Los Alamos National Laboratory
Spallation Neutron Source

D-Plate System
Preliminary Design Review

Response to the Review Committee Report

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Work Package Manager:
The Work Package Manager is responsible for generating constructive and specific responses to the review committee's recommendations. Responses should be generated in a timely manner. Responses should incorporate the action to be taken, who is responsible for the action, the time frame by which the action will be completed if required before the Final Design Review, and any impact to the project cost, schedule or scope. Work Package Manager signature means that all responses having no significant impact on project cost, schedule, or scope will be incorporated into the design of the system. Responses that involve a significant impact to project cost, schedule, and scope must include a description of the impact and be approved prior to implementation by the Project Office.

SNS-2 Group Leader:
Reviews responses for overall technical merit, cost effectiveness and reasonableness for implementation. Reviews responses relative to interfaces with other accelerator systems and for potential impact to these systems.

SNS-3 Group Leader:
Reviews responses for overall technical merit, cost effectiveness and reasonableness for implementation. Reviews responses relative to interfaces with other accelerator systems and for potential impact to these systems.

Physics Review:
Reviews responses for impact to physics design.

Project Office Review:
Review responses for impact to project cost, schedule and scope. Approves or disapproves responses which impact project cost, schedule or scope prior to their implementation.

Division Director:
Provide final review and approval of responses prior to distribution.

Responses to the Design Review will be distributed to:

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The SNS D-plate Preliminary Design Review was held at LANL on July 18, 2001. We received the review committee's report on August 24, 2001. We thank the review committee for their insightful observations and suggestions, and their timely response. In this document we shall address each observation and suggestion. Each item that requires action on our part will be tracked and the progress will be reported at the final design review.

Committee Observations and Recommendations

Committee Observation – Stovall's presentation provided an excellent **motivation** and outline for exploiting the D-Plate.

Recommendation – The outline Jim provided should be **fleshed out**, quantified, and detailed with a commensurate schedule to justify making time for the D-Plate in the commissioning scenario and to serve as realistic input to establish an integrated schedule for Linac commissioning.

Response – The linac commissioning team is now doing this.

Committee Observation –**Systems integration and interface** issues abound with the D-Plate: mechanical, survey, machine protection system, controls system, software, physical plant and supporting utilities, radiation safety, personnel safety, shipping, and schedule. The D-Plate is the odd man out. It has enough similarities to other parts of the linac that it is easily taken for granted, but is sufficiently different to deserve special attention. If the D-Plate is to provide benefit to the project, it uniqueness and special needs must be attended.

Recommendation – **Management** should focus on these systems issues to assure that the D-Plate engineering requirements and specifications are appropriate and that the D-Plate will be sufficiently exploited. The D-Plate must not be considered in isolation. Deliverables from LANL and from suppliers of supporting systems must be clearly defined.

Response – Noted.

Committee Observation – The D-Plate requires vacuum and water **resources**, I&C and power defined for the rest of the DTL. Work-a-rounds should be considered. The facility work will likely drive the schedule for this part of the accelerator. Vacuum and water engineer appears to have more work than can be completed in time frame by one person.

Recommendation – Develop **integrated schedule**.

Response – Noted. To relieve pressure on existing resources, a contract engineer has been hired to work on the D-plate water and vacuum.

Committee Observation – **Pump skids** appear to be on the **critical path** for purchasing, delivery, installation, and testing. A plan to use the DTL Tank 2 skid to provide D-Plate water appears to be inconsistent with the water system schedule.

Recommendation – Develop **integrated schedule**.

Response – The D-plate vacuum and water needs have been incorporated into the integrated schedule.

Committee Observation – There appear to be open questions regarding the **"hand-off"** of the D-Plate system from LANL and ORNL, for instance in areas including assembly and shipping. Who assembles which pieces, where is vacuum leak testing done, how can duplication of effort be minimized?

Recommendation – Assembly and shipping **methodology** need to be carefully considered. Communication between LANL and ORNL mechanical and installation groups needs to take place to resolve these issues at an early stage to avoid un-necessary costs. You might check with recent work done by Phil Mutton at JLAB concerning acceleration of components during shipping.

Response – An Acceptance Strategy document has been written to clearly define roles, work, and responsibilities. We will continue to communicate with the ORNL groups to address interface issues as they arise. The plan is for LANL to check the components to ensure that they have been correctly fabricated and that they fit correctly to mating components. Final assembly and alignment will be done at ORNL. This process allows LANL to ensure a quality product and alleviates shipping concerns.

