the collision and the production probability of the fragment concerned.

A commonly produced fragment in most spallation reactions is a nucleus with two neutrons and a proton, which is the radionuclide known as tritium. The amount of tritium radioactivity present at any given time will depend upon tritium's half-life and the time since production of the tritium has ceased, the flux of high-energy particles and the actions taken to reduce the tritium concentration in the irradiated material (e.g., drain and refill of activated water systems). There are many other spallation fragments that are also radioactive; however, most are very short lived, minutes to days. A few longer-lived radionuclides are produced but most are immobile, with the exception of tritium and

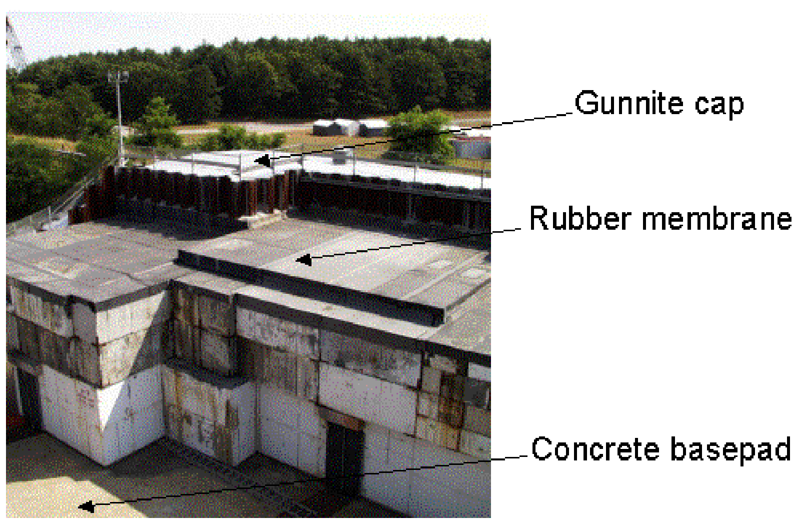
^{22}Na. When one considers the problem of activation of soil and subsequent groundwater contamination, not only half-life but also mobility and transit time of a given radionuclide from its production point to the water table are key parameters.

The term “activation” refers to the process of creating radionuclides in materials such as concrete or soil-shields via the spallation reaction. Soil shields used near beam stops and targets are termed "activated soil" because they contain ^{22}Na and tritium.

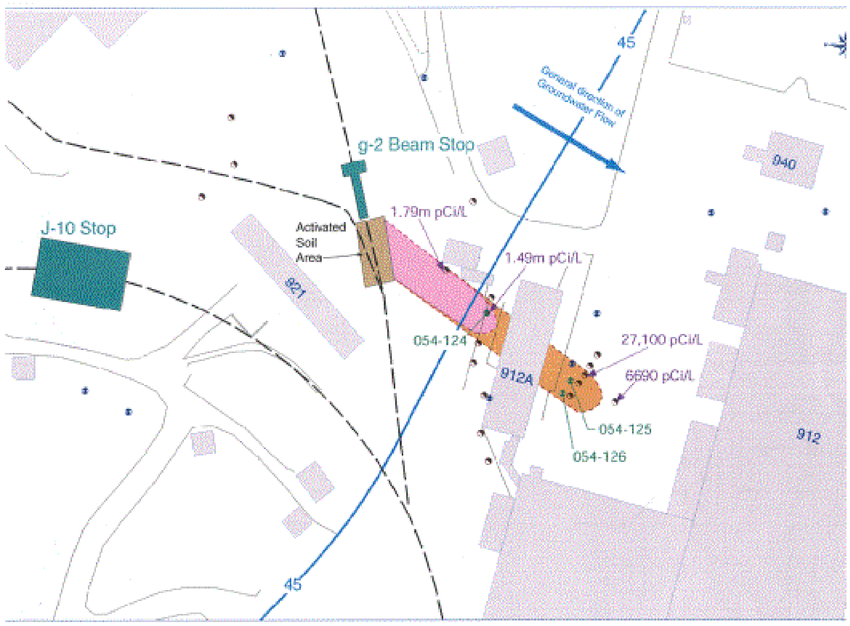
If rainwater percolates through activated soil in the vadose zone, it can leach tritium and ^{22}Na into the groundwater. By preventing the leaching of tritium and ^{22}Na via rainwater in soil, the introduction of radionuclides into the water table is prevented. Reducing the amount of soil activation by using other types of material for shielding or by using engineering controls to reduce beam loss are additional pollution-prevention opportunities. Soil is an ideal radiation shield for human protection. It is dense, conforms to desired shapes, does not deteriorate and is inexpensive. The addition of an impermeable, second shield above the activated soil, the rain barrier, prevents the leaching.

The following illustrates the leachate problem with and without an impermeable water barrier.

Caps Over Known Beam Loss Location



Plume From Uncapped Activated Soil



The objectives of the following design practices are to operate within regulatory requirements, and to integrate pollution prevention and waste minimization into the decision process that results in minimal beam loss in soil. Mitigation of leachate from activated soil is the minimum requirement, and it is to be carried out by capping activated soil.

An evaluation of pollution prevention opportunities leads to the following design practices that are further elaborated upon:

- Determine beforehand via calculations the amount of residual ^{22}Na and ^{3}H created in the soil,
- Determine beforehand via calculations the concentration of radionuclides in any potential leachate from an uncapped region of activated soil,
- Minimize the amount of residual radioactivity in soil using iron and concrete shielding,
- Eliminate potential radioactive effluent from known beam loss locations by capping with effective, maintained water impermeable barriers, and
- Monitor the effectiveness of the design practices.

<u>Standardized Calculation of Soil Activation</u>

Only the radionuclides tritium and ^{22}Na need be considered because of their longer half-lives and mobility.

As part of the evaluation, annual activity concentrations in soil are to be estimated. This requires an estimate of beam loss in a year, the density of hadron interactions as a function of position in soil near the beam loss point(s), and the production probability of tritium and ^{22}Na per interaction.

The density of hadron interactions is normally estimated by Monte Carlo codes. The nuclide production may be estimated by Monte Carlo code. For example, MCNPX is capable of directly estimating tritium production. An alternative to direct nuclide production evaluation is to use measured values “per CASIM star.” These numbers, which correspond to the production probability in soil from a neutron spectrum rapidly falling from 47 MeV, are 0.075 tritium nuclides per star (per interaction) and 0.02 ^{22}Na per interaction. The error on this measurement is at least a factor of 1.5.

The maximum annual activity concentration in water due to direct radionuclide production at the position of the water table shall be estimated. This should be taken to be 10 times the activity concentration in soil multiplied by the leachable fraction, which is 1.0 for tritium and 0.075 for ^{22}Na. In the most common case, the water table is a considerable distance below the position of maximum concentration in soil. The fall-off of transverse interaction density is

$$\frac{e^{-\left(\frac{d}{L}\right)}}{R_T^2}$$

where d is the thickness of shield, L is the interaction length of the shielding material, and R_T is the transverse radial distance from the beam. The transverse interaction length L can be estimated from Monte Carlo, but should not be taken to be lower than the Tesch value, which is L = 60 cm for soil-shield density of 1.8 g/cc, assuming the beam energy is 2 GeV or above.

Standardized Calculation of Radioactivity Concentration in Leachate

Assuming the maximum annual activity concentration in soil is above the water table, the maximum activity in water at the water table due to leaching by rain should be estimated using the model of Lessard[1]. In the example model (see Tables 1 and 2), 3.7×10^8 atoms tritium/cc in one year (soil) results in the drinking water limit of 20,000 pCi/L (water) and 2.1×10^7 atoms ^{22}Na/cc in one year (soil) results in the drinking water limit of 400 pCi/L (water). In these expressions, the soil radionuclide-concentrations are evaluated at the position of maximum soil radionuclide concentration.

[1] E. J. Bleser, “Shielding for the AGS J10 Scraper, AGS/AD/Tech. Note No. 444, Accelerator Division, Alternating Gradient Synchrotron Department, Brookhaven National Laboratory, Upton, New York 11973, September 13, 1996.

