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for the U.S. Department of Energy

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Mr. Frank C. Kornegay
Safety/Environment Manager
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Dear Frank,

Thank you for the opportunity to review the Preliminary Final Safety Assessment document for the Spallation Neutron Source Project. The ASRC Committee members extend their gratitude to all the participants at the January 22 and 23, 2002 meeting, and to Sam McKensie and Mike Harrington who organized two conference calls on January 31 and February 8, 2002. The Committee feels the presentations were high caliber and the subsequent discussions were frank and positive.

After the presentations, Sam McKenzie, Mike Harrington and Ken Reece took detailed input on each page of the PFSAD. Since we went through the PFSAD page by page, we had a wonderful opportunity to indicate all our comments to them. We found this useful and powerful. SNS seems to have put into a place a competent safety-oriented team, and the SNS safety culture and leadership seem good.

Enclosed is our report.

We look forward to future service.

Sincerely,

Edward T. Lessard

Edward T. Lessard
Associate Chair of ES&H/QA

Enclosure: SNS ASRC Report #2

cc: D. Fitzgerald (LANL)
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SNS Accelerator Safety Review Committee

Report on the SNS Preliminary Final Safety Analysis Document

Thursday, February 14, 2002

The SNS Accelerator Safety Review Committee (ASRC) reviewed the preliminary FSAD (PFSAD) and heard presentations made in support of the PFSAD on January 22 and 23, 2002. The Committee was charged to address the following four points:

1. Is the PFSAD a reasonable basis for the Final Safety Assessment Document (FSAD)? Only after your review and resolution of resulting comments will we label it the "FSAD."

2. Does the PFSAD give sufficient evidence that a satisfactory Radiation Protection Program will be in place for SNS operations?

3. Do you believe the proposed Oxygen Deficiency Hazard (ODH) Policy/Plan is appropriate?

4. Does the PFSAD provide a reasonable basis to proceed toward commissioning beginning in FY2003? Please keep in mind that before that time (November 2002) we have two milestones that provide for further development/confirmation of the safety basis for commissioning: (1) Completion of final hazards analysis for the FELK (front end, linac, klystron), and (2) review and approval of the Commissioning Accelerator Safety Envelope.

In performing this task, the Committee defines the following:

<u>Finding</u> - Results of the evaluation compared with the agreed charge of the Committee. Findings provide the basis for the Committee's report.

<u>Observation</u> - Observations are conditions or weaknesses in SNS programs or activities being evaluated that, while not necessarily a departure from a specific requirement, if left uncorrected could deviate from documented requirements or best management practices.

Findings

The Committee concluded specific findings as follows:

Finding 1

The PFSAD is a reasonable basis for the Final Safety Assessment Document (FSAD). However, the following significant issues associated with the PFSAD need to be resolved before labeling it an FSAD:

- If the SNS Project plans to commission the target at low power and to consider it part of the accelerator facility, then a hazard review and approval process for low-power targets and the qualifications for target-watch personnel need to be described in the FSAD. The appropriate low-power parameters also need to be described in the ASE.
- The Fire Hazards Analyses need to be developed to the Title III stage. Important issues were defined in the review presentation on fire protection and they need to be in the FHAs and subsequently in the FSAD. Many of the fire protection hazards are well defined as well as the protective systems. Several exemption requests to DOE were identified and have not been addressed in the existing FSAD.

Finding 2

The PFSAD gives sufficient evidence that a satisfactory Radiation Protection Program will be in place for SNS operations. However, an ALARA design document, per 10CFR835.1002, is required. A shielding policy, per DOE Order 420.2A, needs to be developed. Additionally, monitoring for radiological air emissions, per 40CFR61.93, needs to be addressed in the FSAD, and the continuous stack monitor requirement needs to be addressed in the full operations ASE.

