SNS 102030000-ES0001-R02

SPALLATION NEUTRON SOURCE

ENVIRONMENT, SAFETY AND HEALTH PLAN

March 2003

A U.S. Department of Energy Multilaboratory Project

SPALLATION NEUTRON SOURCE

Argonne National Laboratory • Brookhaven National Laboratory • Thomas Jefferson National Accelerator Facility • Lawrence Berkeley National Laboratory • Los Alamos National Laboratory • Oak Ridge National Laboratory

SNS

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ENVIRONMENT, SAFETY, AND HEALTH PLAN

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U.S. Department of Energy
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managing
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Argonne National Laboratory
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Thomas Jefferson National Accelerator Facility
Lawrence Berkeley National Laboratory
Los Alamos National Laboratory
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Approved by:

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SNS ENVIRONMENT, SAFETY, and HEALTH (ES&H) PLAN

1. Overall Expectations

The SNS endorses the Office of Basic Energy Sciences ES&H program, which states: The Office of Basic Energy Sciences is committed to conducting research in a manner that ensures protection of the workers, the public, and the environment. Protecting the workers, the public, and the environment is a direct and individual responsibility of all BES managers and BES-supported researchers and their staff. Funds provided by BES for research will be applied as necessary to ensure that all BES research activities are conducted safely and in an environmentally conscientious manner. Only research conducted in this way will be supported.

The SNS shall be designed, constructed, and operated in such a manner to protect the safety of workers, the public, and the environment. This shall be accomplished by:

1.1 Providing design features consistent with the SNS Environmental Impact Statement (EIS),

Design features of systems and structures to minimize waste generation and to accommodate decontamination and removal shall be provided in accordance with the project's decommissioning plan to the greatest extent practical. Design features to be considered shall include volume reduction of waste, avoiding pockets in corners where frequent decontamination is likely, and providing liners or suitable coverings on appropriate concrete walls to prevent activity from being absorbed deeply into the concrete and to allow removal during decontamination. (Note: Since the Hg used in the target will be used throughout the life of the facility, its disposal will be addressed as part of the decommissioning plan.) Guidance on design to minimize waste and pollution is provided by NSNS/97-5, SNS Waste Minimization and Pollution Prevention Plan (see also SNS Pollution Prevention Design Assessment, No. SNS-102030200-ES0001-R00, dated 10/99).

1.2 Incorporating an Integrated Safety Management System Policy that implements the DOE Policy, DOE P 450.4, Safety Management System Policy. SNS follows the ORNL Standards Based Management System (SBMS) which is the ISMS implementing system.

1.3 Adhering to the ORNL Work Smart Standards (WSS):

- ORNL approved WSS for Other Industrial, Radiological, and Nonradiological Facilities;
- ORNL approved Work Smart Standards for the Two Accelerator Facilities at ORNL;
- ORNL approved Work Smart Standards for nuclear facilities applicable to the SNS Target Facility;
- ORNL approved WSS for construction and construction-like activities,;
- ORNL approved WSS for Engineering Design for Standard Industrial, Radiological, Non-reactor Category 2 and 3 Nuclear and Accelerator Facilities, and;
- The DOE Accelerator Safety Order, as specified in the SNS Project Execution Plan.

The approved ORNL WSS can be found on the ORNL server at the following URL:

http://eshtrain.ct.ornl.gov/SBMS/WSSHome/standards.cfm

1.4 Preparing a Safety Analysis Report (SAR) for the target systems and a Safety Assessment Document (SAD) for all other accelerator systems, structures and components.

1.5 Governing radiation protection in accordance with 10 CFR 835, "Occupational Radiation Protection."

1.6 Implementing shielding requirements as described in Section 3.

1.7 Controlling hazards by eliminating them whenever practical. Where eliminating hazards is not practicable, controlling them by physical design features is preferred.

1.8 By following industry consensus standards, unless there is a good reason not to and it has been cleared with the appropriate lead engineer.

1.9 Implementing effective construction safety programs to ensure worker safety on the SNS site during construction and initial system testing. All work performed on the SNS site will be conducted in accordance with the Knight/Jacobs Joint Venture SNS AE/CM Environmental, Safety and Health Plan.

