SNS Accelerator Advisory Committee / Target Advisory Committee Report

May 15-17

2018

Contents

Introduction

The Accelerator Advisory Committee (AAC) and Target Advisory Committee (TAC) for the SNS met together for the first time May 15 – 17, 2018. This was the ninth meeting of the SNS ACC; the previous meeting was March 8 – 10, 2017. Committee members are shown in Appendix A. Absent from this meeting was Peter Ostroumov.

Accelerator Advisory Committee / Target Advisory Committee Charge

In this meeting, we were given a total of eleven charge questions in the context of two high-level objectives for the next two years. The objectives are:

A. By the end of FY 2018, achieve sustainable and predictable routine operation at or near 1.4 MW to the First Target Station (FTS) with availability against published schedule of ≥ 90% while using up to 3 target vessels per year.
B. Enable success of the Proton Power Upgrade (PPU) project by providing key technical and management resources as required to meet project objectives.

Charges:

1. Are the SNS responses and ongoing actions to recommendations from the 2017 AAC meeting satisfactory?

Charge for Accelerator Systems:

2. Do the capability and performance of the accelerator complex and neutron source support achieving Objective A?
3. Is the Prioritization process and Project Planning strategy that has been developed and is in use for outage planning reasonable?
4. Is the scope of work identified for ongoing and future Accelerator Improvement Projects (AIP) appropriate and balanced between the competing interests of maintaining necessary margin for routine operation at 1.4 MW while addressing system obsolescence?
5. Is the Accelerator R&D plan presented appropriately positioned to widen collaborations and to leverage external resource support?
6. Are the PPU pre-CD-2 activities properly focused?

Charge for Target Systems:

7. Is the SNS Target Management Plan a reasonable approach to improving both performance and understanding of SNS mercury targets?
8. Have lessons learned from the IRP-01 and IRP-02 experiences been adequately considered in the design and fabrication plan of the next-generation IRP (IRP-03)?
9. Is the major procurement planning sufficient for controlling long term cost and improving component manufacturing reliability?
10. Is the proposal for early use of the 2 MW PPU target in operations reasonable?
11. Do the benefits proposed from the PPU 2 MW target design changes outweigh additional potential complexities?

Executive Summary

This is the first year that the Accelerator Advisory Committee and the Target Advisory Committee met jointly. This document is the full report containing material from both committees. As in the past the meeting was two days of presentations (one day of plenary talks, and one day of tours and breakout talks) and a final half-day to wrap up and present a close-out report to the facility. Both committees felt that the joint meeting was beneficial. However, the presentation schedule was very dense, and we would have liked more time for committee discussion. This issue should be discussed with SNS management prior to the next meeting.

Upon our arrival, SNS was in the process of turning the facility on after a five-month shutdown. An extensive amount of work was done during this time including the very important tasks of Inner Reflector Plug (IRP) replacement, and Radio Frequency Quadrupole (RFQ) replacement. All of the critical shutdown work appears to have been done efficiently and successfully. We commend the facility for the way in which the work was done and the progress that was made, particularly in achieving the facility objectives noted above. We now look forward to seeing the benefits of this work realized in the next operational running period. Underlying the planning for the work in the recent outage is continued progress in project prioritization, which we see evidence of across the facility.

Organizationally, since our last meeting, changes have been made within the Neutron Sciences Directorate. There are minor changes impacting accelerator and target systems. The committee feels that the present organization is beneficial in supporting both the operational needs of SNS and the PPU Project: we believe it is important to maintain stability in the facility operations management for a period of time. Additionally, we welcome new Division Directors in the Research Accelerator Division (Fulvia Pilat) and the Neutron Technologies Division (Graeme Murdoch) and express our thanks and appreciation to the outgoing directors, Kevin Jones and Don Abercrombie for their support to these committees over the past years.

Finally, we note across all systems and groups the culmination of many positive technical changes that have been discussed over many years in these meetings. Our report will provide the details, but it is especially noteworthy that clear progress towards the stated goal of predictable and reliable operations at 1.4 MW with 2-3 target replacements per year was demonstrated during the past year. No early target failures occurred, and more positively, planned improvements, e.g. gas injection into targets, were successfully implemented.

Going forward, the facility will need to focus on the issue of obsolescence mitigation and integration of the PPU both organizationally and technically, while continuing to support an active accelerator R&D program.

I. Operations

Observations and Comments

The SNS team should be congratulated that since the last AAC meeting, continued sustained operation with beam powers between 1.0 and 1.2 MW has been achieved. The performance for FY17 and Q1 of FY18 has been impressive:

- In FY17 6,079 operating hours were achieved, with 4,807 hours delivered to the user community (exceeding the target of 4,230 hours). Overall availability was 87.5%, but would have been 94% excluding the Inner Reflector Plug water leak.
- FY18 has started with excellent machine performance and availability of 93.5% so far.

In recent years, long duration events have dominated overall downtime numbers. The ambition is to eliminate events such as the Medium Energy Beam Transport (MEBT) water leak, the Inner Reflector Plug (IRP) water leak, and target failures – which would leave a residual downtime per month of ~45±25 hours – equivalent to ~94±3% availability (and easily sufficient to achieve the ≥90% availability required to meet Objective A).

Performance metrics and downtime analysis at SNS are particularly strong. Progress is still being made in year-on-year reduction in the number of short trips and SCL cavity trips, supported by appropriate AIP and spares initiatives. This all appears to be in very good order.

The five-month long outage (December 2017 – May 2018) was very effectively managed and has prepared SNS for 1.4 MW operations, with most issues identified at the last meeting having been addressed.

Recommendations

1. Keep producing and analyzing the high-quality performance metrics that have proved so useful up to now.

II. Shutdown Planning

Observations and Comments

Since the last AAC meeting, the SNS has undergone planning and execution of three outages. They identify these outages as 2017B (summer of 2017), 2017C (October 2017), and 2018A (the long outage beginning in December 2017).

SNS is continuing to use the prioritization and outage planning process which was developed and initially implemented in 2016. The purpose was to have a process which is more quantitative and integrates overall facility activities. The process continues to be as described last year, but is evolving from "this is what we're developing as a tool" to "this is our tool."