For FELK commissioning, we did not encounter enough information in the PFSAD to ensure ourselves that the proposed shielding, 1 m of concrete around the DTL tanks, was sufficient to control neutron radiation to acceptable levels at the planned beam intensities for commissioning. We feel the PFSAD should better document the analysis and the justification for FELK shielding. We note that PFSAD Section 4.2.1.1.4 has a reference to a document in progress on shielding of the front end.

Finding 3

The ODH policy proposed by the SNS Project does not conform to the best management practice used by other “cold” labs in the DOE system. If you choose to proceed with different ODH criterion and control requirements, then the proposed policy should be peer reviewed.

Finding 4

The FSAD can be submitted as an FSAD for the FELK (front end, linac, klystron) and it provides a reasonable basis for commissioning beginning FY2003. The Committee feels the FELK Accelerator Readiness Review (ARR) can proceed smoothly once the FELK systems are

built and FELK systems experts are trained to the extent necessary. If FELK systems experts perform the commissioning, then full operations procedures would not be needed for commissioning. The FELK FSAD approach conforms to DOE requirements. If the safety basis for the FELK is completed by November 2002, then we conclude the FELK commissioning ASE can be developed from the FSAD and the milestones mentioned in Charge #4. Thus, we feel the DOE should be able to authorize FELK commissioning in early FY2003.

Although not specifically asked to comment, the Committee was told they could view an older version of the Commissioning Plan on the web. The Committee feels the Commissioning Plan covers all appropriate elements but it needs to be communicated to all the stakeholders and responsible parties. Specifically, the Commissioning Plan should be the SNS roadmap for getting ready for the ARR, and this should be stated up front as its main goal. In our experience, it helps when the Commissioning Plan relates specific names of staff to specific responsibilities and specific product due dates.

The Committee feels the FELK FSAD is mature and the committee agrees with the overall long term FSAD path. We concur that starting the target up under the FSAD for an accelerator facility might expedite target operations. However, in order to form the basis for authorization to commission the remaining portions of SNS, we feel the FSAD should lay out conduct of operations, QA requirements and emergency response associated with the target low-power operations.

Additionally, the yet to be formed Experimental Safety Review Committee and the Instruments need to be more fully described in the FSAD for it to apply to the experimental hall.

Observations

The Committee concluded specific observations as follows:

3-24 What are the anticipated extraction losses and where do they occur?

3-24 Does low-pressure helium gas circulate in the cavities?

3-25 Need a Figure showing helium loops.

3-25 Need a Table showing ODH areas and volumes. Does helium end up in stairways and would it be a problem when exiting during an ODH event in the tunnel?

3-25 Need a description of the waste stream from cryogenic operations (e.g., charcoal, acid and oil).

3-25 The cavity cleaning operations identify a strong cleaning agent. In the presentations this was identified as hydrofluoric acid. This chemical is an extreme hazard to personnel and equipment. There are issues associated with significant toxic release potentials during a fire. It is advisable to investigate the use of strong ultrasonic methods. BNL recently replaced their HF cleaning facility with ultrasonic equipment.

3-27 Need to state the dose criteria for periodic replacement of vacuum windows. For example, state that you intend on meeting ALARA goals.

3-27 What happens to short-lived airborne Cl isotopes emanating from the copper 200 kW beam stop?

3-28 What beam dump materials surround the 200 kW beam stop? Also, use of the terms stop and dump should be consistent. Beam stop can be used to indicate primary beam is stopped. Beam dump can be used to indicate all primary and secondaries are stopped.

3-31 ALARA suggestion: Attach the stop to the dump shield block above the stop, and have water and vacuum disconnects outside the shield block. This way you can disconnect the stop and pull it with shield block in place. A canyon of shielding can then receive the shield block/stop assembly.

3-34 Need more description on experimental approval process. For example, how do you plan to stay informed and to control what users bring in? (Biohazards, fissile materials, etiologic agents, human data, combustibles, explosives, etc.)

3-34 Need to describe the low-power-target approval process and any links to the ASE.