1.10 Incorporating energy conservation features into the design of SNS facilities as required by 10 CFR 435 and in accordance with guidance outlined in NSNS/97-6, SNS Energy Conservation/Life Cycle Cost Plan.

1.11 Performing Independent Design Reviews on systems, structures, and components designated as safety significant or safety class in the SAD or SAR.

1.12 Operating procedures will be developed and implemented to control work on SNS technical systems (see SBMS Subject Area: *Internal Operating Procedures*).

1.13 Reporting and investigating Occurrences and Incidents in accordance with SNS Occurrence Reporting, SNS 102030102-PR0001-R00.

2. Hazard Identification and Control

SNS structures, systems, and components shall provide adequate assurance of safety against hazards, including those identified in Table 2-1. This table identifies hazards known to exist or to have the potential to be applicable to the conceptual design, lists safety features designed to mitigate them, and, in some cases, gives the design criteria governing those features. Regardless of whether design criteria are specified in the Table, designers shall assess, understand, and control the hazards posed by the systems, structures and components within their scope. Work performed shall be evaluated using a Job Hazard Analysis (JHA) per SNS 104070400-PR0003-R0, *Job Hazard Analysis*. The JHA shall identify the work to be performed, the hazards anticipated, and the actions to be taken to address the hazards. The JHA shall be prepared by the worker(s) performing the tasks. When work changes, unanticipated conditions are encountered, or new workers become involved, the JHA shall be revisited, and revised as necessary.

Table 2-1 SNS hazards survey and safety assurance requirements

Hazard or challenge	**Present or possible in:**	**Qualitative Assessment**	**Design safety assurance measures**	**Design Criteria**
Seismic event	All	Potential occurrence for any industrial, accelerator, or nuclear facility.	In general, design and construct to the Uniform Building Code. Higher requirements are specified for certain structure, systems, or components in the PSAR or FSAD	See structural design criteria in NSNS/97-4, and the appropriate safety document.
Electrical power outage	All	Common industrial occurrence.	Battery-powered emergency lighting, emergency egress provided per the Life Safety Code; diesel-backed power available for selected loads, including target hot cell ventilation systems.	
Fire	All	Potential occurrence for any industrial facility.	Use of flammable materials shall be minimized in SNS. Fire detection system, sprinklers, hydrants, and other fire-fighting features provided per applicable NFPA standards.	The appropriate SNS Fire Hazard Analysis document will (FHA) define any additional requirements.
Combustible materials, in general	All: e.g., wiring insulation.	Standard industrial hazard.	SNS is to be an Ordinary Hazard facility by minimal use of combustible materials. Wiring insulation represents the most common combustible material. Fire retardant insulation to be used in target hot cell.	
Combustible gas—hydrogen	Ion source: small H_2 cylinder.	Standard industrial hazard.	Small approved cylinders of H_2 may be used and stored inside buildings, providing that air concentration would remain below the lower explosive limit if cylinder contents escape.	See ORNL SBMS *Compressed Gas Cylinders and Related Systems*
Combustible gas—hydrogen	Target facility cryogenic moderator system holds ~v 4 kg of H_2.	Standard industrial hazard plus potential fire-related spread of radioactive target material.	Cryogenic H_2 surrounded by monitored vacuum barrier within monitored He barrier. Core Vessel normally purged with He gas. Major active components in a Safe Room with monitored atmosphere with separate ventilation system	Standards NFPA-50A and 50B.

Table 2-1 (continued)