All projects are put into the new tool to be categorized and scored under a number of criteria. The projects are categorized, based on funding stream, into one of five categories. The categories may be either an Accelerator Improvement Project (AIP), General Plant Project (GPP), Institutional General Plant Project (IGPP), Line Item Construction (LI/MIE), or Operational Improvement Project (OIP). The relative importance of projects is also considered within the context of mission imperatives. The criteria of delivering predictable and reliable operation, maximizing operating power, improving facility capability, responding to external drivers, and supporting externally funded projects are considered. SNS has developed a scoring methodology which includes relative weighting of the different criteria. The projects are also assessed by risk management, with discrete scores for probability and consequence being factored in.

The outage planning tool is moving from MS Project to Primavera (P6) and a permanent planner has been put in place; further indications that this process is maturing into a robust tool that will be flexible and scalable to the length and scope of each outage. Anywhere from 300 to 1,465 tasks have been tracked in an outage. Coordination and pre-planning continues to be a priority. They spent considerable time validating and adding logic ties in the most recent outage. A high-level block schedule continues to be used effectively for coordination. In this facility-wide schedule, activities that may impact the work of individual teams are listed, with examples being power outages, major projects, tunnel access restrictions for testing, etc. This effectively provides all potentially impacted organizations with a framework of scheduling constraints around which to detail their team level activities.

The process continues to improve, with Lessons Learned from SNS's first long outage having been identified:

- Distribute priority projects early to allow for proper identification of all needed resources
- Put in start-up tasks at the beginning for logic linking
- Evaluate logic as it is entered
- Attempt some amount of resource leveling at the beginning
- Continue to educate planners/task leaders/team leaders on scheduling techniques

The committee encourages implementation of identified improvements of the outage planning process.

Recommendations

Recommendations for this topic are found in the answer to Charge Question 3.

III. Beam Test Facility (BTF), Ion Source, and RFQ

Observations and Comments

BTF: The demonstrated benefit for offline testing of accelerator hardware was shown with the successful installation of the new RFQ. The BTF offers SNS the opportunity to reduce risks and the time it takes to develop accelerator components. Now that the new RFQ is installed and operating, the buildup of the BTF with the old RFQ is in progress. This work should continue as an essential

SNS system. The committee heard plans for a small expansion to the BTF, continuation and improvement the 6D emittance measurement effort, and hardware and software testing opportunities. The SNS should move forward with the expansion and fully commit to putting the BTF operation on a more permanent footing. The continued use of BTF for testing of beam line elements, diagnostics, and beam physics concepts could help expand opportunities for graduate students, external funding and collaboration with other facilitates.

As with last year's AAC observations and comments, the use of the facility should be prioritized and supported with both labor and funds.

ION SOURCE: Again, this past year (FY17) has been very productive for both ion source development and operations. The new External RF Source (ERFS) is closing in on completion. For example, one external antenna source ran for ~1600 hour without source maintenance but with extensive operational interruptions for facility outages and other accelerator issues. The hours were not continuous and should be repeated without incident before the ERFS is installed on the SNS accelerator. SNS is encouraged to make this a priority and use the BTF to test several ERFS. Each source should operate for at least 1600 hours to ensure it can survive on the present SNS schedule of three shutdowns per year. Additionally, a functional ERFS will reduce risk by ensuring multiple vendors. Improvements to the plasma chamber and performance also need to be understood. We heard of several laboratories that are collaborating with the SNS source team with plans to expand the collaboration effort.

There is interesting ion source physics to be explored and SNS is leading the effort on many fronts and it should be encouraged.

RFQ: At the AAC meeting last year, the committee congratulated SNS for the successful testing of the new RFQ! This year the SNS team installed and started operations with the new RFQ. The start-up results have verified the test stand RFQ performance. The success of this work was critical to the laboratory and the nations science program. The AAC heard plans to operate first at 1.3 then 1.4 MW this year. The new RFQ fully meets the near term needs as well as the planned upgrade to 2.8 MW.

Last year, the AAC commented on SNS ordering an RFQ spare. The AAC still sees this as an important option to consider. However, it is understood that only after a period of operating will SNS fully gain confidence in the RFQ performance and then consider a spare unit.

Recommendations

1. Make room available to the BTF to fully utilize its potential. This BTF offers the possibility to expand SNS beam physics, collaboration and outside funding contributions.
2. Consider moving SNS operations to the external antenna ion source as soon as reasonably possible to obtain the benefit of longer lifetime and reduce vulnerability. This new design will not only benefit SNS but the community.
3. Consider ordering an RFQ spare after verification of performance to guarantee long-term operations.

IV. Superconducting Linac and Superconducting Radio Frequency (SRF)

Observations and Comments

The SNS team reported a 98% availability of the Super Conducting Linac (SCL) during the past 7 years. This proves a very high reliability of the cryomodules and its systems. The committee congratulates the SCL team for the very good operating performance.

The great success of the plasma processing was reported already in the last ACC meeting. Since then, the performances of five additional high beta cryomodules have been improved. Plasma processing is one of the major contributions to the now possible 1GeV beam operation. The AAC supports the development of a new recipe for the use of this successful tool also for medium beta cavities. We also support the ongoing collaboration with other laboratories on the development of plasma processing for different SC cavity designs.

Thanks to the availability of the spare high beta cryomodule, the leaky cryomodule in slot 17 could be replaced in January 2018. This underlines the usefulness of spare cryomodules.

The construction of the spare medium beta cryomodule is progressing. We are happy to hear that the accelerating gradient and quality factor of the first fully equipped tested cavity is very high and exceeds already the PPU specification. The cold string assembly will start in summer this year. The development and construction of the spare cryomodule will not only support the future high performance and availability of the SCL, but will also function as an important development step for the future PPU.

The design improvements of the cavity and cryomodule for the PPU which have been reported in this meeting gain the full support of the AAC.

Besides the necessary R&D program goals for the PPU, the AAC supports the plans to investigate the ex-situ plasma processing and exploring innovative techniques to probe SRF surfaces.

Recommendations

1. In order to assure the full use of the SCL test facility during the PPU construction, e.g. for power coupler testing and conditioning, the use of the RF power source independently from the beam test facility is necessary. We recommend a dedicated HVCM for the SCL test facility klystron.
2. To comply with the R&D goal to probe SRF surfaces, a clean chemistry bench for BCP and EP sample treatment is recommended.

V. Ring and Accelerator Physics

Observations and Comments

The R&D plan

- The Beam Science and Technology (BeST) Group is carrying out an impressive R&D program. Many of the topics are a first in the accelerator community: namely high dimensionality beam dynamics research; self-consistence beam distributions; laser stripping injection; foils for high power injection, high power SRF (plasma cleaning); non-destructive "high dynamic range" beam diagnostics; and laser stripping of H^- to H^0 for demonstration of muon spin resonance (muSR) beam line time structure.
- SNS is leveraging its unique technological strengths to enable these high impact R&D efforts. These capabilities include the highest power beam in world, highest intensity proton ring, the only hadron SCL, and the only 6D phase space measurement system.
- The committee encourages SNS to continue this highly visible R&D program. It will be an important and productive service to the accelerator community.