3-40 A vacuum-window design standard needs to be briefly addressed. What is vacuum window lifetime? Do you intend to have procedures for window manufacture and window replacement?

3-44 Need to address internal security for control programs and pages on your intranet. That is, passwords for operators and the need for or against Property Protection Area status (locked/alarmed areas) for remote workstations.

3-52 Which committee reviews the ODH protection system logic and testing?

3-54 Controlled Access – Magnets Energized mode is working hot, and working hot authorization needs to be addressed. An extra key/authorization should be required of operators to move the machine into the Controlled Access- Magnets Energized mode. Hi-potting the buss to cleanly get into this mode should be considered. Alternatively, operators should look for tools/parts left on exposed buss when they do a sweep.

3-58 Is critical device #2 (control signal removed from RF power supply) failsafe?

3-61 Mention the entire "squeeze box" area can be viewed by the MCR's camera and no one can sneak in under a cart or below the camera's field of view. Training suggestion: A training video showing people going in and out may be useful to help people learn the access control system entry and exit procedure.

3-65 Need to explain the basis of the assumed modifying factor for the Chipmunk response used to get 2.5 microrem/pulse. Indicate that you plan to do neutron quality-factor measurements and mixed radiation field measurements.

3-66 Shouldn't Chipmunk set points be under the purview of the Radiation Safety Committee?

3-66 Should consider having each person use both a thermal neutron dosimeter and a CR-39 dosimeter. Suggest you work with personnel monitoring people to determine which badge should be used for the neutron dose of record. For example, thermal neutron dosimeters seem to be best for users working on the experimental floor, and CR-39 seems to be best for accelerator staff working around high-energy neutron portions of the complex. For high-energy neutron exposures, if the CR-39 result is above MDL (~40 mrem), then it is used at BNL as the dose of record. The thermal neutron result is used if CR-39 result is below MDL. This is conservative and tends to add more neutron dose to the record.

3-66 Will the computer-based RWP system be at ALL radiological areas (High, Radiation, Contamination, High Contamination) at SNS?

3-67 Is there an ODH analyses for He refrigerators planned for the SRF building?

3-71 Need to identify and tabulate the tritiated water systems.

3-73 Need a description of the He refrigerator.

3-76 Need a description of the control of activated materials into the CLO.

3-81 Need to indicate that a continuous air monitoring system for radiological air emissions, per 40CFR61.93, is required. The continuous stack monitor parameters need to be addressed in the operations ASE.

3-85 SNS Project should consider ozone systems as opposed to biocides and rust inhibitors for water treatment. Many NASA facilities and DOE labs have been able to eliminate chemical treatment. Chlorination is also mentioned indirectly on page 4-70.

3-85 Are all tritiated water systems closed looped?

3-86 Have potable water systems been examined to ensure they do not loop through activation areas?

Figure 3.2.5.2.4-1 - HVAC condensate from re-circulated air during operations will contain tritium, and it should be directed to the Low-Level Liquid Waste System.

3-91 What controls will keep activated items from entering clean waste streams, or from being shipped back unlabelled to Universities/Institutions participating in SNS research?

3-94 Is there a UPS for cryogenic controls?

3-95 Indicate that target operations and chain of command will be in the appropriate Commissioning Plans, and that you intend to keep the SAD administratively up to date. That is you plan to remove the SNS Project organization chart (3.3.2-1) and replace it with the SNS operating organization post CD4. It may also be useful to introduce the Unreviewed Safety Issue process, similar to what is done at BNL, in order to make changes to the FSAD without having to re-process the whole FSAD.

3-98 You need to mention that cryogenics system operators will not be on shift and will be called in when needed during the off-hours.

3-99 You could probably eliminate most of the availability discussions from the SAD. Be less proscriptive. An example is on page 3-99: "…for operations we assumed 90% availability..." Another example is on 3-98, it is best to not over promise. That is, you probably should list minimum number of operators and not say optimum number.

