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Second Target Station (STS) Project

Radiation Safety Policy and Plan

October 2020

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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1. STS RADIATION SAFETY POLICY

The Second Target Station (STS) and Spallation Neutron Source (SNS) facilities place the safety of the public and workers above all other considerations. Direct radiation exposures resulting from beam operations and residual radiation emitted by activated materials are two of the most important non-industrial safety hazards at the SNS work site.

The STS facility is being designed and constructed incorporating features that will minimize worker and visitor exposures to radiation to levels well below regulatory limits, and in fact As Low as Reasonably Achievable (ALARA). The STS facility design objective is to limit predicted prompt radiation levels in all continuously occupied areas to less than 0.25 mrem/h under normal operating conditions and as far below that level as is reasonably achievable.

Engineered controls are the preferred and primary methods used to maintain anticipated radiation exposures in occupied areas to ALARA levels in accordance with 10 CFR 835.1001 and 1002. Access restrictions, administrative procedures, appropriate area classifications, and compliance with ORNL SBMS radiological safety requirements are additional components in the STS defense-in-depth strategy to limit projected personnel radiation exposures in potentially occupied areas where it is not possible to completely shield personnel from radiation.

The ALARA process must also be used to optimize control and management of radiological activities so that doses to members of the public (both individual and collective) and releases to the environment are kept as low as reasonably achievable in accordance with DOE Order 458.1. The ALARA process must: consider DOE sources, modes of exposure, and all pathways which potentially could result in the release of radioactive material into the environment or exposure to the public; use a graded approach; and, to the extent practical and when appropriate, be coordinated with the Occupational Radiation Protection Program, 10 CFR Part 835 ALARA process.

2. STS DESIGN AND CONSTRUCTION RADIATION SAFETY PLAN

It is anticipated that the design development and construction phases of the STS project will include only very limited activities involving radioactive materials or worker exposure to radioactivity. Examples of anticipated activities which might involve worker exposure to radioactivity include work in the Ring to Second Target (RTST) tunnel “stub” during beam operations, advanced neutron detector development studies, and beam commissioning. Any STS project activities involving radioactivity will be regulated using procedures in the SBMS “Radiological Protection” and “Environmental” management systems, as long as those procedures adequately mitigate the anticipated hazards.

2.1 ENSURING WORKER SAFETY

STS personnel who will potentially be exposed to radiation will be appropriately trained and will wear appropriate dosimetry, including extremity and neutron dosimeters if appropriate. Safety for nonionizing radiation at ORNL facilities is ensured by implementing the ORNL SBMS subject areas “Lasers” and “Nonionizing Radiation” in the “Worker Safety and Health” SBMS management system. Work control documents, including Radiological Work Permits (RWPs), will be used to impose appropriate controls for STS workers who might be exposed to hazards or hazardous conditions. If some STS activities should involve hazards that are not adequately covered in SBMS procedures, then specific procedures covering those hazards will be developed and incorporated into the STS procedure manual.

2.2 TRANSITIONING STS TO OPERATION AS PART OF SNS

STS will become part of the SNS accelerator envelope when STS commissioning using the SNS proton beam is demonstrated in accordance with the Key Performance Parameters. Beginning at that point STS will be operated as part of the SNS accelerator complex under SNS Operations Procedure Manual (OPM) procedures. The SNS OPM includes the administrative procedures that implement accelerator-related safety policies (including radiation safety) at SNS facilities, supplementing ORNL SBMS requirements.

2.3 LIMITING WORKER EXPOSURE TO ACTIVATED MATERIALS

The majority of worker dose at the SNS installation is the result of exposure to activated materials. Therefore, materials included in STS facility designs are chosen to minimize activation and the generation of hazardous/mixed waste. The STS accelerator, target, experiments, and all associated systems will be designed and operated to minimize activation and worker exposure to activated materials. Localized and general area shielding will be employed as necessary to reduce the dose received from activated equipment and items. Personnel exposure to liquid and gaseous activated materials (including cooling water, dust, and activated air) will be minimized through designs incorporating appropriate combinations of confinement, differential pressure, holding for decay, flushing, local shielding, and protective equipment.