TABLE 1

Quantity	Value	Units
^{22}Na Atoms per unit volume of soil in one year	2.13E+07	atoms/cc_{soil}
Available atoms per unit volume of soil since 7.5% of ^{22}Na is leachable	1.60E+06	atoms/cc_{soil}
Fraction of soil that is water	0.1	
Concentration factor since 1 unit volume of water can leach nuclides from 10 unit volumes of soil	10	
Dilution factor:		
a. Radioactive atoms are essentially contained in a 1/e thickness of irradiated soil	60	cm
b. fraction of soil that is water	0.1	
c. height of water column in 1/e thickness of soil	6	cm
d. annual rainfall that percolates down to groundwater	55	cm
e. dilution per year = 55/6	9	
Overall concentration factor of leachable atoms from soil to water	1.1	
Annual average ^{22}Na atom concentration in effluent	1.76E+06	atoms/cc_{water}
Half-life of ^{22}Na	2.60E+00	year
Annual average ^{22}Na activity concentration in effluent	4.01E+02	pCi/L

TABLE 2

Quantity	Value	Units
^{3}H Atoms per unit volume of soil in one year	3.75E+08	atoms/cc_{soil}
Available atoms per unit volume of soil since 100% of ^{3}H is leachable	3.75E+08	atoms/cc_{soil}
Fraction of soil that is water	0.1	
Concentration factor since 1 unit volume of water can leach nuclides out of 10 unit volumes of soil	10	
Dilution factor:		
a. Radioactive atoms are essentially contained in a 1/e thickness of irradiated soil	60	cm
b. fraction of soil that is water	0.1	
c. height of water column in 1/e thickness of soil	6	cm
d. annual rainfall that percolates down to groundwater	55	cm
e. dilution per year = 55/6	9	
Overall concentration factor of leachable atoms from soil to water	1.1	
^{3}H atom concentration in effluent	4.13E+08	atoms/cc_{water}
Half-life of ^{3}H	1.24E+01	year
^{3}H activity concentration in effluent	1.98E+04	pCi/L

Beam Tuning To Minimize Beam Loss

The accelerator management shall design beam loss to soil such that levels that are as low as reasonably achievable with operational, economic and community factors taken into account. As a minimum, the accelerator management shall meet the following requirements:

- Responsibility for determining acceleration, extraction and transport loss limits for setting threshold values to activate alarms shall be formally assigned by the management of the accelerator.

- Changing acceleration, extraction and transport loss limits as operations evolve shall be done via a formal approval mechanism.
- Accelerator management shall assign responsibility for determining appropriate instrumentation for measurement of the losses, and for ensuring measurements are reviewed at appropriate intervals in order to validate loss assumptions.
- Accelerator management shall ensure that alarm threshold values used by operations personnel are incorporated into the appropriate computerized controls programs.

Management shall ensure that operations procedures contain loss limits. Response by operators to alarms shall be clearly written in procedures. Loss problems shall be corrected within minutes, otherwise operators shall reduce the beam intensity to the affected area. Accelerator operations staff shall determine whether there will be a negative impact on the environment, safety or health of workers, a negative impact on the physics program, or a negative impact on accelerator equipment if prolonged high-loss operation is permitted. Authorization for prolonged high-loss operation, with an alarm present, shall come from the highest-level manager of the accelerator and be documented.

Management shall ensure that the responsibility for maintaining loss-monitor systems is assigned. Beam current transformers and loss monitors used to determine operating efficiencies and losses shall undergo verification by the operations staff in the control room at start-up of a running period.

Residual radiation surveys on new elements or new beam lines shall be made after the first operational running period in order to confirm loss assumptions.

Standard for Prevention of Rainwater Infiltration

The accelerator management shall prevent leachate from activated soil due to rainwater or stormwater such that levels are as low as reasonably achievable with operational, economic and community factors taken into account. As a minimum, the accelerator management shall meet the following requirements:

- Annual activity concentration in leachate should be prevented if it is calculated to be measurable in rainwater leachate.
- A cap should be applied to activated soil to eliminate exposure to rainwater.
- If the annual activity concentration in leachate is calculated to exceed 0.05 (5%) of the drinking water standard, then a cap shall be used unless the BNL management is convinced otherwise. That is, impermeable caps shall be required for soil activation areas where the predicted annual activity concentration in leachate, leachate that may be created by infiltration of rainwater or stormwater runoff through activated soils exceeds 1,000 pCi/L for tritium or 20 pCi/L for Na^{22}.

The water of interest for the activity-concentration calculation is rainwater/stormwater leachate. It is not the concentration in groundwater at the "point of assessment." It is noted that leachate concentrations at 0.05 (5%) of the drinking water standard are not anticipated to be measurable at the "point of assessment." See Verification by Monitoring for further discussion of "point of assessment."

A hydraulic barrier layer or cap is to be designed to prevent or minimize rainwater infiltration into the activated soil areas. The cap shall be designed to incorporate the following criteria as a minimum:

- The peak rainwater infiltration rate is less than or equal to the infiltration rate in 18 inches of low permeability soil (hydraulic conductivity less that $1x10^{-5}$ cm/sec) with one inch of ponded water above the cap. This equates to an allowable peak infiltration rate of approximately 1 cm/day. This is approximately 0.3% of the infiltration rate for natural soils at BNL.

- The long term average infiltration rate, as estimated with the Hydrologic Evaluation Landfill Performance (HELP) Model, Version 3.07 or newer,[2] is less than 0.12 cm/year (0.047 inches/year). This is approximately 0.2% of the natural groundwater recharge rate at BNL.

Direct Activation of Groundwater

The accelerator management shall prevent direct activation of groundwater to levels that are as low as reasonably achievable with operational, economic and community factors taken into account. As a minimum, the accelerator management shall meet the following requirements:

- The highest level of the water table shall be determined based on archival information for the BLL site.
- The shield thickness or alternatively the thickness of soil in the vadose zone shall minimize direct activation of groundwater.
- For direct activation of groundwater, if the estimate of annual radioactivity concentration produced directly in the groundwater at its highest level exceeds 0.05 (5%) of the drinking water standard, then the physical configuration is not acceptable. Planned losses shall be reduced, the distance to the water table shall be increased or the shielding between the BLL and the groundwater shall be increased.

Acceptable BLL Capping Materials

- Concrete or Gunnite Overlay (Conventional)

[2] USEPA, "The Hydrologic Evaluation of Landfill Performance (HELP) Model," Version 3.07. EPA Office of Research & Development, 1995.

- The cap shall be placed directly over the area to be protected, reinforced with welded wire fabric and meet the American Concrete Institute code. The cap shall be sealed to existing structures using flexible sealants or grouts.

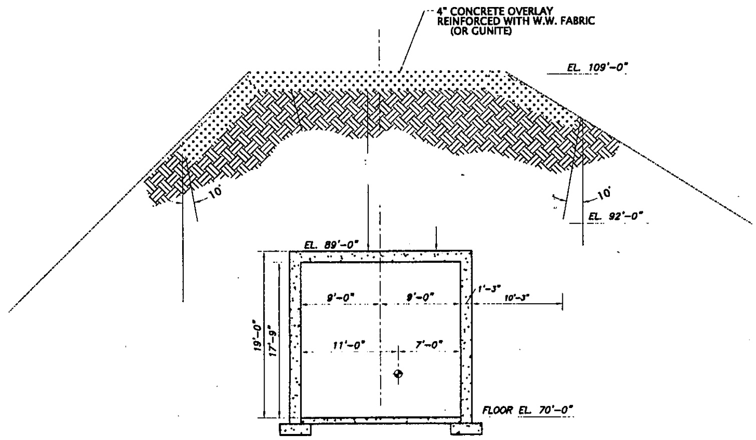
- Geomembrane Covers (Conventional)
  - Standard landfill geomembranes and construction techniques may be used. The geomembrane cap shall meet the general requirements of 6NYCRR, Part 360, 2.13, R.
- Low Permeability Soil Covers (Conventional)
  - A minimum 18-inch thickness of low-permeability, properly pre-planned barrier soil, meeting the general requirements of 6NYCRR, Part 360, 2.13, J and Q, may be used.
- Metal or EPDM Roofing (Alternative)
  - Standard roofing technique may be used if they meet the building code and the manufacturer's recommended instructions. The roofing shall be sealed to existing structures using flashing and sealants.

Innovative or alternative capping systems such as metal roofing, rubber membranes such as EPDM or paving may be used if it is demonstrated that the infiltration-rate design-criteria will not be exceeded (see Standard for Prevention of Rainwater Infiltration). This demonstration shall be made using the HELP model analysis[2] or moisture monitoring from beneath the capping system using lysimeters or equivalent.

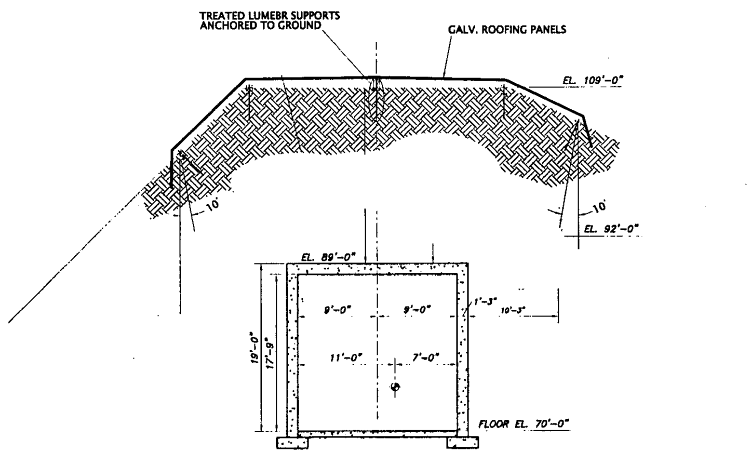
Validating the As-Built Cap

- The as-built cap structure shall be inspected and validated against design drawings.
- The as-built cap overlap shall be inspected and validated.
  - The cap shall overlap the activated soil that is to be protected by 10 degrees as shown in the following illustrations.