3-102 You still need authorization from DOE to commission/operate. That is, SNS authorities can approve ARRs and the FSADs beforehand and DOE can approve the ASEs beforehand. However, the permission to commission letter from DOE pulls all three together and approves the onset of commissioning.

4-3 The term Safety Significant is defined in the Occurrence Reporting Order (232.1) and it is different from the term as used in 5480.23 Order for Nuclear Facilities. Accelerator facilities are better served by the definition in 232.1

Table 4.1.2-1 The last row has a non-10CFR835 dose-rate characterization for Controlled Area.

4-6 The section on SNS job hazard analysis policy is good advice but the policy doesn't ensure all jobs are reviewed and all reviews are documented. Work planning normally addresses all jobs, and a good policy would not exempt work that invokes the use of permits (LOTO, RWP, Confined Space, etc.). Permits do not address work complexity or coordination level. It is common practice at many accelerator facilities that all jobs are reviewed and categorized as low, medium or high risk and documented as such by the supervisor or work coordinator. An SNS supervisor may approve low risk work and assign it to personnel but he should also document each job and risk level in a log or other work control system. Additionally, medium and high ESH risk, complexity, or coordination-level work should be reviewed and approved by several qualified supervisors and/or an ESH professional.

4-7 The feedback step is missing from the SNS hazard analysis methodology. The Hazard Analysis Methodology section might better be termed "work planning and control for operations" to match the jargon of Integrated Safety Management. This section should capture the five core-functions from DOE's Integrated Safety Management System Guide, DOE P 450.4:

- Core Function 1, Define Scope of Work
- Core Function 2, Analyze Hazards
- Core Function 3, Develop/Implement Controls
- Core Function 4, Perform Work and Operation Authorization
- Core Function 5, Feedback/ Improvement

4-10 The paragraph should mention the four objectives of the Fire Safety program. List life safety of public and workers, prevention of excessive interruption to the experimental program, loss of property, and insults to the environment from a fire. From that the thresholds should be mentioned, compliance with NFPA 101 Life Safety Code for life safety, no more than 6 month interruption to the program from a fire, <$1 Million of property loss (with separation of high valued fire areas to less than $50 Million per area), and no significant insults to the environment.

4-10 List the exemption requests that are being filed regarding deviations and variances from the required DOE codes and standards.

4-10 Typical risk minimization elements form a comprehensive fire safety program. These elements include fire prevention programs, automatic fire suppression systems, fire alarm systems with manual fire fighting elements, adequate water supplies for manual fire control, emergency prefire plans, and fire barriers.

4-10 Keep the citation to the FHAs. The FHA should be updated from the current level of understanding, especially since the facilities are now in Title III and their configurations are well understood (both conventional and experimental use). The construction is beyond the cited SNS FP Design Criteria and Philosophy document and it should be deleted.

4-19 The control of shielding in the experimental areas should be addressed. Specifically, what is the configuration control plan for Instrument shielding?

4-20 The configuration control on the location of Chipmunk radiation monitors should be addressed. Also, the configuration control of Chipmunk interlocks, alarm set points, control room interfaces, and network interfaces should be discussed. Chipmunk installation and decommissioning procedures should be controlled.

4-39 through 4-43 Ensure that risk assessment boxes are appropriately checked following mitigation. That is, in many cases consequences will not change, only the probability will change.

4-46 A statement needs to be added that indicates experimental devices will comply with the intent of the NEC. That is, NEC rules should be followed for Instruments (e.g., fusing, connector types, cable types) where reasonably achievable. SNS needs to designate an authority to determine if Instruments meet intent of NEC, perhaps Chief Electrical Engineer or Electrical Safety Committee.

4-50 Vacuum window lifetime needs to be addressed as well as controls for new window manufacture and installation. Windows may need to be periodically changed out based on lifetime.

4-56 What nuclides make up the off-gas from the beam dumps and is the off-gas piping proximate to occupied areas?