Linac Beam Dynamics

- SNS has developed two linac simulation codes: "OpenXAL Online Model" and "PyORBIT". The committee appreciates the great success of the fast tuning by the "Open XAL". "PyORBIT" is extendable for new physics and new diagnostics. It shows good benchmark results with a conventional code. The committee supports the continuous development of these codes. Further benchmark tests of PyORBIT are suggested for validation.

Ring Stripper foil R&D

- The stripper foil development program is designed to address issues with foil conditioning, predictability, and lifetime. It is making significant progress. The foil test stand now in operation uses a pulsed rastered 30 keV, 5mA electron beam with 0.3 mm^2 spot size to simulate 2.8 MW equivalent heat loads to study different type foils. A precise foil temperature measurement system is being developed. The enhanced R&D effort should provide sustainable progress on stripper foils to withstand higher beam power.
- A new removable electron catcher is designed with a larger viewport and is movable and allows different electron catcher geometries. A tentative plan is to install it during the winter 2018 outage looks unlikely as of this writing. A method for verification of the final position of the electron catcher must be developed.

Laser stripping

- Laser stripping is very promising basic research that is being carried out by the BeST Group. It could have significant impact on the accelerator community. Last year progress included a demonstration of a large mode optical cavity for enhancement of UV laser pulses in burst-mode and identification of technical challenges toward full-cycle (1.0-ms/60-Hz) green (nm 532nm) laser. SNS is making significant progress to maintain this research. The committee views this as very important research for the accelerator community. We encourage SNS to support this work at an appropriate level after the present grant runs out in July 2018.

Self-Consistent Beam Distribution

- The committee heard very promising progress toward resolving several key issues like fringe field, bi-polar power supply and understanding of painting and injection kicker limitations, sensitivity of solenoids, and tunes. Specification of requirements to realize self-consistent beams is complete. The next step will be the design, fabrication and installation of solenoids, confirmation of the lattice settings, painting waveforms, and the measurement of the correlation coefficients between phase space variables. It will be interesting to check the 4-D emittance of the rotating beams.

Recommendations

1. A figure of merit for charge exchange foil must developed for 2.8 MW beam power.

VI. Target Status and Plans

Observations and Comments

Clear progress towards the stated goal of reliable operations at 1.4 MW, with 3 target changes per year was demonstrated during the past year. No early target failures occurred, and more positively, implementation of gas injection into the target significantly reduced pressure pulse stresses in the target vessel. The comprehensive post-irradiation examination (PIE) of spent target vessels has now been demonstrated as a powerful tool that SNS is using to better understand the impact of design changes and develop improved targets.

The Target Management Plan (TMP), which has now undergone its third revision, provides a roadmap for developing and implementing target improvements aimed at satisfying current operational goals (2 targets per year at 1.4 MW), as well as providing information critical to the development of 2.0 MW capable targets needed for PPU. The team is commended for creating such a document and utilizing it to focus development as well as operational efforts.

Successful replacement of the first IRP is a major achievement, but until IRP-3 is delivered, failure of this complicated, inaccessible, highly stressed, and intensely irradiated system will represent a single-point-of-failure risk with a multi-year impact for the SNS science program.

Recommendations

1. The IRP design and associated manufacturing initiative should be given high priority by Directorate management to deliver IRP-3 on a reasonable time scale.

Target Systems – IRP Operation, Fabrication and Development

Observations and Comments

A leak in IRP-1 complicated operations prior to the long shutdown. The engineering team developed a creative solution that allowed operations to continue until IRP-2 was ready. This effort showed a great deal of creativity by the engineering team and demonstrated the broader effort to analyze the safety basis, etc., to allow the facility to continue operating.

IRP-2 fabrication was completed by the vendor, the first time this has happened. However, fabricating the IRP continues to be a complicated and difficult task with little schedule predictability. A new approach is proposed to manufacture the IRP in stages, completing and testing components along the way, then assembling at the end.

Steps were taken to lengthen the life of IRP-2 and to further lengthen the life of IRP-3.

Recommendations

1. Be sure to look at all issues which may determine the lifetime of the IRP, and not just the moderator poison thickness.

Target Systems – Target Manufacturing and Procurement

Observations and Comments

SNS routinely manufactures targets, IRPs, and PBWs. These are part of the normal operation of the facility, but the targets are also part of a major deliverable for PPU. The average annual cost for 3 targets per year, one IRP every 4 years, and one PBW every other year is approximately $7M. This is just the hardware cost; engineering costs for redesign, etc., are in addition to this cost. SNS currently has one original style spare target, with eight on order in various stages.

Target delivery is slipping routinely, costs are rising, and vendors are less likely to bid on new targets. In an attempt to address the manufacturing challenge, SNS is starting a pilot target manufacturing program to improve the process and improve program control by breaking orders into components to widen the vendor pool and reduce risk.

Recommendations

See Charge Question 9.

Target Operations

Observations and Comments

A leak in IRP-1 was the major contributor to unavailability of the target station in 2017, while stable operation of the target at 1.2 MW was achieved without any major problems giving confidence for the planned power increase to 1.3 MW and 1.4 MW.

The Source Development & Engineering (SDE) team has developed many improvements aimed at increasing the reliability of target operation, i.e., target vessel lifetime, at high power levels. Sometimes more than one major improvement was introduced to a new target vessel, making it somewhat difficult to distinguish which improvement had the biggest impact. Therefore, introducing fewer changes/improvements per target, especially as long as three targets are utilized per year, should be considered.

The comprehensive PIE of spent targets is an extremely useful tool to determine the effectiveness of newly implemented design changes. By now it can be done on a nearly routine basis at SNS, which is very impressive. This is unparalleled among all major spallation neutron sources.

The team has successfully developed a robotic laser-line scanning system for inspecting samples from spent targets.

In T19 a blockage of the orifice openings in gas injection systems had occurred reducing significantly the capability to inject gas into the mercury.

Recommendations

1. A robotic laser-line scanning system for determining the thickness of the walls of the target nose is a very useful improvement and should be fully deployed and utilized in the service bay.
2. The flowrate of the orifice gas injection system should be checked at the manufacturer prior to shipment to SNS in order to be corrected if some blockage has occurred.