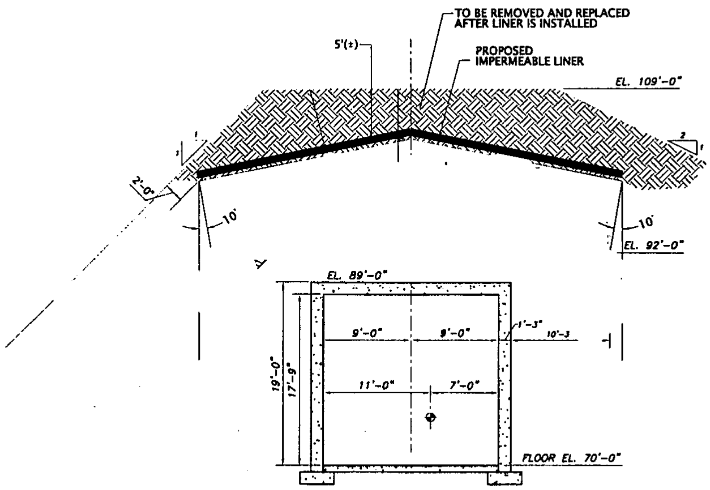
It is noted that for below-grade caps, visual inspection for overlap is possible during the construction phase. However, below-grade caps are not able to be directly inspected for tears or cracks after construction. On-the-other-hand, soil used at a BLL is constructed uniformly and tested since it is used as radiation shielding. It is not undisturbed local soil. Soil shields are homogeneous in composition. Below-grade caps are not exposed to animals or other surface sources of penetration. If installed properly, the chief concerns for below-grade caps are: 1) soil erosion that can expose the membrane and 2) trees whose roots can damage the membrane, and both concerns shall be monitored (see Preventive Maintenance Schedule and Reporting). The project engineer in charge of installing the cap shall validate the as-built structure against the design drawings, and update the drawings according to internal change procedures. See Internal and External Approvals.



CONCRETE OVERLAY OR GUNNITE METHOD Conventional



METAL ROOFING METHOD Alternative



LINER METHOD Conventional

Stormwater Management

Stormwater runoff from capped beam-loss areas shall be collected and conveyed to the BNL stormwater collection system, when practicable. If the BNL stormwater system is not convenient, then stormwater runoff shall be collected and discharged to an area outside the area of beam loss influence. The following design considerations shall be reviewed during design of loss areas:

- Stormwater run-on from adjacent areas shall be prevented.
- The design shall not allow a direct pathway from the stormwater piping or recharge system through a beam-loss location.
- Drywells, if necessary shall be located at least 100 feet outside the beam-loss areas. All drywells shall be approved by the BNL manager who has that authority.
- Rooftop drainage from adjacent structures shall be conveyed away from beam-loss areas.
- Storm, sanitary and domestic water piping shall not be located within beam-loss area.

Preventive Maintenance Schedule and Reporting

BLL caps shall be inspected at the start-up and conclusion of each running period, which is typically twice per year. In no case shall inspection of all caps be less frequent than annually. Sufficient time should be allowed before operations to allow for repairs. A written procedure shall be used to conduct inspections. A record of inspection shall be maintained in accordance with internal operating procedures. The following items shall be inspected and they shall be specifically listed in internal operating procedures:

- Check for penetrations such as cracks in concrete or Gunnite caps.
- Check sealed areas such as penetrations or fence posts or sheet piling.
- Check for holes, cracks or tears in waterproof membranes such as EPDM rubber roofing membrane.
- Check for excessive ponding of rainwater.
- For above-grade, below-grade caps and paved areas, check for trees and woody shrubs whose roots can damage the cap.
- For below-grade caps, check for soil erosion that can expose the membrane.

Preoperational Monitoring (Baseline)

Wells shall be installed and sampled before the operation of the facility to obtain DOE required pre-operational monitoring data. At a minimum, two sampling events in two separate calendar quarters should be conducted. See Establishing Environmental Monitoring Programs Subject Area.

Soil samples in the area of planned beam loss locations shall be obtained before new operations are conducted at the facility or beam line. Since beamlines are re-used for new experiments, and since accelerators evolve in order to be used for different modes of operation, the purpose shall be to provide a baseline level of soil activation. A sufficiently representative number of soil samples are recommended. Accelerator management shall decide the number and location of soil samples based on planned beam-loss locations, former beam-loss locations, soil locations not planned to be activated, and energy and type of particles accelerated.

Verification by Monitoring

BNL has a comprehensive environmental monitoring program that includes monitoring the air, drinking water, surface water, groundwater, soil, sediment, flora and fauna. Guidance for the evaluation of environmental monitoring requirements at BNL is provided in the Environmental Monitoring Subject Area. This program is designed to provide early warning of potential environmental releases, monitor potential pathways for exposure to the public and the environment, monitor the effectiveness or environmental remediation systems, measure the potential impact BNL operations may have on the environment, and provide data to demonstrate compliance with applicable laws, regulations, and permit limits. It includes planning, implementation and reporting activities associated with the collection and analysis of samples, or the direct measurement of environmental media, including liquid effluent monitoring, air emissions monitoring, and environmental surveillance.

Groundwater monitoring is a means of verifying that operational and engineered controls at BLLs are effective in protecting groundwater quality. Verification of groundwater quality is based on actual measurements at the groundwater "point of assessment." A hydrogeologist along with other Subject Matter Experts shall determine the "point of assessment" (see Environmental Monitoring Subject Area).

When establishing a groundwater monitoring program:

- Groundwater monitoring programs shall be established in soil activation areas that are capped. A staff hydrogeologist shall evaluate the geology and hydrology of the potential soil activation area.
- The wells shall be positioned as close as reasonably achievable to known or potential soil activation.
- The number of wells required for a monitoring program shall be based upon the size of the potential soil activation area, and take into account potential variations in groundwater flow directions due to natural or synthetic effects (i.e., pumping and recharge effects).
- Typically, two downgradient wells shall be required for small activation areas.
- Upgradient wells may be required if other known or potential soil activation sources may influence measurements at the "point of assessment."
- All monitoring wells shall be installed according to BNL requirements (see Environmental Monitoring Subject Area).
- Depth of the wells and location of the screened sections shall be based upon depth to groundwater and complexity of potential contaminant migration pathways.
- Groundwater modeling may be used to assess contaminant migration pathways and rates.
- Typically for wells located close to a potential soil activation area, the well's screened section should be 20 feet in length, and installed across (i.e., straddling) the water table to accommodate fluctuations in water table position.
- A groundwater sampling and analysis plan shall be developed, and incorporated into the annual BNL Environmental Monitoring Plan as per relevant DOE Order. Factors to consider when defining the frequency of sampling (i.e., annual, semi-annual, or quarterly) should be: archival and current water quality data; the potential for a contaminant release; distance from the soil activation area to the well(s) and groundwater flow velocity; and the proximity of the soil activation area to active potable water supply wells.
- All monitoring wells shall be sampled according to BNL requirements (see Environmental Monitoring Subject Area).
- Groundwater samples shall be analyzed for tritium and Na^{22} using methods acceptable to the EPA.
- All groundwater data should be stored in, and be accessible through, the BNL Environmental Information Management System (EIMS).
- The BNL Groundwater Contingency Plan will be used to respond to monitoring results that are above established thresholds described in the plan.
- If groundwater monitoring indicates that the sources pose a continuing threat to groundwater quality (i.e., concentrations at the point of assessment exceed stated thresholds), then the need for additional protective measures shall be evaluated.

- The continued adequacy of the monitoring program should be periodically verified. Additional wells may be required if significant changes groundwater flow directions are observed.

Verification by Soil Sampling

Direct measurement of soil program shall be incorporated, where practicable, into the conduct of operations. A direct soil-sampling program shall:

- Provide a baseline, see Preoperational Monitoring (Baseline)
- Verify/benchmark soil-activity calculations.
- Establish soil-sampling access ports at beam height, where practicable, which is likely the location of maximum soil-activity concentration.
- Meet sample Volume and Container Requirements.
- Comply with relevant Radiological Control Procedures.

Incorporate Lessons Learned

There are two elements to incorporating Lessons Learned: (1) conform to the SBMS Lessons Learned Subject Area, which will track off-normal performance of these engineered controls and (2) track and trend results from inspections of cap systems and results from maintenance requirements. Nonconformance shall be reported in accord with SBMS requirements.

Accelerator management shall demonstrate that these sources of information have been incorporated into their formal conduct-of-operations procedures.

Internal and External Approvals

The following shall be approved or documented by the accelerator manager/department chair or designee according to internal formal conduct-of-operations procedures:

- As-built drawings for caps and membranes.
- Locations for loss monitors.
- Procedures for cap maintenance.
- Procedures for response to loss monitor alarms.
- Benchmark soil-activity calculations.