Hazard or challenge	Present or possible in:	Qualitative assessment	Design safety assurance measures	Design Criteria
Combustible gas—natural gas	Utilized for heating in some buildings.	Standard industrial hazard.	NFPA standard 54 followed for system and installation design.	NFPA-54
Ionizing radiation - external radiation.	From ion source/ RFQ to the target facility, including X-rays from klystrons and RF generators.	Standard accelerator radiological hazards.	Adequate shielding thickness, and interlock system to prevent beam operation when people are in the tunnel. Shielding shall comply with SNS Requirements (see Sect. 3). Personnel Dosimetry and area radiation monitoring sufficiently sensitive to type and energy of radiation potentially encountered.	10 CFR 835, SNS Final Safety Assessment Document (FSAD) for FELK, SBMS Subject Ares: *External Dosimetry*, *Posting*, *Labeling*, and potentially any SBMS subject area beginning with "Radiation" or "Radiological."
Ionizing radiation - control of radioactive material	All facilities with mobile radioactivity: linac, beam stops, ring, target facility, etc.	Standard accelerator radiological hazards except for target system (target and related systems constitute a Nuclear Facility).	Airborne and other contamination control features including designated contamination areas, posting, access control, ventilation systems, etc. HEPA filtration of exhaust flows where needed.	10 CFR 835 ORNL-RPP-128[a] SBMS Subject Area: *Posting, Labeling, and Control of Radioactive Materials*
Electrical energy, including high voltage	Essentially all.	Standard industrial hazard.	Installations follow consensus electrical standards or provide equivalent safety features. Specific safety design requirement(s) or standards for high voltage accelerator and related equipment shall be provided by partner labs for the areas under their design purview.	OSHA 29CFR 1910, Subpart S; ORNL-SH-P25[a] *ORNL Electrical Safety Program;* ORNL OSHP-59[a], *ORNL Program for Lockout/Tagout of Hazardous Energy Sources or SNS 104070400-PR0007-R01 Lockout/Tagout of Hazardous Energy Sources*
Nonionizing radiation	Klystron building, linac, storage ring: radio frequency electromagnetic radiation.	Standard accelerator hazard	Designers to examine potential for radio frequency (rf) and microwave problems during design; ensure inclusion of adequate control/prevention features. Design confirmed by pre-operational surveys.	ORNL-SH-P18[a], *ORNL Non-ionizing Radiation Safety Program,* American Conference. of Governmental Industrial Hygienists (ACGIH) 29CFR 1910.97 limits on microwave radiation in accessible areas.

Table 2-1 (continued)

Hazard or challenge	Present or Possible in:	Qualitative assessment	Design safety assurance measures	Design Criteria
Magnetic Fields	Front End, Linac, ring, transfer lines, shops, etc.	Standard hazard for accelerator and fusion-energy facilities.	Installations follow consensus standards/ guidelines in accessible locations (including special advisory for pacemaker wearers).	American Conference. of Governmental Industrial Hygienists (ACGIH) recommendations (DOE-STD-6003-96, “Safety of Magnetic Fusion Facilities: Guidance.”)
Potential energy–cranes	Maintenance shops, target, and ring buildings	Standard industrial hazard.	Installations follow consensus standards. Operations per ORNL safety procedures[a].	ORNL Standard ESS-IS-115[a], *Hoisting and Rigging SNS 104070400-PR0005-R0 Hoisting and Rigging Program*
Potential energy – falling hazards	Potentially all	Standard industrial hazard	Safe design and placement of ladders, walkways, working spaces, etc. Railings strongly preferred to eliminate falling hazard in areas accessible to workers.	OSHA (29 CFR) Regulations for fall protection. ORNL-SH-P26[a] *Walking/Working Surfaces and Fall Protection Program*
Asphyxiant	Various	Standard industrial hazard	The *SNS Personnel Safety for Cryogenic Operations* shall be followed.	OSHA regulations for asphyxiating gases, SBMS Subject Area: *Compressed Gas Cylinders and Related Systems*
Asphyxiant	Linac tunnel and Central Helium Liquifier Building:	Inert gases present in large amounts in these 2 buildings – exceed intent of “standard industrial hazard.”	The amounts of gas are large compared to the volume of the space. For each designed use of asphyxiating gas, assessment of creation of confined space hazard shall be performed. The *SNS Personnel Safety for Cryogenic Operations* shall be followed. Automatic oxygen deficiency alarms provided per SNS FSAD.	OSHA regulations for asphyxiating gases, *SNS Personnel Safety for Cryogenic Operations*, SNS Final Safety Assessment Document (FSAD) for FELK, ISA-S84.01-1996 *Application of Safety instrumented Systems for the Process Industries*
Confined space – inadequate oxygen or other applicable hazard	Manholes, Certain target building instrument enclosures	Standard industrial hazard	SNS policy is to eliminate confined spaces by design if possible.	OSHA regulations; SBMS Subject Area: *Confined Space*