Target Systems – Remote Handling

Observations and Comments

The team responsible for the remote handling system development and operations is working very professionally. All major steps of non-routine operations are practiced in mock-ups and optimized in order to ensure maximum safety to the workers and optimal results.

With successful completion of the first IRP replacement, they now have a proven record in all major planned remote handling operations.

Photo-neutron emission by the beryllium reflector within the spent IRP was found to lead to excessive background on the detectors of a nearby instrument. Measures were expeditiously taken to minimize the impact using spare shielding materials.

Recommendations

1. A new exchange flask for the lower part of the IRP should be designed in such a way that photo-neutrons coming from the reflector material are better shielded in the future.

Target Systems – Mercury Target Engineering

Observations and Comments

Seven of the eighteen target vessels used at SNS have developed mercury leaks in service, necessitating unplanned replacement and facility down-time. It should be noted that three of these seven targets exceeded nominal lifetime expectations but were intentionally run to end-of-life.

Mercury leaks are caused by fatigue failure due to high-cycle pressure waves and low cycle thermal loading, which in some cases appeared to be aggravated by mercury cavitation erosion of surfaces.

The Target Management Plan (TMP) has provided reliable operation for SNS users, and key operational data on target performance. The mercury target engineering team still faces challenges but is moving forward in a determined and deliberate fashion.

Strain reduction was achieved with very low gas flow rate, leading to the supposition that injection of more gas could lead to further strain mitigation. High radiation dose rates were observed at the mercury pump. Understanding why this occurred, in particular from the viewpoint of safety, should be pursued. The relationship between the bubbler position and the bubble distribution in the flowing mercury, and the effect of accumulated gas somewhere in the loop as well, should be considered in this evaluation.

It is good news that gas injection also appears to have mitigated cavitation damage, and no cracks. Collaboration with numerical simulation experts to understand the interaction between bubbles, pressure waves, and elastic deformation of the vessel should be pursued.

The surprising erosion observed in the T16 jet-flow target suggests that locally high velocity led to unexpectedly high erosion. Understanding the erosion mechanism for this target might be very helpful in informing both incremental improvements needed to sustain reliable operations and to develop PPU targets.

Recommendations

1. Make an effort to understand the mechanism of the erosion in the case of T16 jet-flow target.

Target Systems – Target Gas Injection

Observations and Comments

Very promising results were obtained with the swirl bubblers in off-line tests. Pressure drop is acceptable and bubble size generated is smaller than expected. The swirl bubbler is ready for operation and only fabrication details need to be set. A check of the mechanical properties is advised if 3D printing is used to manufacture the swirl bubbler that will be implemented in the production target vessel. Further collaboration with the J-PARC team working on swirl bubblers is encouraged. They developed a 2-vane bubbler that indicates lower pressure drop as compared with a 4-vane bubbler.

Experimental and numerical results for the gas wall layer concept show encouraging progress. Experimental and numerical analysis activities aimed at exploring more suitable conditions should be sustained. Also, pursuing a ramp-up in the gas flow rate that is more rapid than the currently planned ramp-up schedule is highly encouraged. Finally, flow erosion due to the jet-flow with gas wall should be considered, in particular using the TTF loop to demonstrate no-effect should be evaluated.

Recommendations

1. Continue to collaborate with the J-PARC team, particularly in the area of vane bubbler development.

Target Systems – Post Irradiation Examination (PIE)

Observations and Comments

The PIE team is commended for achieving impressive PIE work and developing PIE techniques over the past year. Eight PIE activities are performed on each spent target as part of standard operating practice. In addition to identifying any leak locations and erosion damage, target vessel material samples are evaluated for changes in mechanical properties. Such efforts have been central to decisions on raising the DPA limit for operational targets.

PIE activities continue to be the best tool for the evaluation of the effects of target design changes and validating simulations. Without successful PIE, evaluating new features, such as jet-flow or small gas bubble injection, would be difficult and less certain. Management has recognized these benefits and has fully supported the PIE efforts.

Some highlights of the past year's PIE activities include:

- Confirmation that increasing mercury flow velocity (T13 target and on) has resulted in less center baffle damage (i.e., no center baffle cracks have been found in T13 and onward).
- Jet-flow targets (T16 and T17) showed reduced erosion in corners of outer wall, but increased erosion (vertical striping) in the central area of the inner wall. In addition, T17 (operated at 16% higher average power) showed evidence of pitting in the corners extending to a depth of about 1/3 of the full wall thickness. This led to the speculation that the higher local mercury velocities help mitigate pitting initiation, but perhaps increase pitting rate once initiated. Simulations showed a higher saturation time in the corner areas with the jet flow (longer time with the mercury in tension).
- A robotic arm was added to the laser-scanning set-up to enable scanning high activity samples without dose to operator and which may result in higher quality scans. This is a very good application of newly available commercial technology to extend the capabilities and improve the quality of the PIE efforts.
- The proton beam window made from Inconel 718 was sampled and tensile tested using Digital Image Correlation (DIC). Results showed 10% elongation remained even up to 10 DPA, which does not agree with literature data. The TAC wonders if decay heat, especially if the sample was enclosed in a container, could be enough to anneal some of the displacement damage post-operation.

Currently, consideration is being given to PIE activities on the aluminum proton beam window. Due to the level of observed corrosion and the off-normal results from the Inconel 718 window, the TAC encourages PIE activities on Al PBW samples. The TAC notes that there have been reports from studies performed for the Accelerator Production of Tritium project indicating pitting corrosion may exhibit in the presence of irradiation.

Recommendations

None

Target Systems – Target Development Plan for 2.0 MW PPU

Observations and Comments

The general goals of the 2 MW PPU target development plan include applying the entire set of alternatives currently being explored to reduce fatigue stresses and combat cavitation erosion. This includes jet-flow, small bubble gas injection (with swirl bubblers), gas-wall, and general design exploration to reduce fatigue stresses and increase inspectability. This seems appropriate because it is not yet clear that current results can be extrapolated to higher beam powers and/or higher gas flow rates. It should be noted that the goals for gas bubble injection are based on tests run many years ago at the WNR beam-line at LANL, while optimal jet-flow velocities are currently undetermined. So, it is very difficult to tell at this point what is required for stable 2 MW operation. It is therefore prudent to pursue all beneficial design features within the 2 MW PPU target development plan.