Committee Observation – It was not clear that the D-Plate has been specified consistently with all the beam measurements that need to be made from a **beam physics perspective**; for instance, no momentum spread analyzer is included. Not all **requirements** of D-Plate diagnostics are yet well defined, especially for non-standard equipment like large bore BPMs and slit/collector emittance device. What is required accuracy, sensitivity, resolution for what beam parameters (full current/reduced current). Some accuracy parameters are derived from purely theoretical formulae without real life considerations, for example in the TOF measurements. Numerous accuracy requirements were presented in a hand-waving manner. It appeared that requirements that had been established for permanent linac diagnostics systems were simply attached to D-Plate systems. It is not obvious that the same requirements apply to meet the commissioning goals of the D-Plate as described by Stovall.

Recommendation – Carefully consider again the **full range of measurements and beam modes** for which each D-Plate subsystem is required to perform.

Response – We agree that ideally the D-plate specifications would follow from linac commissioning studies. However, due to limited resources in the physics team, and therefore lack of input from the team, some of the D-plate specifications had to be derived based on experience with other accelerators. The LANL physics team leader (J. Stovall) is well aware of the D-plate specifications. As physics resources become available more effort will be focused on the D-plate, hopefully in time to make any mid-course corrections that may be necessary. Also, a member of the D-plate design team (M. Plum) is also a member of the physics and commissioning team. This will help optimize input from physics team and refinement of the D-plate requirements.

Recommendation – Consider **electrically isolating** the D-Plate beam **absorber** to provide an additional inexpensive beam intensity diagnostic.

Response – Good idea. We have modified our design to do this.

Committee Observation – Design of the **emittance slit and energy degrader** were not presented. It was claimed that they would be similar to existing LEDA hardware. However, beam parameters are not exactly the same, therefore it would be desirable at least to provide simplified analysis of thermal load etc. Emittance measurements are likely to be the most important contribution of the D-Plate.

Response – We agree. Thermal model calculations have now been performed and the design has been optimized for the D-plate.

Committee Observation – Thermal analysis of the **beam stop** has received considerable attention and development time, but still there is no confidence that all scenarios are considered: beam mismatch, beam offset etc. There is no direct measure of beam spot size on the beam stop; what happens if the D-Plate system is started up with a reversed quadrupole magnet? The safety margin for the design is not clear.

Recommendation – The D-Plate system, especially the beam stop, would benefit from a **failure mode analysis** effort. Beam stop analysis should consider worst-case beam spot and not just average ideal centerline case. Look at the optics and design for the smallest beam or devise controls to prevent delivery of the worst-case beam if it will burn through the beam stop wall. What mis-steering and mis-focusing scenarios can damage components? What mitigation concepts might avoid that damage?

Response – We have studied the optics and identified the worst case scenario. The beam density can be up to 14 times higher than nominal if the quadrupole magnet is set improperly. We plan to have the control system monitor the quad readback current and shut off the beam if the current strays outside of nominal settings. We are also investigating infrared detector systems to monitor the temperature of the beam stop. Minor beam mis-steering will identified by the 8-segment halo scraper system, and gross mis-steering will be identified by monitoring the current difference between the upstream current monitor and the current intercepted by the beam stop.

Committee Observation – Design of mechanical supports were presented but **mechanical tolerances** were not discussed.

Committee Observation - No **alignment specifications or procedures** were offered and apparently none have been defined for the D-plate. Alignment of individual devices on the D-Plate itself and alignment of the D-Plate relative to DTL Tank 1 should have been considered by this stage of mechanical design. Laser trackers require much more forethought and engineering design to be used effectively with equipment originally designed for optical alignment. This needs a lot of work.

Recommendation – Determine alignment requirements as soon as possible. **Establish specifications and alignment procedures** so that impacts on mechanical design may be addressed at the earliest opportunity.

Response – We now have a table of alignment requirements, and we are working with Joe Error at ORNL to optimize the laser alignment target placements.

Committee Observation – The committee was presented a block diagram for the water control systems that will be used throughout the SNS Linac and for the D-Plate. **No hardwire connection between the water systems and the Machine Protection System** was identified on the diagram.

Recommendation – This obvious oversight **must be rectified**.