Table 2-1 (continued)

Hazard or challenge	**Present or Possible in:**	**Qualitative assessment**	**Design safety assurance measures**	**Design Criteria**
Internal pressure	Cryogenic equipment	Standard cryogenic hazard	Provision of safe relief path if potential exists for internal pressurization.	*SNS Personnel Safety for Cryogenic Operations*
Internal pressure	Piping or process systems	Standard industrial hazard	Provision of adequate relief per consensus industry codes and standards.	SBMS Subject Area: *Safety of Boilers, Pressure Vessels and Relief Devices Program*
Shop hazards	Repair shops	Standard industrial hazard	Equipment designed or purchased, and laid out in accordance with industry consensus and good practice standards.	OSHA regulations

3.1 SNS General Site Area

- Radiation levels outside the SNS Controlled Area (see Figs. 1 and 2) shall be sufficiently low such that active measures are not necessary to control possible incidental intrusions by members of the general public. No fence is needed to control access to the large area that extends out to Bethel Valley or Bear Creek Roads. Warning signs near Bethel Valley Road will discourage casual use of the SNS access road. An existing warning sign across Bear Creek Road west of the SNS site discourages approach by members of the public.
- Limit: 10 mrem/y at the warning signs (see first bullet), or along Bethel Valley or Bear Creek Roads, considering all sources of SNS caused external radiation. [per year of operation].

3.2 Posted Areas:

- A fence is used to control access to the Controlled Area. It surrounds readily accessible areas that have non-negligible radiation hazard. In some cases, the outer walls of buildings may serve as part of the Controlled Area boundary.[***Note***: Some SNS buildings, e.g. the administration building, will be the outside of the Controlled Area but they are well within the site boundary.]
- Ingress/egress through the fence/buildings is by card key or locks/keys.
- Radiation areas within the Controlled Area are defined according to the radiation level inside each area: Radiation Area, High Radiation Area and Very High Radiation Area. 10 CFR 835 provides requirements for posting of and controlling access to each type of radiation area. [***Note***: the area designation may be reduced after accelerator shutdown, as provided by appropriate radiological health physics procedures.]
- For design considerations, the allowable radiation levels within continuously occupied parts of the Controlled Area will be such that the dose to the maximally exposed worker is below 500 mrem/year
- Allowable radiation levels within the Controlled Area must also be consistent with very low dose levels for visitors: 100 mrem/y for non-radiological workers and 50 mrem/y for members of the public without dosimeters.
- Shielding design requirement for parts of the facility that do not have occupancy time limits and/or special access controls (e.g., higher levels of card key and other control mechanisms and/or requirements):

  Dose rate < 0.25 mrem/h at accessible exterior surface(s) of shield with the facility operating at its maximum design level.
- Shielding design requirements for parts of the facility that do have time occupancy limits and/or special access and rad-worker training controls may consider shield-face radiation dose rates above the 0.25 mrem/h design limit. Additional design requirements include consideration of ALARA principles and must ensure worker exposure levels are below 1000 mrem/y for areas that are not continuously occupied.
- Shielding design thickness must provide for passive personnel safety assurance in the event of proton beam control accidents. The integrated radiation dose at any accessible point in the Controlled Area outside the accelerator shielding shall not exceed 25 rem as a result of the

maximum credible beam control accident. The corresponding requirement for any member of the public outside the Controlled Area for the same event is a maximum of 1 rem. These quantitative goals are taken from the DOE guidance document corresponding to DOE Order 5480.25, the order that has been superceded by the current accelerator safety order 420.2 [Note: Similar guidelines may be found in EPA 400-R-92-001, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents, and in DOE G151.1-1, Volume 2. Appendix B.]

- Contamination and/or Airborne Radioactivity Areas will be defined within specific areas inside the Controlled Area on an as-needed basis. Access to and surveillance of Contamination or Radiation Areas is controlled by appropriate procedures that implement the requirements of 10 CFR 835.
- Building layout and design must be consistent with ALARA principles: e.g., auxiliary facilities such as labs, break rooms and bathrooms should, where possible, be situated in locations with very low or negligible radiation levels.