However, it is also currently unknown how some of these mitigation techniques may interfere with each other. Although PIE of spent targets and gas injection R&D have been executed at an extremely high level of confidence with promising results, not much time exists for further studies before the PPU 2 MW target final design is due to be completed (~1½ years). For instance, the goal for gas wall (60%) coverage is a 5 cm wide area, but with jet-flow velocities, will the uncovered areas see rapid erosion as in T16 and T17? In this case, the PPU target team should be cognizant of what features can be easily "turned off" (e.g. gas-injection can be turned off, but jet-flow cannot).

Several advances in design studies have been made, such as the possibility to eliminate the center baffle (dilatational mode suppression acceptable) and the use of automated design exploration. The latter resulted in a predicted decrease of ~30% in the "minimum of maximum stresses." These design studies have been very fruitful, but the team must be careful in applying the results since optimization studies can be highly dependent upon parameters that are held constant for a particular exploration study. If those parameters are different (for various reasons) in the final design, the resulting stress fields may be different than predicted.

As PIE results and operational experience with the next few iterations of 1.4 MW targets come in, the TMP should be updated considering the PPU 2 MW target final design configuration. The resulting TMP should balance:

- First establishing operational robustness for 1.4+ MW operations
- Testing PPU 2 MW target design features and scaling effects

Ideally, the above "balanced" TMP would result in a 1.4 MW operational target (chinstrap +) capable of running at higher powers as a potential back-up for the PPU 2 MW target should it fail prematurely.

Recommendations

1. Continue pursuing all beneficial design features in the PPU 2 MW target design while keeping in mind the potential for interferences between the techniques as well as considering methods to possibly mitigate any such interferences.
2. After establishing 1.4+ MW reliable operation, proceed with plans for early operation of the PPU 2 MW target before the long shut-down, coordinating and integrating the plan with 1.4 MW operations to achieve a balanced TMP.

VII. Pulsed Power and Electrical Systems

Topic: RF Systems

Observations and Comments

The RF systems team is doing an excellent job evolving their maintenance and upgrade activities to enhance the reliability of these systems through the Stewardship Program (ongoing review/revision of operational procedures to enhance component lifetime, e.g. reducing cooling water flow rates).

The on-going replacement of RF circulators is improving operational reliability of RF systems.

The on-going purchase of klystron spares is important to assure operational reliability.

Based on SNS operational experience, second source replacements for Thales klystrons should be developed, to assure operational reliability.

PPU will require development of a vendor for 3 MW klystron for DTL.

Commissioning of the new LLRF system for the ring should be a priority to provide operational experience, as this system will serve as the basis for the PPU LLRF.

Recommendations

1. Operations funds should be provided ASAP to develop 2nd source for 5 MW klystron.
2. PPU funds should be provided ASAP to develop source for 3 MW klystron.

Topic: High Voltage Converter Modulator

Observations and Comments

The committee is pleased to see the implementation of pulse flattening in all HVCMs, which increases the RF overhead and also reduces the electrical stress and should ultimately improve HVCM reliability.

Although the HVCM failures still account for the largest block of unplanned outages, this is trending down. The ongoing system improvements are increasing operational reliability, demonstrating the efficacy of the evolution of the preventative maintenance activities, e.g. replacing booster caps, primary buss, voltage dividers, etc.

Reliability and MTTR is improved by replacing the existing oil cooling system (AIP-36) and this upgrade should be implemented on all HVCMs. Interim replacement of the pump motors (prior to upgrade) is improving operational reliability.

The FR3 dielectric fluid is reaching end-of-life and should be replaced in all HVCMs.

The planned upgrade of the IGBT gate drive circuits will have an added benefit of providing a pathway to replacement of discontinued IGBTs.

The TPC arrays are a promising replacement for the resonant boost capacitors.

The laminated buss to connect energy storage to the switch plates greatly reduces the parasitic effects of the original coaxial cables and should be introduced as an upgrade to the existing HVCMs.

The Alternative Topology HVCM (AT-HVCM) is a promising design for new installations and future upgrades. Most significantly, this design eliminates the voltage reversal on the resonant boost capacitor, which should significantly increase boost capacitor lifetime. The failure of these capacitors continues to be a significant cause of HVCM failures. Initial testing of the AT-HVCM identified oscillations during turn-on as a significant concern, but these have been eliminated with the addition of a by-pass diode. This topology now appears to be viable for the PPU. The HVCM team should continue to develop the AT-HVCM as the baseline design for the 3 new PPU modulators and select the best topology for the application at the beginning of CY2019 as proposed.

The PPU will place significant demands on the HVCM system team. Three additional HVCMs will be required. A new HVCM "tune" must be developed for the 3 MW DTL klystrons. Further, although the SCL HVCMs have been demonstrated at the voltage/power required for the PPU, data for CCL should be evaluated to determine if higher voltage qualification of this "tune" is required prior to CD-3. We encourage management to fill the open position for the PPU Power Electronics engineer to alleviate concerns over the additional work load inherent in the PPU scope, so the existing team doesn't lose focus on operational improvements.

Recommendations

None

Topic: AC Power Distribution Systems

Observations and Comments

The AC power distribution system is part of the foundational infrastructure on which the SNS facility is built. However, there is often a lack of integration between the stewardship of facility and experimental program infrastructures. The integration of Electrical Power Systems into RAD Electrical and RF Systems can be an effective step in addressing these challenges. Equally important is that the resource needs for the maintenance and upgrade of the electrical power systems be addressed in the same fashion as any other technical system.

The SNS AC power distribution system maintenance needs may be evolving with the aging of the infrastructure. This has been experienced by other Labs in the DOE complex and it may be worthwhile to reach out to technical experts at those facilities to benefit from their experiences.

There is a deficiency of long-lead spares (e.g. transformers) that could lead to extended operational interruption if the failure rate continues to rise.

ORNL has migrated to a new communications standard for AC power systems (Schneider Electric ION) that is incompatible with much of the SNS infrastructure.

Recommendations

1. Request funding from ORNL management to upgrade SNS infrastructure to be compatible with the new ORNL standard (Schneider Electric ION).

2. The priority for AC power system upgrades and obsolescence replacements should be evaluated using the project prioritization process.

VIII. Controls

Observations and Comments

Responses to last year's recommendations were:

- Evaluation of archivers was started but put on hold due to resource limitations
- A review was held to assess the suitability of the uTCA solution. This validated the selection of uTCA. Time is also proving this to be a good decision.