4-62 Some indication in the table should be given to dose at a typical penetration even though it is not the worst case.

4-62 The last row in Table 4.4.1.3-1 should be reconsidered. Limiting the integrated exposure time to 4 four seconds due to melting the vacuum pipe with full beam power neglects partial beam losses that could lead to higher integrated exposures. Using the Chipmunk response time, which has been tested to be less than 10 seconds at BNL, is an alternative; however, enough Chipmunks must be used to "see" beam loss along the entire berm. Additionally, inside the accelerator enclosures at BNL, we use beam-line instrumentation that alarms in the Main Control Room (MCR) whenever a portion of the beam is lost, and operators have procedures to respond to these alarms. Alarms for Chipmunks are set well below interlock levels. If Chipmunks are alarming in MCR, operators are trained to limit the average exposure rate in one hour. That is, they sometimes re-tune or reduce intensity to stay below a previously agreed to level, usually 2 mrem in one hour.

4-63 Credit should be taken if the accelerator berm is to be fenced and posted as a Controlled Area.

4-64 through 4-68 The traditional term "ODH" identifies the hazard, whereas the term CRYO does not convey hazard. The lack of an area designation where the oxygen level is not anticipated to have the potential to fall below 16% is not as conservative as OSHA. OSHA

indicates adequate controls should be in place to preclude workers from exposure to oxygen deficient atmospheres, which OSHA defines as <19.5%. At other "cold" laboratories, areas with the potential to go <19.5% have been posted as ODH areas and awareness training is the minimum requirement. Some mention about oxygen gradients in a helium leak event is appropriate in order to: 1) indicate the 18% alarm level at the ceiling oxygen sensor may correspond to a level of 19.5% or greater for a worker standing on the floor, and 2) indicate non-uniform, non-instantaneous mixing occurs where helium is leaking into the work area. The statements on oxygen physiology, while interesting, do not take into account the working environment. A worker who gets dizzy at 16 - 17% can fall off a ladder or drop a welding torch or drop a wrench on exposed energized buss. This makes the work potentially high hazard as opposed to low hazard when one considers only the physiologic response. Additionally, there are other stressors in any helium leak including noise, reduced visibility and cold air all of which could play a role in causing a severe injury. It was indicated in the presentation that CRYO1 and CRYO2 controls would depend on the work to be done as opposed to the area designation. Assuring safety for non-CRYO designated workers who happen to be in the same work area is somewhat more difficult if this is truly the policy. Thus, the approach taken by other "cold" laboratories, while more conservative, is reasonable and practical in our opinion.

4-70 Experience shows the migration of tritium and Na-22 is much faster than most other activation products in the soil. For example, tritium travels several hundred feet per year and Na-22 about 100 feet per year once these nuclides have joined groundwater on Long Island. True it may take more time to reach groundwater in Tennessee; however, the fact that nuclides reached groundwater was the public's overwhelming concern on Long Island, as opposed to reaching water that people were actually drinking. The bottom line is that any migration of radionuclides is a problem from the public's standpoint, and it can mushroom into a severe public dialogue even though it results in zero exposure.

4-72 Meeting the 40CFR61 Subpart H requirement to install a continuous stack monitor should be highlighted here. Also, a connection to specific ASE requirements regarding calibration and maintenance of a working stack monitor should be placed here.

4-73 The first paragraph illustrates the concern that portions of the SAD are written in the future tense. For example, it may be better to state that the waste management plan is a living document and is revised when appropriate. The ARR should be able to pick up the SAD and verify systems, procedures and programs that exist; otherwise, their report may not solidly support a decision by DOE to let you go forward with commissioning.

4-75 ALARA should be discussed in terms of "as far below 0.25 mrem/h as reasonably achievable" as opposed to "should not exceed 0.25 mrem/h." The inadvertent implication that ALARA is a limit should be avoided since ALARA and dose limitation are distinct elements of a radiation protection program if the program is in compliance with 10CFR835.