Access Control Areas – Beam On

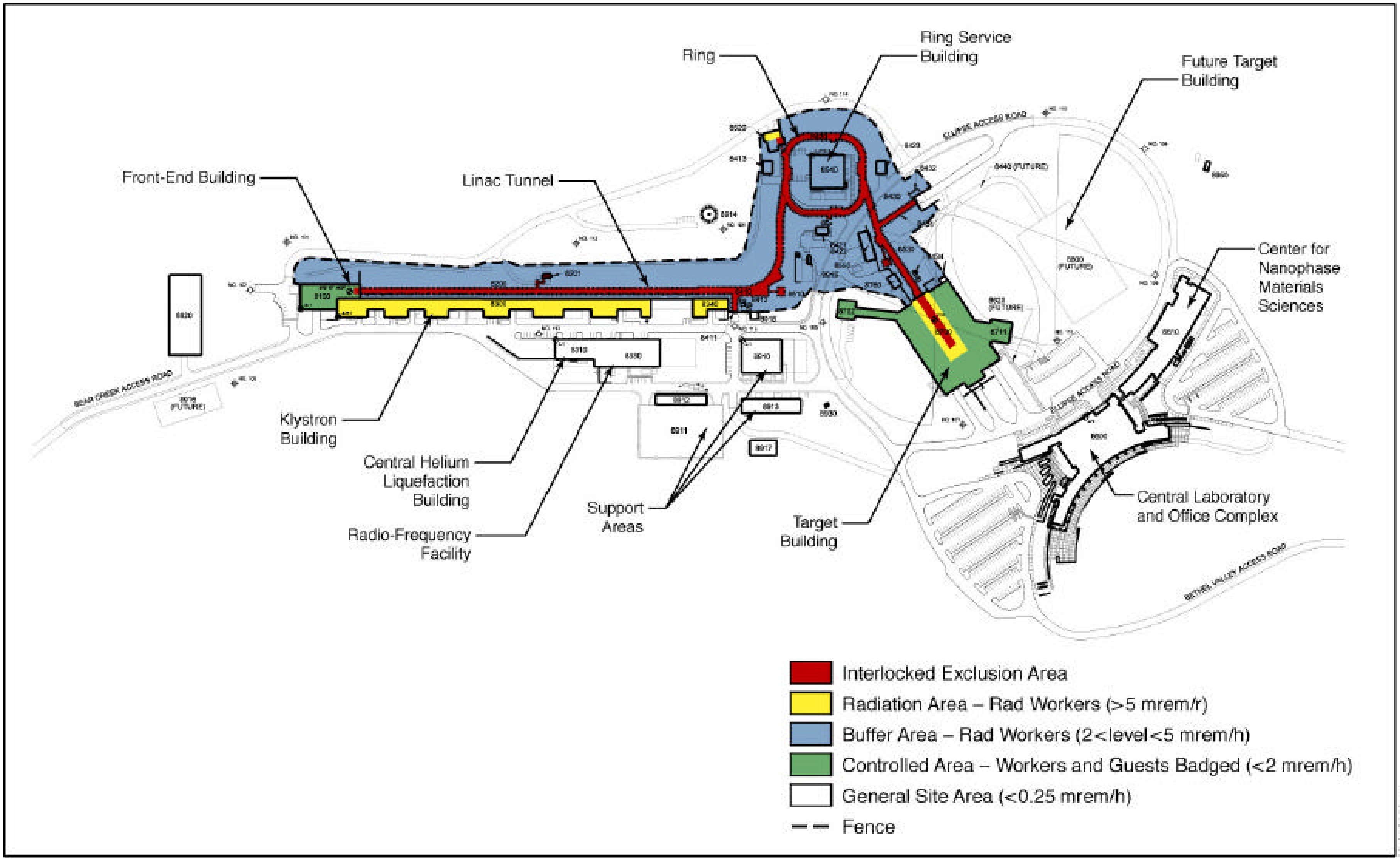

Fig. 1 SNS site access and radiation control areas – BEAM ON.