Work on CS-Studio (CSS) continues to progress. Particularly notable is the decision to proceed without the use of the Eclipse framework. This has made CSS a much lighter weight tool, and should remove many of the barriers to adoption. It is encouraging to see collaboration with other developers here. We encourage continued development.

Controls is the system integrator of a facility. The team has been heavily engaged supporting the many initiatives undertaken by the SNS, including some large projects undertaken during the long outage. These include:

- New RFQ
- Extensive Front End improvements
- New Target with gas injection
- First IRP replacement
- Conversion to heavy water
- Personnel Protection System (PPS)

The completion of the remediation program for the PPS grounding issue on the accelerator is notable. It has taken a number of years and it is good to see the team see it through. Assessment of the Target PPS will follow.

From a facility-wide perspective, it is good to see Controls expertise being used to address some beamline improvements, for example standardization of vacuum controls. Exploiting synergies such as this benefit the whole facility. We note the instrument controls group has been moved from RAD. It is important that senior management continue to facilitate the synergistic relationship between these groups and their capabilities.

The heavy workload during the outage together with emergent requirements meant that some Controls specific tasks have been delayed. The team will endeavor to tackle these during the coming run.

We note that the amount of work being planned by the facility that will involve and be dependent upon Controls is considerable. The PPU project will add to this as well. It would be prudent to assess the level of staffing for EPICS application and Software application to ensure sufficient support can be provided. This area could become a bottleneck.

Obsolescence issues have started to be addressed, notably procuring new Machine Protection System (MPS) hardware that will be extensible to meet PPU requirements. A package is being assembled to bid for AIP funds next year. The committee notes that if full AIP funding is not available it may be necessary to address some obsolescence issues via a multi-year rolling program funded from operations.

With the ability of new systems to capture data at the 60Hz rate, demands on the network infrastructure will increase. The availability of structured data in EPICS 7 will drive up data volumes as scientists and engineers discover the benefits of this. The current infrastructure is approximately 10 years old and is approaching obsolescence (if not already obsolete). The facility will need to fund modernization of the network if it wishes to benefit from the improved instrumentation. The network is the nervous system of the facility; reliable operation requires a dependable, robust network.

Recommendations

1. The facility must look ahead to forecast network requirements post PPU and invest in network renewal to meet those requirements. The network is a foundation. It important to ensure network infrastructure provides adequate capability for the PPU.

IX. Diagnostics

Observations and Comments

The committee was pleased to hear of the progress for the replacement of BPM and BLM electronics under AIP-37 due to obsolescence, and encourages progress for other diagnostics. The new BPM electronics is capable of data acquisition at a rate of 60 Hz instead of 1 Hz. This will open up many new possibilities for diagnostics.

A precise foil temperature measurement system is being developed. It is important and necessary to measure the stripper foil temperature at present operating currents to predict foil lifetime. Measurements using thermal imaging are promising and are encouraged.

The committee congratulates SNS for the pioneering work on 6D phase space measurements of the beam at BTF and encourages further refining the data taking process.

Recommendations

1. The group is over-subscribed; consider ways of adding to this group approaching the PPU.

X. Proton Power Upgrade and Second Target Station

Observations and Comments

Second Target Station (STS) Project activities were suspended in June 2017 to focus on PPU. After a period of FY18 funding uncertainty, CD-1 was approved by DOE in March 2018 with $36M of funding. Although the project has had a number of items ready to go, the project staff are moving quickly to wisely use this funding. Although the vast majority of PPU hardware is replication of existing equipment, there is a list of development items that are being pursued.

WBS	Task	Funding
RF	3MW Klystron design, prototyping, and testing	PPU
	3MW modulator development, prototyping, and testing	PPU
	Low-Level RF control system development	PPU
	Alternate-Topology modulator development, prototyping, and testing	PPU
Ring	Mirror Development & Prototype	PPU
	Extraction Kicker Resonant Charging Supply	PPU
	Injection Kicker Power Supply Development	PPU
	Stripper Foil Temperature Measurement System	PPU / Ops
Target	Ortho-Para Hydrogen Diagnostic components	PPU
	2MW target development	PPU
	Development of infrastructure needed for high-flow gas injection	PPU / Ops
Controls	Control Systems Software Development / EPICs	PPU
R&D	Gas Injection in Mercury	PPU
	Gas Injection in Water	PPU
	Stripper Foil Development	PPU

The committee views this list of development items as needed and relevant to the project. Comments are made on specific items in other sections of this report.

In addition to pursuing the early development work, the project is ready to go with some long lead procurement items. However this will require the approval of CD-3. We encourage the project to work with BES in order to move forward with approval of CD-3.

The project has begun to identify key people for project positions. Given the early stage of the project (i.e., pre CD-2) the staff remains largely matrixed, but project and PPU management are discussing transitions and allocation of effort. Postings for project positions have been made.

Effective matrixing of the SNS staff such that both operations and the project can effectively be done is essential, and must be reevaluated annually as funding availability is made known. (Objective B)

The recent 2018A shutdown was a good step forward in using Primavera scheduling tools to manage work and help prepare the organization for PPU work.

It was reported that the PPU has a proposed key performance parameter that requires achievement of "Target operational time without failure of 1,250 hours at 1.7 MW."

- Having such an operational goal required before project completion appears to unnecessarily impose a serious risk to success; any difficulties encountered in operation, even those unrelated to the target or even any of the equipment included in the PPU project, would lead to a delayed project completion and additional project costs.

Recommendations

None

XI. Charge Question 1: Are the SNS responses and ongoing actions to recommendations from the 2017 AAC meeting satisfactory?

Observations and Comments

Yes. The SNS has been very responsive to last year's recommendations. The committee is pleased to see the progress that has been made. We concur with the SNS conclusion that the closed recommendations have been dealt with. The one recommendation presented as "unclosed," namely the spare medium beta cryomodule, has received funding and work has begun.

Recommendations

None

XII. Charge Question 2: Do the capability and performance of the accelerator complex and neutron source support achieving Objective A?

Observations and Comments

Since the last meeting, the work carried out in the long outage, alongside other technical developments, has produced a step-change in the present capability of the SNS accelerator. This is the most significant advance in recent years.

Prior to the five-month long outage the accelerator was already capable of meeting Objective A, but with very little operational margin. However, improvements have now been made to remove the bottlenecks of poor RFQ efficiency and the SCL being operated below design energy, enabling accelerator capability of 1.7 MW, and therefore considerable margin for 1.4 MW operations.