The following shall be approved or documented by the appropriate BNL environmental Subject Matter Expert:

- A design review according to requirements in SBMS or according to requirements in accelerator department procedures (e.g., C-A OPM 9.2.1 or C-A OPM 9.3.1).
- Monitoring well locations.
- Type and number of monitoring wells.

Topics to Guide the Accelerator Readiness Review (ARR) Committee

The purpose of an ARR is to verify that the facility personnel, hardware and procedures are ready to permit the activity to be undertaken in a safe and environmentally sound manner. An ARR is not a method for achieving readiness but for verifying it. The facilities line management is responsible for declaring and ensuring readiness.

I. Documentation Readiness

A. Accelerator Safety Envelope

The ARR should verify that

1. The Deputy Director of Operations has approved the Commissioning Package or Routine Operations Package

2. The line has declared readiness for the ARR to commence.

B. Safety Assessment Document

The ARR should verify that

1. A Safety Assessment Document (SAD) exists, has been reviewed by the BNL ES&H Committee as an independent safety review, and the comments and recommendations resulting from that review have been adequately addressed by management;

2. Management has documented its conclusions that the activity analyzed in the SAD is an accurate evaluation of the ES&H consequences of undertaking the activity, and that the mitigated risks of the activity to employees, the public, and the environment are acceptably low.

C. Procedures

The ARR should verify that

1. Procedures necessary for safe operation of the activity have been developed, reviewed, verified (by performance where applicable), and approved;

2. A procedure control system has been established, which defines the processes for procedure preparation, review, approval, verification distribution and training, and processes are kept current;

3. Maintenance involving the safety aspects of the activity being reviewed has been identified and maintenance procedures for these activities have been developed, reviewed, verified, and approved;

4. Procedures for safety-related operations and maintenance are kept current;

5. Procedures to deal with off-normal and emergency situations have been prepared and are approved for use.

6. The procedures addressing the ASE-required equipment and systems specify the minimum necessary system components and monitoring devices to allow operation. If these minimums are not met, actions are specified.

D. Compliance with DOE ES&H Requirements

The ARR should verify that

1. Facility management has required a review to be made of the activity's conformance to applicable ES&H requirements;

2. Non-conformances have been identified and schedules and resources for achieving compliance have been established and approved by the appropriate level of management;

3. There is a process for reviewing changes to the proposed activity for impacts on hardware, procedures, training and unreviewed safety issues;

4. Processes exist for evaluating the readiness of radiological control measures and other ES&H items applicable to the proposed activity.

E. Resolution of Findings and Observations

The ARR should verify that

1. A process exists to identify, evaluate, and resolve findings made by internal and external oversight and audit groups;

2. Previous findings made by internal and external oversight and audit groups, including prior Accelerator Readiness Reviews or System/Component Readiness Reviews of the accelerator, which are relevant to the activity under review, have been satisfactorily completed or have corrective actions underway.

II. Hardware Readiness

A. Hardware

The ARR should verify that

1. Equipment and systems having safety importance meet criteria described in the SAD and have been appropriately tested. This includes

    - Shielding
    - Electrical systems
    - Protection against credible fires
    - Protection from oxygen deficient environments
    - Storage, transfer, and use of cryogens
    - Beam transport
    - High power beam dumps
    - Personnel protection systems, including secured area interlock system
    - Fixed and portable radiation monitoring equipment
    - Other instrumentation for monitoring safety and health conditions
    - Systems for controlling environmental, safety, and health parameters
    - Magnets
    - RFs
    - Lasers

2. The results of testing conducted to confirm the readiness of hardware to undertake the activity safely have been documented, evaluated to ensure adequacy, and meet quality assurance requirements.

B. Hardware Operability

The ARR should verify that

1. A program is in place to periodically reconfirm the status and operability of hardware systems that have safety importance.

2. The performance of the physical systems that provide assurance of the viability of the ASE and that maintain the activity within the Operations Envelopes (when used), have been verified, and records of appropriate system, tests, and calibrations exist and are current.

III. Personnel Readiness

A. Training Program

The ARR should verify that

1. Training and qualification programs have been established for general safety orientation, accelerator operations personnel, maintenance and support personnel, experimenters using the facility, and emergency responders. These programs are documented and encompass the range of duties required to be performed in accordance with the SAD

2. A process to periodically evaluate training program effectiveness has been established and documented and specifically includes the following considerations:

   a. Classroom and individualized instruction are appropriate for the facility, and facility management periodically evaluated instructor performance;
   b. A systematic evaluation of training program effectiveness, including feedback from job performance, is used to ensure the training program conveys all the required skills and knowledge.
   c. The personnel protection training program is specific to the facility's hazards and provides the knowledge and skills necessary of individuals to perform their assigned job functions while avoiding exposure to specific facility hazards, such as high voltage-, cryogen-, and oxygen-deficient environments, and minimizing their exposure to radiation and chemicals;
   d. Training and qualification of personnel has been achieved.

B. Qualified Personnel

The ARR should verify that

1. The numbers of trained and qualified operations, maintenance and support persons meet SAD and/or ASE requirements.

2. Individual assignments, responsibilities, authorities, and reporting relationships are defined, documented, and included in training.

3. Qualifications or exceptions to specified areas of training based upon education or experience have been granted and documented.

Subject Area: ***Accelerator Safety***

Unreviewed Safety Issue (USI) Checklist

Effective Date: **April 2000**

Point of Contact: Safety Management Systems Integration Program Manager

- Changing or altering procedures referenced in the Safety Assessment Document (SAD)
- New hazards not currently in the FUAs
- Reorganization impacting departmental/divisional responsibilities listed in the SAD
- Accelerator modifications that are not replacement-in-kind activities
- Non-editorial changes to OSL-related procedures
- Change-out/replacement of safety equipment identified in the Accelerator Safety Envelope (ASE) that is not identical in form, fit, and function

1.0-042000/standard/1r/1r08e011.htm

Introduction

An ARR report should be prepared as soon as possible after the completion of the review. The ARR team leader should obtain input from all team members, and the team should reach consensus on the readiness of the facility to commence the activity for which the ARR was performed.

The conclusions reached by each team member are the principal end product of the ARR. They should be carefully drawn so that they unambiguously reflect the true intent of the team member, and they should be supported just as carefully. Suggestions of the types of information that will help support the conclusions include methodology used in pursuing the review, personnel contacted and their positions, documents reviewed, operations witnessed, and spaces visited.

A conclusion drawn as a result of the ARR effort may lead to one or more findings and/or observations. Findings are more serious and require documented closure. Findings reported by the team should be categorized as Pre-start or Post-start Findings. A Pre-start Finding is one, which, in the Team's opinion, must be corrected before an activity can be started. A Post-start Finding can be corrected after the start of the activity under review.

The final ARR report should be directed to the Deputy Director of Operations (DDO), with an information copy to the appropriate Facility Manager. Each member of the team should also receive a copy of the ARR Report. The DDO will be responsible for any further distribution of the report to the Brookhaven Group Office (BHG).

ARR REPORT TEMPLATE

1. Title/Cover Page

State the subject and date of the ARR

2. Signature Page

Include the signatures of all team members, signifying their agreement with the report and its conclusions. If a signature cannot be obtained for logistical reasons, the ARR Team Leader should obtain concurrence verbally or by facsimile and sign for the member.

3. Table of Contents

Identify all sections (including page numbers), subsections, illustrations, tables, charts, and appendices.

4. Executive Summary

Provide a summary of the review, findings and facility readiness. Suggested considerations include

- Brief synopsis of review;
- A determination as to readiness of the facility to undertake the activity;
- A statement regarding the adequacy of management systems to oversee the activity;
- A synopsis of the significant problems and strengths found by the ARR;
- A brief summary of the findings, including numbers of pre-start or post-start findings.

5. Introduction

Provide background information regarding the activity under review. This should include

- Purpose, scope, and objectives of the ARR;
- Review process and methodologies;
- Composition of the ARR Team;
- Definitions applicable to the ARR.

6. Conclusions

Address each subject identified in the scope and discuss the facility's readiness in each area. State each finding succinctly and unequivocally, and characterize as pre-start or post-start. Provide the basis for each finding.

7. Observations

Identify those items that, in the opinion of the ARR team, do not require action by the facility but would likely enhance the ESH status of the facility.

8. **Readiness Determination**

Provide an overall recommendation as to the readiness of the facility to commission, restart, or routinely operate.

9. Appendices

Append data/documents to support the report. These should include

- Review criteria and approach;
- Team roster with relevant qualifications of each member;
- Differing opinions (when applicable);
- Plan of Action.

Accelerator Safety Assessment Document (SAD) Template

Cover Page: As a minimum the cover page must include

Title of Facility
Building Number

Date of Initial SAD
Subsequent Revision Dates

Signature of Preparer(s)
Signature of Department Chair/ Division Manager
Signature of Appropriate Associate Laboratory Director
Signature of Deputy Director of Operations

Chapter 1: Introduction

In this chapter, give a basic understanding of the facility's function and the protection afforded the public, workers (health and safety), and the environment.