Access Control Areas – Beam Off

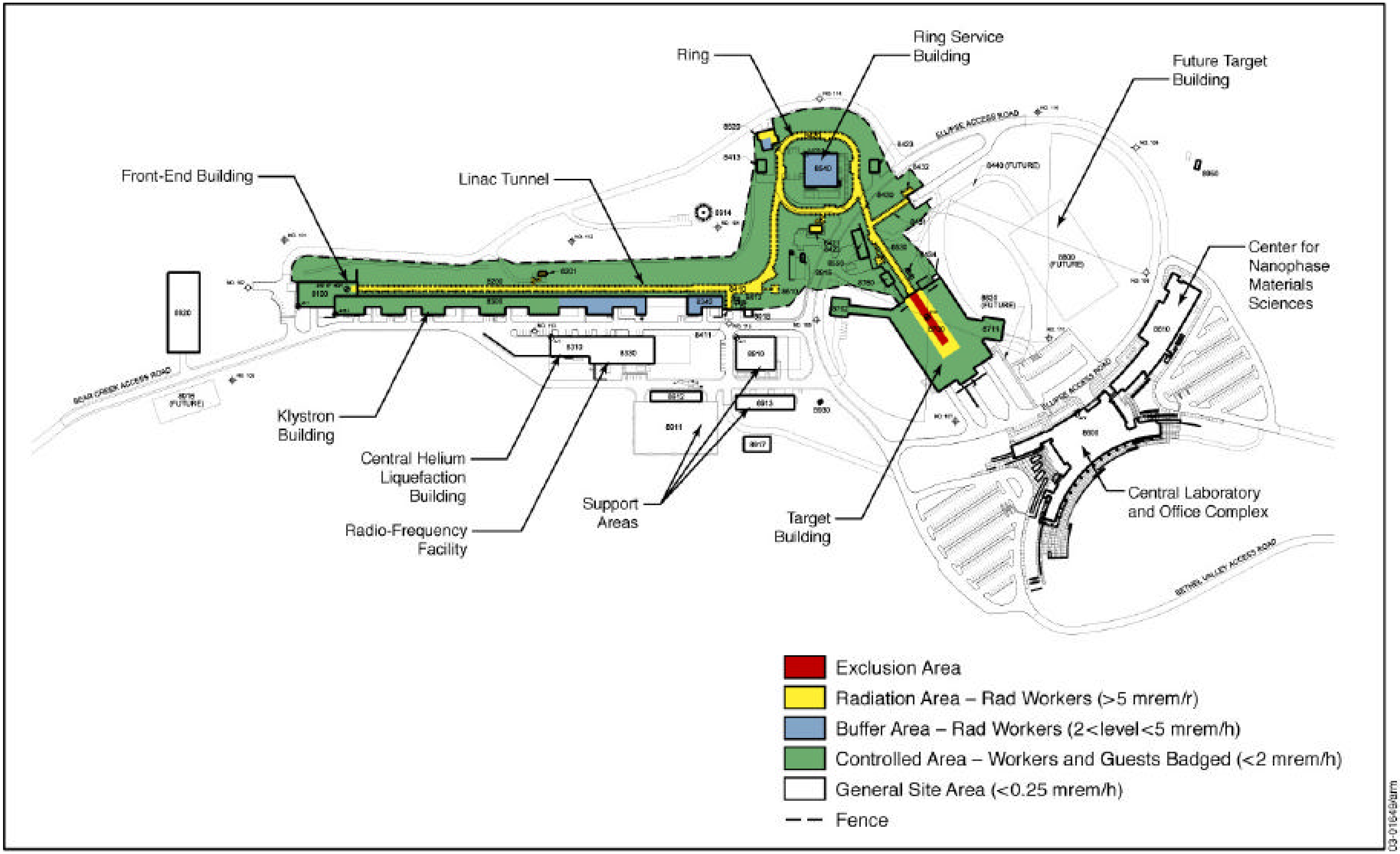

Fig. 2 SNS site access and radiation control areas – BEAM OFF