The installation of the new RFQ is particularly significant (increasing transmission from ~60 – 75% to >90%) and meets a long-standing recommendation of the AAC. The ACC hopes that performance continues to be as good as the early measurements indicate. Whether spares provision for the RFQ is desirable or essential remains to be addressed.

As recommended last year there has been a comprehensive review of key reliability issues, ageing components and single point vulnerabilities, and progress has been made in addressing many of these (e.g. HVCM upgrades, RF system upgrades, improvement in ion source performance, installation of a new LEBT gate valve, development of a spare medium beta cavity and improvement of the injection foils and electron catcher).

At last year's meeting the answer to the charge question regarding Objective A was a qualified 'yes' as there was still a lot of work that had been identified as needing to be done, particularly focused on the long outage. Now that this work has been successfully completed the answer has moved on to a definite and deserved 'yes'!

Regarding the neutron source, considerable progress is being made in developing targets and it appears that the SNS is on track to meet Objective A (1.4 MW, > 90% availability, 3 target replacements/year) by the end of 2018.

Recommendations

1. Monitor RFQ performance for any deterioration at full operational parameters.
2. Give due consideration to RFQ spares provision.

XIII. Charge Question 3: Is the Prioritization process and Project Planning strategy that has been developed and is in use for outage planning reasonable?

Observations and Comments:

Yes, the prioritization process and planning strategy has clearly matured and been refined since the last AAC meeting.

Re-iterating comments from Operations: The five-month long outage (December 2017 – May 2018) was very effectively managed and has prepared SNS for 1.4 MW operations, with most issues identified at the last meeting having been addressed.

Recommendations

1. Continue to implement and refine the outage planning process as it was developed. This should include implementing lessons learned identified from the long winter outage.
2. The team should review the effectiveness of the three outages per year operating strategy at regular intervals to ensure it remains optimal.

XIV. Charge Question 4: Is the scope of work identified for ongoing and future Accelerator Improvement Projects (AIP) appropriate and balanced between the competing interests of maintaining necessary margin for routine operation at 1.4 MW while addressing system obsolescence?

Observations and Comments

AIPs have shifted in emphasis from addressing initial design problems towards ensuring operations become reliable predictable 1.4MW. More recently obsolescence issues have started to impact reliable operations and these are starting to be addressed by the AIP process too.

Obsolescence can be a difficult issue to quantify and prioritize. The staff want to be good stewards of the machine, but unless an old system is demonstrably causing problems it can be difficult to compete for resources in a fiscally constrained environment.

The idea to quantify and model failure rates is a good one and is important. Obviously, this can only work when the sample size is big enough.

The prioritization system introduced attempts to measure the impact to the facility of the disparate requests for project funding. This seems to be an excellent starting point, providing management with a basis on which to make prioritization decisions.

The balance between the competing interests of maintaining necessary margin for routine operation at 1.4 MW while addressing system obsolescence seems fair.

The committee recommends that all projects go through the same prioritization process. Those that rise high enough and that fit AIP rules should use AIP funding.

In order to get a better picture of AIP/modernization funding required it could be worth costing (to first order) all obsolescence and operations (sometimes known as mission readiness) projects on the wish list. With that total known, a better appreciation of the level of funding and phasing required may be obtained.

From what the committee saw, an annual rate of $4M - $5M for infrastructure investment seems reasonable.

Recommendations

1. Put all AIPs through the project prioritization process. Those that rise enough and that fit AIP funding rules should be funded as AIPs.

XV. Charge Question 5: Is the Accelerator R&D plan presented appropriately positioned to widen collaborations and to leverage external resource support?

Observations and Comments

The accelerator R&D plan is focused on areas of both facility need and technological strengths at SNS: high power, high intensity, and SCLs.

R&D efforts are aimed at improving performance of the SNS accelerator and/or solving challenges for the high-power/high-intensity accelerator community.

The R&D program is experimentally focused and includes a number of novel technologies – 6D beam dynamics, laser stripping, and SRF cavity surface process characterization and improvement – that are broadly applicable to the community and therefore are good candidates for external funding and for collaborations with other hadron accelerators (Fermilab, Los Alamos, BNL).

The SNS team has been aggressive and quite successful in pursuing external funding. However, these resources are shrinking and the competition for these limited resources is fierce.

It is therefore important that the NScD directorate support the R&D internally between external funding cycles, as it is not likely that projects will be funded on a continuous basis and it is important to maintain momentum.

As the only accelerator-based directorate at ORNL, it is important that NScD champion the important field of accelerator R&D as an ORNL strategic area, allowing and encouraging LDRD proposals. In addition to providing some needed money, it is vital to show laboratory support to to draw future external funding once the initial internal investment is made.

Recommendations

1. The committee recommends that NScD advocate for a strategic ORNL initiative in Accelerator R&D.

XVI. Charge Question 6: Are the PPU pre-CD-2 activities properly focused?

Observations and Comments

Yes, development work is proceeding.

- A number of the development items have been covered in the talks in those areas. These include SRF, power systems, foil development, controls and targets.

The project has identified and is pursuing long lead procurement items. The project is in process of contracting an AE firm to assist in planning the klystron gallery equipment layout (3D model).

Recommendations

None

XVII. Charge Question 7: Is the SNS Target Management Plan a reasonable approach to improving both performance and understanding of SNS mercury targets?

Observations and Comments

Yes, besides serving the purpose of focusing efforts on target development, which is so critical to the success of SNS operations as well as the PPU Project, the TMP integrates efforts across the Directorate, i.e., integrates and balances target development goals with machine operations (RAD) and science program goals.

Recommendations

1. Continue to evaluate and revise the TMP on a regular basis as new information is learned.

XVIII.Charge Question 8: Have lessons learned from the IRP-01 and IRP-02 experiences been adequately considered in the design and fabrication plan of the next-generation IRP (IRP-03)?

Observations and Comments

Yes. Numerous issues with IRP-1 operation and IRP-2 fabrication and installation have been identified and have been accounted for in the design and approach to IRP-3. These include moderator welding, alignment issues, cadmium spraying, pipe chases added back in from the IRP-1 design which were left out of IRP-2, elimination of right angles on the cryogenic moderator feedlines (mitre bends), etc. Most importantly, the approach to IPR-3 has identified the difficulty in fabrication and is addressing it by building components in stages and assembling at the end, either on site or at a vendor.

Recommendations

None

XIX. Charge Question 9: Is the major procurement planning sufficient for controlling long term cost and improving component manufacturing reliability?