Chapter 2: Summary/Conclusions

The summary gives an overview of the results and conclusions of the analysis contained within the SAD. Address the comprehensiveness of the safety analysis and appropriateness of the proposed Accelerator Safety Envelope.

Authorized deviations from SBMS requirements (such as subject areas and manuals) used to implement DOE accepted codes, standards, and regulations should be identified, and justification for the deviations should be provided in the SAD.

The analysis for an operation that involves only hazards that are routinely encountered by the public may be replaced by a simple, formal statement of that fact.

Chapter 3: Description of Site, Facility and Operations

The function of this chapter is to accurately show the environment within which the facility will be constructed (or modified), those facility characteristics that are safety-related, and the methods to be used in operating the accelerator and associated equipment.

The SAD may be prepared as a single document addressing the hazards of the entire accelerator facility, or as a set of separate SADs for discrete modules of the facility, such as injectors, targets, experiments, experimental halls, or any other type module. For large facilities/experiments, this approach will allow changes to be made easily to only the effected module. However, it is important to verify that any such changes do not also affect any of the other modules in some way (either obvious or subtle).

Address the following items in this chapter:

- The location of the accelerator site should be characterized, including any special site requirements or unusual design criteria. Data typically address site geography, seismology, meteorology, hydrology, demography, and adjacent facilities that may impact or be impacted by the accelerator facility.

- This chapter should also detail design criteria and as-built characteristics for the accelerator, its supporting systems, and components with safety-related functions. Particular attention should be given to those design features that minimize the presence of hazardous environments, such as confined spaces, and ensure that chemical and radiation exposures are kept ALARA during operation, maintenance, and facility modification. This section should also identify any impacts to the existing Facility Use Agreements that may require modification.

- Administrative functions should be addressed with a safety and operation assignment matrix. The functioning of engineered and administrative controls should be described for both routine operations and emergency conditions. Critical operating procedures to prevent or mitigate accidents should be identified, as well as normal and emergency procedures required to operate the facility within the analyzed safety envelope (e.g., sweep and interlock operating procedures).

- Address the Department/Division work planning and control program for that work that could impact the safety of the accelerator facility.

- Describe the maintenance, performance testing, inspection and surveillance activities required to maintain the inherent reliability of safety-related systems (e.g., interlock tests).

- Similarly, also identify training and certification required to maintain the facility within the analyzed safety envelope.

- Describe experiments that will be conducted in the accelerator facility, including design criteria and characteristics of the experimental equipment, systems, and components having safety-related functions. The Department/Division 1.3.5 Experimental Program should be described or referenced.

Chapter 4: Safety Analysis

This chapter documents the analysis, including any systematic methodology (i.e., Failure Mode and Effects Analysis, Fault Trees) used for identifying and mitigating potential hazards. It should also identify, characterize, and quantify hazardous materials, (i.e., chemicals, compressed gasses, explosives) energy sources, (i.e., air, pressure, steam, hydraulic, flammable/combustible materials, lasers, RF, microwave) and potential sources of environmental pollution (i.e., air and liquid emissions) at the facility, including radiological hazards (contamination, activation, criticality*)*.

The level of detail necessary will depend largely upon the complexity of the facility and magnitude of the hazards. The purpose of the SAD is not only to detail the hazards identified, but also to demonstrate that a rigorous study of the activity has been completed and that all significant hazards have been identified.

Coupled with identifying hazards should be a description of the controls that will be used for their mitigation. In this description, include a discussion of credible challenges and estimates of consequences in the event of failure. Analysis of estimated consequences and likelihood of occurrence may signify the need for additional or more reliable controls. Credible maximum bounding accident scenarios for the accelerator and experiments may be described to indicate the need for and extent of emergency plans or site assistance agreements.

Where appropriate, discuss the residual risk to workers, the public and environment. However, a separate effort beyond that of the safety analysis is typically not necessary for residual risk estimation , since requirements, codes, and consensus standards establish acceptable risk.

Risk assessment, i.e., the predicted severity of consequences and the probability of occurrence for all hazards, may be expressed qualitatively or quantitatively. However, for research and development activities typical of those at BNL, the severity classification of hazards, and the determination of the probability of occurrence usually will be qualitative. The qualitative risk assessment process typically used at BNL is described in *ES&H Standard 1.3.3, Safety Analysis Reports/Safety Assessment Documents* and is based on experience with similar equipment, data from other laboratories, industry experience, and the best judgment of the analyst.

For each hazard identified, include a risk matrix that summarizes the risk assessment before and after mitigation. A risk assessment form is attached to this template.

Implicit in the above discussion is that professional judgment is involved in all analysis of hazards, hazard consequences, and effectiveness and reliability of controls. However, professional judgment should be supported by sound technical and/or scientific bases, using accepted methods for hazard analysis that are valid for the types and magnitudes of hazards present.

Chapter 5: Quality Assurance

Describe the Quality Assurance (QA) Program to be applied to the accelerator facility, focusing upon those activities that impact protection of the worker, public, or environment. Contact your Departmental Quality Representative for assistance.

Chapter 6: Considerations for Decommissioning and Decontamination (D&D)

Describe the structural and internal features that would facilitate D&D of the accelerator facility. Discuss waste management of radiological and hazardous material generation from the D&D operation within the context of DOE requirements.

Chapter 7: References/Glossary/Acronyms

RISK ASSESSMENT

FACILITY NAME:____ NUMBER: ______________

SYSTEM:____
SUB-SYSTEM:____

HAZARD:____

Event Possible Consequences & Hazards: Potential Initiators:	

Risk Assessment Prior to Mitigation						
Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV ( ) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C ( ) Occasional	D ( ) Remote	E ( ) Extremely Remote	F ( ) Impossible
Risk Category:	1 ( ) High Risk	2 ( ) Moderate	3 ( ) Low Risk	4 ( ) Routine		

Hazard Mitigation	

Risk Assessment Following Mitigation						
Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV ( ) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C ( ) Occasional	D ( ) Remote	E ( ) Extremely Remote	F ( ) Impossible
Risk Category:	1 ( ) High Risk	2 ( ) Moderate	3 ( ) Low Risk	4 ( ) Routine		

Is the mitigated hazard adequately controlled by existing laboratory policies? Y/N _____ If No, roll up into ASE.

Accelerator Safety Envelope (ASE) Template

Background and General Instructions

The Accelerator Safety Envelope (ASE) formally establishes the set of bounding conditions on engineered and administrative systems, within which the Department/Division proposes to operate an accelerator facility. These bounding conditions are based on the safety analysis documented in Chapter 4 of the Safety Analysis (SAD) for the accelerator facility. The ASE assures the validity of the basis set of assumptions used in the SAD safety analysis and ensures that the physical and administrative controls used to mitigate potential hazards are in place.

DOE requires adherence to the approved bounding conditions of the Accelerator Safety Envelope, because it is the authorization basis for all commissioning and operations activities.

This template provides general guidance for the content of the document, and it also contains an example of the language that can be used (with minor modification) to fit the majority of accelerator facilities.

To understand the appropriate level of information to include in the accelerator safety documentation, one must first understand the overall flow-down of information from the "highest" safety limits to the lowest machine operating procedures. This flow-down generally has four levels that provide a defense-in-depth to ensure the safe and environmentally sound operations of the accelerator. The top two levels of this information are placed in the Accelerator Safety Envelope (ASE). The lower two levels are formally established in the accelerator's Conduct of Operations documentation and procedures.

The highest-level information, "Safety Envelope Limits," is documented in Section 2 of the ASE (see Section 3 of the Accelerator Safety Subject Area). There are two categories of these limits. One is the absolute limit that BNL places on its operations to ensure that the regulatory limits established to protect our environment, public and staff/visitors are met. BNL requirements include

- Less than 25 mrem in one year to individuals in other BNL Departments or Divisions adjacent to an accelerator facility.
- Less than 5 mrem in one year to a person located at the site boundary.
- Off-site drinking water concentration and on-site potable well water concentration must not result in 4 mrem or greater to an individual in one year.
- Less than 1250 mrem in one year to an accelerator facility staff member.
- Tritium concentrations in the sanitary sewer effluent less than 10,000 pCi/L.
- Radioactive liquid effluent from soil activation is to be prevented.
- Airborne effluents must result in emissions less than 0.1 mrem in one year to a person at the site boundary.

- The second level is the design/operating limits used as a basis for the Safety Analysis Document (SAD) analysis.

This second level of information, "Experimental and Operational Limitations" is documented in Section 3 of the ASE. This section identifies the calculated limitations on critical operating parameters that, in conjunction with the specifically identified hazard control considerations established by the facility design, construction or experimental design constraints, ensure the accelerator or experimental operations will not exceed the corresponding Safety Envelope Limits or operational safety parameters as evaluated in the SAD. These parameters are derived from the safety analysis of the SAD. Examples might include the following:

- Beam loss. For example, $7x10^{19}$ 28 GeV-protons per year stopped at one location in the AGS Ring.
- Effluent limits. For uncapped soil, greater than $2.5x10^{20}$ protons per year at 28 GeV at one location with the equivalent of 1.5 meters of heavy concrete between the stopped protons and the soil.