2.4 DIRECT RADIATION CONTROLS

Where shielding is relied on to prevent unacceptable exposures of workers or the public to radiation, the shielding configuration will be planned, approved, and controlled. Shielding configurations are designed with input and guidance from health physicists, neutronics modelers, physicists, and operations personnel. Baseline shielding for normal operation of the proton transport line is determined based on best estimates of beam loss locations and intensities. Shielding for target and instruments is based on maximum loss assumptions. Detailed modeling codes use source terms based on projected beam loss to calculate anticipated radiation levels and the effect of installed structures and shielding on that radiation. Conservative design recommendations are used to allow for the uncertainty in this process, and typical shielding is based on models involving areas of greatest loss. In addition to normal operating conditions, fault and accident conditions are considered when designing shielding and establishing access controls. Expected occupancy levels and special training required for access to certain areas may be considered in establishing acceptable predicted radiation levels. Active real-time radiation detectors with beam shut-off capability through the high-integrity Personnel Protection System (PPS) will be placed in potentially occupied areas where credible off-normal accidents could produce unacceptable radiation levels.

2.5 DESIGN REVIEWS

ALARA design reviews by management and technical experts are incorporated into the design process and are part of the approval process for STS facility plans prior to construction. Low-power fault studies during commissioning and periodic radiological surveys during full-power operations will confirm the initial and continuing adequacy of installed shielding, or indicate where additional protective measures are needed. To prepare for commissioning studies, detailed shielding plans are developed as the work planning evolves. When the facility design stabilizes, the Radiation Safety Committee will consider and approve (or modify) a shielding plan; their deliberations include discussions of the work under consideration, the anticipated radiation source terms, and the appropriate shielding configuration. In addition, a review of shielding is part of every Accelerator Readiness Review or Instrument Readiness Review (ARR or IRR) and of periodic ongoing operations assessments. Active protection systems (e.g., specialized versions of the PPS or interlocked radiation detectors) are incorporated into the shielding plan before its review, approval, and implementation.

2.6 CONFIGURATION CONTROL

Facility shielding features will be placed under configuration control appropriate to their importance to worker safety. Any shielding which would, under normal operating conditions, expose workers to radiation fields greater than 1 rem/h if removed will be permanently installed, locked in place, or otherwise secured to prevent inadvertent worker access. Exceptions to this policy can be granted by the Operations Manager on recommendation from the Radiation Safety Committee.

2.7 ADMINISTRATIVE LIMITS

As was stated above, the STS facility design objective is to limit radiation levels in normally occupied areas to 0.25 mrem/h or less, and in fact to keep anticipated radiation levels as ALARA. An administrative limit of 100 mrem of radiation exposure a day has been established for radiation workers at SNS – the maximum radiation dose to a single worker at SNS in recent years has typically been around 600 mrem per year. In case of a radiation accident at SNS or a failure associated with the PPS, the STS PPS will be designed to respond to limit the highest whole-body exposure to an individual under a credible accident scenario to 500 mrem or less.

2.8 PERFORMANCE GOALS

The effectiveness of the STS shielding and access control policy will be demonstrated during operation of the Second Target Station as part of SNS by achieving the following performance goals:

- Radiation exposures at the STS facility during commissioning operation will be ALARA, based on policies and practices implemented by the STS. Subsequently, radiation exposures during operation and maintenance will be ALARA based on policies and practices implemented by the SNS.
- Operation of the STS/SNS, including both normal and accident conditions, will not result in an integrated dose greater than 25 mrem per year at the site boundary.
- No member of the public or untrained visitor will unintentionally access a Radiological Area at the STS.
- No one who is not trained as a Radiological Worker (including minors less than 18 years of age) will receive more than 100 mrem in any calendar year while working at or visiting STS.