Response – There was a miscommunication at the D-Plate PDR. The water cooling system is tied into the Machine Protection System. As presented in the DTL and CCL Water Cooling and Resonance Control Systems Final Design

Review (see documents SNS-104020500-DE0003-R00 and SNS-104020500-DE0001-R01), the water cooling system PLC is tied into a Global Control System IOC, which is in turn, tied into the Machine Protection System (as well as other systems). There is no need for a hard wire interface between the water cooling system PLC and the Machine Protection System. The thermal inertia of the RF structures is so large that there is more than sufficient time to send signals from the PLC to the IOC, and on to the Machine Protection System in the event of a malfunction in either the DTL or CCL water cooling systems.

Committee Observation - It was noted that the **water systems throughout SNS** (not just for D-Plate) are planning to rely on manual valves for flow control. This is especially dangerous for the Linac. Copper structures are very sensitive to water flow velocities. Ranging flow meters will work for a few years and then they will stick due to copper oxide deposits. LANSCE has lost two drift tubes due to water channel erosion and is slowly installing Griswald flow controllers on all systems. These prevent well-intended personnel from open a valve unannounced and possibly ruining expensive Linac copper structures.

Response – This specific issue was addressed during the preliminary and final designs of the DTL and CCL water cooling systems. The advantages and disadvantages of both globe valves/flow meters, Griswald-type flow control valves, and orifice plates were explored. The final decision was to use a combination of globe valves/flow meters and orifice plates on the DTL, and to use orifice plates and flow meters on the CCL. The Griswald-type flow control valves are bulky, expensive, and do not allow for any adjustment in flow rate. The flow fields are sufficiently complicated in the DTL and CCL that a means of flow adjustment is required (hence the use of valves and flow meters). The problems noted with the water cooling system on the LANSCE accelerator have been studied and thoroughly addressed in the SNS Linac water cooling system design. Water purification systems will prevent copper oxides from being generated and deposited on instrumentation. Water channel erosion has been eliminated by restricting the water velocities within the channels. All globe valves on the DTL will be placed on the hard-to-access, non-aisle side of the structure, thereby limiting access to the valves. In addition, lower and upper alarm limits on all flow meters have been established in the PLC ladder logic to prevent operation of the Linac with either low or excessive water flows. There are sufficient flow meters to monitor flow rates in all areas of the DTL and CCL. All flow meters have been designed to be removable for maintenance of either the electronics or the flow monitoring heads/seals. Finally, upon initial testing of the water cooling systems, all water line flow rates will be checked and confirmed with an ultrasonic flow meter that attaches to the outside of the water lines.

Committee Observation – There appeared to be confusion or lack of closure on the **water pressure requirements** for the D-Plate beam stop.

Recommendation – There is no reason the beam stop should drive special water system pressure requirements. **Design beam stop to use normal water system pressures.**

Response – This issue has been resolved. The beam stop will use normal water pressures, and no extra pumps will be required.

Committee Observation – Calculations of **vacuum load** in the D-Plate system at full power were not presented. Is beam load taken into account? Transient pressure bursts might be important for operation at full power.

Recommendation – Consider whether it might be wise to do **vacuum calculations** to include the loading caused by the beam on the dump. The loading will probably be addressed as "conditioning" as the beam power is increased during the initial operation of the system.

Response – Extensive vacuum calculations have now been performed, including beam loading, and the vacuum system originally planned is more than equal to the task.

Committee Observation – The D-Plate drawing depicts a **large diameter vacuum connection** from the D-Plate to the Tank 1 interface. The purpose of this was not appreciated by the committee and it was noted that the high conductance connection might increase the possibility that "bad vacuum" from the D-Plate might feed back into the DTL tank. Is it optimal to connect DTL vacuum to the D-Plate chamber (presumably dirty) by a high conductance pipe?

Recommendation – Consider whether a lower conductance connection might not be preferred.

Response – The vacuum calculations mentioned above address this issue. No changes to the vacuum connections to the DTL tank will be necessary.

Committee Observation – There confusion was expressed as to what materials and design was needed for a **Faraday cup** and there was no specification provided for the **energy degrader**.

Response – The energy degrader and Faraday Cup were omitted from the review due to time limitations. However, the design is now complete, and a tech note is now being written to describe the requirements and specifications. We hope to present this design to the committee at the Final Design Review.