The third and fourth levels of information are not included in the ASE. Rather, these are more detailed levels that appear in the accelerator operating procedures that are generally covered in the Commissioning/Routine Operation Plans and tested via the Accelerator Readiness Reviews. This information consists of documented or measurable limits and corresponding controls necessary to establish an operational margin of "safety" that is more conservative than that established in the ASE. This "operating margin" provides a defense-in-depth approach to ensuring that BNL will operate the accelerator well within "Experimental and Operational Limitations," agreed-to by DOE in formally approving the ASE. These operating limits and controls are not incorporated into the ASE. Rather, these considerations are incorporated into the accelerator safety process through the Commissioning/Routine Operation Plans and the corresponding Accelerator Readiness Review processes. Compliance with these operating limits and controls is achieved through the design of the facility and adherence to formal Conduct of Operations for the Accelerator Facility. (See Section I of the Operations and Maintenance Manual).

Examples of the third level may include limits designed into the machine itself, such as its maximum beam power, beam energy, or beam intensity.

Examples of the fourth level include authorizations that prohibit use of the accelerator unless certain conditions are met, such as a fully functional personnel protection system, or a fully functional fire protection system, or an effluent is released to the sanitary system. Other fourth-level examples include procedures to ensure that a certain number of fully trained operators are on-duty, or to ensure that the loss-monitor system is working to limit beam loss to a specific location, such as a fully shielded beam stop.

Cover Page:

Include as a minimum the following:

Accelerator Safety Envelope
Title of Facility
Date of Initial ASE
Subsequent Revision Dates
Version of the SAD that the ASE applies to

Signature of Preparer(s)
Signature of Appropriate Division Manager/Department Chair
Signature of Appropriate Associate Laboratory Director
Signature of Deputy Director of Operations

ASE Contents:

Section 1. Introduction

Include the following:

- General actions to be taken upon discovery of a violation of the Safety Envelope, including shutdown of the facility.
- A description, or reference, to the method used by the Department/Division for change control of the ASE.

Section 2: Safety Envelope Limits

This section contains two categories of limits: the absolute limits that BNL places on its operations to ensure we meet the regulatory limits established to protect our environment, public and staff/visitors; and the design/operating limits used as a basis for the Safety Analysis Document (SAD) analysis. Examples of Safety Envelope Limits are the following:

- Less than 25 mrem in one year to individuals in other BNL Departments or Divisions adjacent to an accelerator facility.
- Less than 5 mrem in one year to a person located at the site boundary.
- Off-site drinking water concentration and on-site potable well water concentration must not result in 4 mrem or greater to an individual in one year.
- Less than 1250 mrem in one year to an accelerator facility staff member.
- Tritium concentrations in the sanitary sewer effluent less than 10,000 pCi/L.
- Radioactive liquid effluent from soil activation is to be prevented.
- Airborne effluents must result in emissions less than 0.1 mrem in one year to a person at the site boundary.
- Accelerator Design/operating limits used as a basis for the analysis of the SAD.

Section 3: Experimental and Operational Limitations

This section identifies the measurable limitations (if any) on critical operating parameters that, in conjunction with the specifically identified hazard control considerations established by the facility design, construction, or experimental design constraints, ensure the accelerator or experimental operations will not exceed either the corresponding Safety Envelope Limits or operational safety parameters, as evaluated in the SAD. These parameters are derived from the safety analysis of the SAD. Examples might include

- Beam loss
- Effluent limits.

Section 4: Engineered Safety Systems Requiring Calibration, Testing, Maintenance, and Inspection

Include in this section the identification of the systems and requirements for calibration, testing, maintenance, accuracy or inspection necessary to ensure the continued reliability of engineered safety systems that ensure the operational integrity of the Experimental and Operational Limitations described in Section 3. Requirements must be consistent with established Laboratory Policy (i.e., interlock testing frequency as established in ES&H 1.5.3, Interlock Safety for Protection of Personnel). For example, include statements, such as

- Interlock systems for personnel protection per Laboratory requirements.
- Oxygen deficiency alarm systems must be tested upon installation and per Laboratory requirements thereafter.
- Capture key systems must be tested upon installation and per Laboratory requirements thereafter.
- Flammable gas alarm and interlock systems must be tested upon installation and per Laboratory requirements thereafter.
- Fire protection systems must be tested per Laboratory requirements.
- Environmental monitoring systems for airborne or liquid effluent control must be tested per Laboratory requirements.
- Area radiation monitors must be tested per Laboratory requirements and be within the Laboratory calibration requirements of the true value.

Section 5: Administrative Controls

Include in this section the administrative controls necessary to ensure the operational integrity of the Experimental and Operational Limitations described in Section 3. For example, these could include

- Minimum staffing level requirements.
- Qualification and training requirements for operation.
- Minimum operable equipment.
- Critical records to be retained.
- Currency of procedures critical to safe operation.
- Work planning and control systems.

- Environmental release mitigation measures.

Example

1. Introduction

This Accelerator Safety Envelope (ASE) governs the operation of the X Facility, including the linear accelerator, the transport line, and the target areas. Violation of those ASE limits requires an immediate halt of operations and notification of DOE and Laboratory management. Upon correction of variances from the relevant ASE parameter and completion of any reviews that may be deemed appropriate, the notification of Laboratory and DOE management and the approval of X Department Management is required to return to operation.

This document, as well as the companion Safety Assessment Document listed on the cover page is subject to change control managed by the X Department according to the relevant SBMS subject area.

2. Safety Envelope Limits

The operation of the X Facility, including the linear accelerator, the transport line, and the target areas must be carried out in a manner that ensures that the following safety envelope limits are not exceeded:

- Less than 25 mrem in one year to individuals in other BNL Departments or Divisions adjacent to an accelerator facility.
- Less than 5 mrem in one year to a person located at the site boundary.
- Off-site drinking water concentration and on-site potable well water concentration must not result in 4 mrem or greater to an individual in one year.
- Less than 1250 mrem in one year to an accelerator facility staff member.
- Tritium concentrations in the sanitary sewer effluent less than 10,000 pCi/L.
- Radioactive liquid effluent from soil activation is to be prevented.
- Airborne effluents must result in emissions less than 0.1 mrem in one year to a person at the site boundary.
- The X Facility shall operate with a beam power of less than 0.1 Mev with 8 inches of shielding as analyzed in the SAD Chapter 4.

3. Experimental and Operational Limitations

The Experimental and Operational Limitations necessary to ensure the operations of the X Facility remains within the Safety Envelope Limits are as follows:

- The beam loss in any part of the X Facility with the exception of the targets shall be limited to less than $1x10^{18}$ 10-GeV protons or equivalent per year.
- The beam at targets shall be no more than $1x10^{22}$ protons per year per target.
- The X facility shall maintain an inventory of less than 1 Curie of tritium in all its water systems.

4. Engineered Safety Systems Requiring Calibration, Testing, Maintenance, and Inspection

- Interlock systems for personnel protection shall be tested per Laboratory requirements.
- Capture key systems shall be tested upon installation and per Laboratory requirements thereafter.
- Flammable gas alarm and interlock systems in the target areas shall be tested upon installation and per Laboratory requirements thereafter.
- Fire protection systems in the target areas shall be tested per Laboratory requirements.
- The Linac stack air shall be sampled once per year at full Linac power.
- Area radiation monitors shall be tested per Laboratory requirements and be within the Laboratory calibration requirements of the true value.

5. Administrative Controls

- Two persons must be present at the facility during accelerator operation, at least one of whom must be a fully qualified operator. The other individual must be qualified at a minimum to shut the machine down and to respond to emergency conditions within the facility.

Template for the Accelerator Readiness Review (ARR) Plan of Action

The ARR Plan of Action (POA) is a document developed by the ARR Team. The POA is intended to be a short and concise document that establishes the path forward for the ARR. The POA summarizes the proposed methodology and acceptance criteria for the ARR. This will assure that the appropriate scope and depth of the review is established.

The purpose of an ARR is to verify that the facility's personnel, hardware, and procedures are ready to permit the activity to be undertaken in a safe and environmentally sound manner. An ARR is not a method for achieving readiness but for verifying it. The facility's line management is responsible for ensuring and declaring readiness.

ARRs are required before commissioning and before routine operations. In commissioning, the ARR should confirm that construction is sufficiently complete; required safety-related systems are installed; operations and relevant procedures have been approved; and appropriate personnel have been assigned and adequately trained. The purpose of a routine operation ARR is to confirm that the facility is fully ready for routine operations, including that construction is complete, systems are fully tested and operational, procedures are established and operationally verified, staffing is complete, and personnel are fully trained.

Depending on the complexity of the facility, a POA may be established for each phase of the ARR or be combined into one POA for both phases.