4-75 The last paragraph does not convey the idea that air will be recycled to keep the humidity low. There will have to be some air makeup due to fugitive exhaust through the openings at doors and other penetrations. This brings to mind two sources of radiation exposure. One is the condensate from the HVAC, which will contain tritium, and the other is immersion in short-

lived gases and low-energy neutrons that tend to emanate out the edges of doors, trenches and other penetrations.

5-1 We note DOE prior to the ARR can approve the ASE. The ARR process needs to be lightly explained. Be sure to mention that one ARR is for commissioning and another ARR is required for routine operations. You should also bring out the fact that DOE will use the SAD to judge the completeness of the ASE, and that DOE will use the ARRs to judge whether or not you are ready to commission or routinely operate.

Table 5-1

- Item 3.1 could be worded to give you more flexibility. For example, all portions of the PPS that are in use must be 100% functional.
- Items listed under "Classification of Radiological Areas" should include the idea that the target is an accelerator facility until the radionuclide inventory, when averaged over an 8-hour period, exceeds the Category 3 Threshold for Nuclear Facility status.
- The title "Classification of Radiological Areas" could be changed to "Classification of Radiological Areas, Accelerator Facilities and Nuclear Facilities."
- Whoever approves low-power operations and the specific power limits should be mentioned in the ASE.
- A new sub-section needs to be added to part 3 of the ASE and it should include parameters associated with the stack monitor.
- Section 5 of the ASE may lock you in a bit; however, the idea in Section 1 that only violations of Section 2, 3 and 4 are to be treated as reportable occurrences may unlock you. In any event, it may be best to be flexible in this Section too. For example, the ASE should have flexibility in terms of operators required, and the number of operators should be allowed to diminish if you are only operating the Linac or Front End.
- Is the chopper maintenance schedule an ASE issue, and what is review and approval process when changes to choppers are made?

5-8 With the ring on but no beam extracted, how are people in the Target Facility protected from stray radiation rumbling down the beam-pipe penetration if beam is inadvertently lost near the extraction system in the ring?

Table 5.2.2-1 How do you plan to track combustible amount limits in the Target Hall?

6-1 The concept of a Category 3 Nuclear Facility threshold should be mentioned here. The operations interface is not that clear with low-power operations in view, and the Committee is not sure you want to stress that it is that clear. You may want to stress that Nuclear Target Facility status occurs once you exceed the threshold. Once reached, backing down from Nuclear Target Facility status to accelerator target facility status is more complicated but could probably be done if you invoked local DOE approval as part of the backing-down process.

6-3 through 6-6 Will it be apparent to workers inside the facility, as opposed to drawings, that there are specific boundaries between the accelerator facility equipment and Target Nuclear Facility equipment? For example, will there be fences, and card readers? Will there be configuration controls on both sides of piping systems and other penetrations? Perhaps a full

definition of accelerator area, experimental area, and target area should be developed in the FSAD. Ownership of all territory and equipment should be easily identifiable. If a pipe leaves the target basement and passes through the experimental hall, then there should be clear easily referenced ownership listings.

6-10 This section should stress operations interfaces and avoid the physical interfaces such as "locked cabinets" or "on one side." That is, how are keys to the cabinet administratively controlled? Or, how are plans to change the authorization basis of one facility communicated in a timely way to the staff of the other facility? What is the charter for the "SNS nuclear configuration control group?"

8-3 You should define the terms Greenfield and Brownfield.

Appendix C The concept that the Accelerator Safety Order 420.2A and the QA Order 414.1A apply to beam dumps, and all accelerator facilities in general, should be emphasized. Additionally, you should mention that QA Order 414.1A contains the same set of requirements, virtually word for word, as 10CFR830.120 but without the fines and penalties that apply to nuclear and radiological facilities.

Appendix D We feel this new approach should be peer reviewed by experts in oxygen deficiency hazards and control.