Template

Facility Name

1. Objective/Scope

To ensure that operation of the ___________________ Facility, located at _________ can be run in a safe and environmentally safe manner. The ARR process shall verify that all facility conditions and operations with the potential to affect worker or public safety and health, or to have a negative impact on the environment, have been evaluated with appropriate safeguards established, and that the requirements of DOE Order 420.2 are met.

2. Methodology

Review methodologies include those aspects of each requirement that the reviewer plans to address by some combination of evaluating procedures and/or other documentation, conducting interviews and performing first hand observations or inspections. This could include

- Scope of the ARR;
- Phases for which the review will be conducted (commissioning and/or operations);
- Documentation to be reviewed;
- Hardware to be reviewed;
- Personnel training/qualification requirements to be reviewed;
- Physical walk downs to be conducted;
- Verification of pervious ORR/ARR results;
- Members of Team and their assigned area of review;
- Facility point-of-contact;
- Recommendations for commissioning/routine operations;
- Deliverables;
- Schedule for ARR phases.

3. Acceptance Criteria

The ARR team should decide on the minimum acceptance criteria for each of the topics to be evaluated. Findings reported by the team should be categorized as Pre-start or Post-start findings. A Pre-start finding must be corrected before an activity can be started. A Post-start finding can be corrected after the start of the activity under review.

A methodology for determining acceptance criteria for findings that could be used is as follows:

Pre-start acceptance criteria screening:

- Does the issue involve equipment of a system having safety importance?
- Does this issue involve processes, functions or components identified in the ASE?
- Does this issue involve potential adverse environmental impact exceeding regulatory or site specific release limits?
- Does this issue impact non-safety processes, functions, or components, which could adversely impact processes, functions, or components having safety importance?
- Is this issue non-compliant with BSA- or BHG-approved start-up directives?

- Does this issue indicate a lack of adequate procedures or administrative systems having safety importance?
- Does this issue indicate operational or administrative non-compliance with procedures or policy having safety importance?
- Has this issue occurred with a frequency that indicates past corrective actions have been lacking or ineffective?
- Does this issue require operator training having safety importance not specified in existing facility training requirements?
- Does the issue involve a previously unknown risk to worker public safety and health or previously unknown threat of environmental insult or release?

If the response to any of the above was yes, further evaluation, in accordance with the issue impact criteria below would be used. If the response to all of the above is no, the issue may be resolved after restart.

If the response to any of the questions below is yes, the item should be considered pre-start criteria.

- Does the loss of operability of the item prevent safe shutdown, or cause the loss of essential monitoring?
- Does the loss of operability of the item cause operation outside the ASE?
- Does the finding indicate a lack of control, which can have near-term impact on the operability or functionality of equipment or subsystems having safety importance?
- Does the finding involve a violation or potential violation of worker safety or environmental protection regulatory requirements, which pose a significant danger to workers, the public or of environmental insult or release?

Template for Commissioning Plan

OR

Routine Operations Plan

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The commissioning/routine operations plan (plan) describes the necessary activities to be completed by the responsible Department/Division before commencing either commissioning or routine operations of the accelerator. The plan is intended to ensure that the Department/Division avoids unsafe or environmentally unsound commissioning/operations. It also is intended to help the Department/Division prepare for an appropriate Accelerator Readiness Review (ARR), as required in DOE Order O 420.2, Section 5 b. (2) (b). An ARR must be conducted following the declaration of the facility management accelerator readiness for commissioning/routine operations. The Brookhaven Group Office (BHG) uses the ARR Report to support its decision to approve the commencement of commissioning/routine operations of the accelerator and associated experiments.

It is permissible that the plan for the experiments be incorporated into the plan for the accelerator. Significant changes to Conduct of Operations, Training, Administrative or Technical Controls, Contingency Plans, or the ARR process itself shall be submitted as configuration-controlled updates to the plan.

This template reflects the requirements of a very complex accelerator. A simple accelerator plan may be written in one or two pages.

I Introduction

In the Introduction to the plan, give the background and context for the planned activities.

II Scope

In the scope of the plan, identify which aspects of the accelerator are to be ready for verification by the ARR. For example,

1. procedures, administrative controls, and personnel training and qualification for routine operations at full-intensity, and
2. engineered safety systems for the accelerator and accelerator-associated experimental facilities,
3. specific facilities, sub-systems, and operations modes.

Also, identify the location of controls for the beam and major sub-systems.

Establish a schedule of the most current plan, and the planned date for achieving readiness for the ARR.

The Department/Division shall identify by date and revision number the Safety Assessment Document (SAD) for the accelerator applicable to commissioning or routine operation. An Accelerator Safety Envelope (ASE) for commissioning/routine operations shall also be identified.

III Relevant Documents

Provide hyperlinks to documents or a list of available documents, including, for example,

1. Safety Assessment Document,
2. Accelerator Safety Envelope,
3. Department/Division Conduct of Operations,
4. Department/Division Operations Procedures,
5. Sub-system Safety Analysis Reports, if any,
6. Categorical Exclusion, Environmental Assessment, or Environmental Impact Statement,
7. Shield drawings, access control system, wiring diagrams, and logic diagrams,
8. Training Plan,
9. Quality Assurance Manual,

10. Configuration Control Plan,
11. Unreviewed Safety Issues.

IV Conduct of Operations

Briefly, describe the following:

1. the facilities,
2. to whom problems encountered are reported, (e.g., operational, safety, scheduling problems)
3. who makes the necessary notifications or arrangements for operations or authorizations, and
4. where the required authorizations are documented.

List all aspects of commissioning/operating activities requiring authorization. For example,

1. delegating authority,
2. operating systems,
3. starting-up or restarting systems,
4. performing maintenance on systems,
5. producing, classifying or removing existing procedures,
6. approving temporary procedures,
7. signing-off changes to procedures,
8. reviewing procedures,
9. appending training and qualification listings, and
10. declaring "critical" systems.

Identify the Department/Division-level documents that address requirements in ES&H Standard 1.3.6, Work Planning and Control for Operations. For example, indicate the Department/Division procedure for work planning. Indicate how work planning is executed by users who are assigned tasks related to experimental setup, equipment modification, or facility tie-ins.

V Training

State the policy to ensure general, facility-specific, and job-specific training of any employee, visitor, contractor, or experimenter who will require unescorted entry, into one or more of the buildings which form the accelerator.

Identify an examination system for training, which can be audited.

State the number and type of qualified personnel required to maintain periodic or round-the-clock operation, whichever is applicable. For example,

1. Operations Coordinator (6),
2. Accelerator Operator (12),
3. Radiological Control Technician (5),
4. Watch Technician (4),
5. Cryogenics Operators (18),
6. Accelerator Support (8), and
7. Experiment Shift Leader (20).

VI Contingency Procedures

To clarify the use of contingency procedures, assume situations that use equivalent safety or protection techniques may arise when commissioning/operating large accelerator facilities. Indicate contingency procedures that may be invoked to ensure safe, environmentally sound, and reliable operations. For example, a procedure involving manual lockout tagout in lieu of automatic access controls.

VII Commissioning and Operations Modules

Assemble the commissioning/operations activities into convenient modules. For each module, tabulate the schedule, briefly describe the objective, and list the operating items and persons responsible. For example,

Module for Accelerator Operations, Persons Responsible, Scheduled Readiness Date

SCHEDULE: Accelerator operations with beam on or about February 15, 2005.
DESCRIPTION: The accelerator will spiral and accelerate particles.
OPERATING ITEMS (Persons Responsible) 1. All related ORR and ARR items are closed out (Joe Smith). See Section XI. 2. Critical devices, beam-current monitors and reach-backs for radiation protection have been established (Pete Green). 3. The access-control system is operational and tested (John Williams). 4. Emergency procedures are complete (Sam Jones). See Section X.

5. Operations procedures are complete (John Appleseed). See Section X.
6. Fault Study Plan prepared (Sam Jones).
7. Safety Check-Off List(s) prepared (George Washington).
8. Safety Review Committee issues closed out (Pete Greene). See Section XI.
9. Accelerator Safety Envelope is complete (John Jones).
10. Sweep procedures are complete (Paul Allen). See Section X.
11. Training records for round-the-clock operations staff are complete (Bill Gates).

Module for Experiment Operations, Persons Responsible, Scheduled Readiness Date

SCHEDULE: Experiment operations readiness with particles on or about April 1, 2005.

DESCRIPTION: Fully accelerated particles will interact at the target.

OPERATING ITEMS AND/OR DOCUMENT

1. Experiment-related ORR and ARR items are closed out (Bob Money). See Section XI.
2. The access control system is operational and tested (John Williams).
3. Emergency procedures for experiments are complete (George Bush). See Section X.
4. Experiment Operations procedures are complete (Bill Bradley). See Section X.
5. Fault Study Plan prepared (Jack Benimble).
6. Experimental Safety Committee Checkoff Lists prepared (Jake Thedog).
7. Accelerator Safety Envelope is complete (John Gagnon).
8. Sweep procedures are complete (Bill Bradley). See Section X.
9. Training records for Users complete (Roslyn Mayo).

VIII Technical and Administrative Controls

List specific technical and administrative controls. A *technical control* is an act, service, or document used to satisfy a specific requirement stated in a DOE Order or Federal Law to ensure safety or protect the environment. Examples include the following:

1. Safety Assessment Document (SAD),
2. Accelerator Readiness Review (ARR),
3. Accelerator Safety Envelope (ASE),
4. Radiological training requirements,
5. DOE approval prior to operations,
6. Internal Safety Review Process,
7. Facility-specific shielding requirements (referred to as shielding policy in the DOE Order)

Technical controls are described in DOE Order 420.2, Accelerator Safety; 10 CFR 835, Occupational Radiation Protection; and DOE 5480.19, Conduct of Operations Requirements for DOE Facilities.

An *administrative control* is an act, service, or document used to satisfy a specific requirement stated in a BNL or Department/Division policy to ensure safety or protect the environment. Examples include

1. design reviews for safety and environmental protection,
2. safely-off modes, critical devices, and reach backs for radiation protection,
3. access control procedures for operators,
4. operations procedures,
5. fault studies,
6. sweep procedures,
7. records to ensure training is completed,
8. an ALARA program for dose reduction, and
9. roles, responsibilities, authorities, and accountabilities document (R2A2s)
10. work permits.

Administrative Controls are described in Brookhaven's Standards-Based Management System, Department/Division Conduct of Operations Matrix, and Department/Division Procedures.

IX List of Operations Procedures Required for Operational Readiness (Person Responsible)

List the relevant procedures applicable to each module in Section VII. A few examples are the following:

Authorization Procedures (Joe Smith)
1. Authorization of Startup, Operations, and Procedures
2. Operational Safety Limits/Accelerator Safety Envelope
3. Configuration Management Plan

Operations Procedures (Pete Jones)
1. Procedure For LockOut TagOut Of Injection Kickers
2. Procedure for Sweeping Primary Beam Enclosures

Emergency Procedures (Mel Ott)
1. Local Emergency Plan
2. Emergency Call-Down Lists
3. Emergency Procedures to be Implemented by the Department/Division Emergency Coordinator

Access Control System Procedures (Pete Williams)
1. Control Of Temporary Hardware Changes/Bypasses In The Access Control System
2. Access Security System Gate Check

Sub-System Procedures (Pete Smith)
1. Checklist for Operations Turnover
2. Compressor Room – Vacuum System Operation
3. Procedure for Power Failure Recovery

Experiment Operating Procedures (Al Smith)
1. Purging the Detector Gas System
2. Operating the Detector Main Hydraulic System
3. Procedure for Exciting the Experimental Magnet

X List of Prior Open Items (Persons Responsible)

List prior open items from internal reviews, commissioning ARR(s), external reviews and reportable occurrences. For example,

1. Review of fault study from commissioning run (Pete Smith)
2. Closeout of Open DOE Reportable Occurrences (Jake Thedog)
3. Review of access-control system experience with ARR Team (John Jones)
4. ARR Post Start Action Items from Commissioning Phase (Joe Green)
5. Open ORR Issues and Tier 1 Items (Hank Bush)
6. Open Safety Committee Items (Joe Smyth)

XI Responsibility Matrix

Construct a Responsibility Matrix to ensure all persons identified in the plan are notified of the responsibilities in the plan, and that all areas are assigned.

Acceptance Plan Element

	Training Records And Training Coordination	Fault Study Plan	Prior ARR Items (Post Start Findings)	Safety Off Modes	Emergency Procedures	Operations Procedures	RSC Checklists	ESRC Checklists	Prior Open ASSRC Issues	ASE	Sweep Procedures	Experiment Operating Procedures	Open RHIC Project Occurrences	Review of Access Control System Experience	Review of Fault Studies During Commissioning	Collider Fencing	Enhanced Work Planning For Experimenters	Development and Delivery of Facility Specific Training	Prior ORR Items
John Smith		X													X				
Al King			X			X				X			X						
Pete Jones	X																		
Sally Field	X					X					X								
Bill Gates		X					X	X	X			X				X			
Strom Thurm						X													X
Zeke Real					X														
Pat Jones									X										
Paul Smith						X								X					
Sam Tim						X													
Allen Funt				X			X	X				X							
Jake Thedog		X														X			
Pete Rose							X	X				X							
James Tool							X		X										
																	X	X	
			X				X	X				X							

Subject Area: ***Accelerator Safety***

Definitions: Accelerator Safety

Effective Date: **April 2000**

Point of Contact: Safety Management Systems Integration Program Manager

Term	Definition
accelerator	A device employing electrostatic or electromagnetic fields to impart kinetic energy to molecular, atomic, or sub-atomic particles and capable of creating a radiological area.
accelerator facility	The accelerator and associated plant and equipment using, or supporting the production of, accelerated particle beams to which access is controlled to protect the safety and health of persons. It includes experimental enclosures and experimental apparatus using the accelerator, regardless of where that apparatus may have been designed, fabricated, or constructed.
Accelerator Readiness Plan of Action	A document developed by the Accelerator Readiness Review (ARR) Team that is a concise path forward for the ARR.
Accelerator Readiness Review	A structured method for verifying that hardware, personnel, and procedures associated with commissioning or routine operations are ready to permit the activity to be undertaken safely.
Accelerator Readiness Review Report	The final report generated by the Accelerator Readiness Review Committee and submitted to the Deputy Director of Operations.
Accelerator Safety Envelope (ASE)	A set of physical and administrative conditions that define the bounding conditions for safe operation at an accelerator facility.
authorization basis	That set of documents or requirements upon which a decision is made by DOE whether to authorize the commencement or continuation of activities.
change control	The act of ensuring that documents are reviewed for adequacy, approved for release by authorized personnel, and distributed to and used at the location where the prescribed activity is performed.
commissioning	The process of testing an accelerator facility, or portion thereof, to establish the performance characteristics. It starts with the first introduction of a particle beam into the system.
commissioning package	Consists of the Safety Assessment Document, Accelerator Safety Envelope, the Accelerator Commissioning Plan or the Routine Operations Plan.
design/operating limits	These limits are calculated limitations on critical operating parameters that, in conjunction with the specifically identified hazard control considerations established by the facility design, construction or experimental design constraints, ensure that the accelerator or experimental operations will not exceed the corresponding Safety Envelope Limits or operational safety parameters as evaluated in the SAD.

experimenters	All persons directly involved in experimental efforts at the accelerator facility, using the accelerator or its beams, including visiting scientists, students, and others who may not be employees of the operating contractor.
hazard	A source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to a facility or to the environment (without regard for the likelihood of a harmful event occurring or of consequence mitigation).
module	A logical group of functions/components to support multi-stage authorization for commissioning.
risk assessment	A systematic methodology to evaluate and document a hazard for severity, probability of occurrence, and method of initiation. This analysis is typically done before and following mitigation to determine the residual risk involved and the final risk category. Results of a "Risk Assessment" are either rolled up into the ASE or covered by existing laboratory policies.
routine operation	Routine operation of an accelerator commences at that point where DOE authorization has been granted either (1) because the commissioning effort is sufficiently complete to provide confidence that the risks are both understood and acceptable and the operation has appropriate safety bounds, or (2) to permit the re-introduction of a particle beam after being directed to cease operation by DOE because of an environmental, safety, or health concern.
safety analysis	A documented process to systematically identify the hazards of a given operation; describe and analyze the adequacy of measures taken to eliminate, control, or mitigate the hazards and risks of normal operation; and identify and analyze potential accidents and their associated risks.
Safety Assessment Document (SAD)	The document containing the results of a safety analysis for an accelerator facility pertinent to understanding the risks of the proposed undertaking.
safety envelope limit	The absolute limits that BNL places on its operations to ensure that the regulatory limits established to protect our environment, the public, and staff/visitors are met.
Unreviewed Safety Issue (USI) Process	A process to determine if a proposed change, modification, or experiment will 1. Significantly increase the probability of occurence or the consequences of an accident or malfunction of equipment important to safety from that evaluated previously by safety analysis; or 2. Introduce an accident or malfunction of a different type than any evaluated previously by safety analysis, which could result in significant consequences.

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Subject Area: ***Accelerator Safety***

Revision History: Accelerator Safety

Point of Contact: Safety Management Systems Integration Program Manager

Revision History of this Subject Area

Date	Description	Management System
September 2000	A step on the approval for routine operations, in addition to the approval of an Accelerator Safety Envelope, was added to Section 7. Obtaining Approval for Routine Operations, to be in compliance with the wording in DOE Order 420.2, "Accelerator Safety." A formal design practice was added to Section 2. Developing the Safety Assessment Document (SAD). This was added to integrate the BNL Groundwater Protection Program into accelerator design for accelerators capable of causing measurable soil activation.	Facility Safety
April 2000	This subject area was developed by a team using the process for Standards-Based Management development. This is a new subject area. It meets the requirements of DOE Order 420.2, Safety of Accelerator Facilities.	Facility Safety

2.0-092000/standard/1r/1r00a011.htm

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