Observations and Comments

SNS procurement planning is sufficient to ensure improvement of component manufacturing reliability. However, as only a very limited number of target vessel suppliers with adequate manufacturing skills are available on the market, it is nearly impossible to control the long-term target costs. A reasonable approach could be to seriously consider production of the target in house or at least parts of it. Even if this means extra investment in the near-term, we are convinced that it will pay off over the longer term. Another approach might be to award incentive-type contracts for the target vendor based on succeeding in delivering the required quality in due time.

Recommendations

1. Ensure the target, IRP, and the Proton Beam Window (PBW) manufacturing program is successful by providing the required resources.
2. Consider ways to utilize ORNL expertise to support the success of SNS and PPU, such as leveraging advanced manufacturing for complicated target components (e.g. 3D printing of metal structures).

XX. Charge Question 10: Is the proposal for early use of the 2 MW PPU target in operations reasonable?

Observations and Comments

A qualified Yes. The PPU target design is moving from conceptual to preliminary design level. It is not clear which design features beyond those already identified in the TMP can be explored during early operation.

The preceding 1.4 MW target design iterations (chinstrap +) are unknown and may not converge with the chosen PPU target design. If the PPU design presents a large departure, the risk to operations may be greater and separate effects analysis may be complicated. With the above caveat, the cons presented appear to be manageable, so there is little down-side.

A strategy to make this decision should include documenting what design features and manufacturing prototyping questions can be explored (beyond the current TMP) with early operation versus what cannot be explored with early operation, e.g. effect of tapered nose can be explored, but gas-wall cannot.

Recommendations

None

XXI. Charge Question 11: Do the benefits proposed from the PPU 2 MW target design changes outweigh additional potential complexities?

Observations and Comments

It appears too early to answer this question due to:

- The benefits of each of the PPU 2 MW design features are not fully understood yet (scaling to higher beam power and higher gas flow rates; combined effects of jet-flow, gas bubbles, and gas wall, etc.).
- The consequences of potential complexities not quantifiable yet since the 2MW target is early in the design phase (cusp of preliminary design).

A similar question that can be answered now is:

- Should all pressure wave and cavitation damage mitigation techniques, identified thus far, be explored/included in the design of the PPU 2 MW target?
    - Given the time constraints and unknowns, Yes

Recommendations

None

Appendix A: AAC / TAC Committee Members 2018

Accelerator Advisory Committee

Name	Affiliation	E-mail Address
Burkhart, Craig	SLAC National Accelerator Laboratory	burkhart@slac.stanford.edu
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Target Acceleratory Advisory Committee

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Appendix B: AAC / TAC Meeting Agenda 2018

May 15-17, 2018

Building 8600

Event Contact: Lisa Eady, 865-574-0557 (office); 865-567-7202 (mobile); eadylb@ornl.gov					
Tuesday, May 15, 2018					
Time	Length	ID	Event	Lead	Location
7:30-8:00 am	*30*		*Badging at the Guest House for the U.S. Citizens* *Badging at the Visitor Center for the Foreign Nationals*	*Committee*	
8:00-8:30 am	30		Executive Session	Committee / Fulvia Pilat	C-156
8:30-8:50 am	20	P1	Directorate Perspective – Neutron Sciences Directorate (NScD) Overview	Paul Langan, Associate Lab Director, NScD	C-156
8:50-9:20 am	30	P2	Accelerator and Target Systems Management Overview and Responses to 2017 AAC Recommendations	Fulvia Pilat, Director, Research Accelerator Division (RAD)	C-156
9:20-9:50 am	30	P3	Spallation Neutron Source (SNS) Operations Performance Metrics	Glen Johns, Group Leader, Accelerator Operations	C-156
9:50-10:05 am	15		Discussion	All	C-156
10:05 –10:25 am	*20*		*Morning Refreshment Break*	*All*	
10:25-11:05 am	40	P4	Overview of Proton Power Upgrade (PPU) and Second Target Station (STS) Projects	John Galambos, Director, SNS Upgrades Office	C-156
11:05-11:45 am	40	P5	Status of Technical Initiatives to Support 1.4 MW Reliable Operations	Sarah Cousineau, Group Leader, Beam Science and Technology (BeST)	C-156
11:45 am – 12:15 pm	30	P6	Overview of Target Status for the First Target Station	Mark Wendel, Group Leader, Source Development and Engineering Analysis	C-156
12:15-1:15 pm	*60*		*Working Lunch / Report on PPU Upcoming Reviews*	*Pick up lunch in C-150 and return to C-156 to eat*	*C-150*
1:15-1:55 pm	40	P7	Overview of Inner Reflector Plug (IRP) Issues	Graeme Murdoch, Director, Neutron Technologies Division (NTD)	C-156
1:55-2:15 pm	20		Discussion	All	C-156
2:15-2:35 pm	*20*		*Afternoon Refreshment Break*	*All*	
2:35-2:55 pm	20	P8	Accelerator Improvement Project (AIP) Investment Strategy	George Dodson, Deputy Director, RAD	C-156
2:55-3:15 pm	20	P9	Outage Planning	Glen Johns, Group Leader, Accelerator Operations	C-156
3:15-3:55 pm	40		Discussion	All	C-156

Tuesday, May 15, 2018 (cont.)					
Time	Length	ID	Event	Lead	Location
3:55-5:30 pm	95		Executive Session / Adjourn at 5:30 pm	Committee only, others at Committee request	C-156
6:00-8:00 pm	*120*		*Dinner and Discussion led by Fulvia Pilat, Topic: Accelerator Science & Engineering at ORNL – at Lakeside Tavern in Knoxville*	*Committee and Presenters*	*Private Room*

Wednesday, May 16, 2018					
Time	Length	ID	Event	Lead	Location
8:00-9:30 am	90		Tour of SNS Accelerator / Target Facilities. Depart from Conf. Room C-156.	George Dodson / Mike Baumgartner, Group Leader, Mechanical Systems & Operations	C-156
9:30-10:00 am	30		Executive Session	Committee Only	C-156
Accelerator Breakout Sessions					
10:00-10:20 am	20	A1	The R&D Plan	Sarah Cousineau, BeST	C-156
10:20-10:40 am	20	A2	Beam Test Facility Performance Update	Sasha Aleksandrov, Team Leader, BeST	C-156
10:40-11:00 am	*20*		*Morning Refreshment Break*	*All*	
11:00-11:20 am	20	A3	Linac Beam Dynamics: Measurement and Simulation	Andrei Shishlo, Accelerator Physics	C-156
11:20-11:40 am	20	A4	Laser Stripping Experiment Status	Yun Liu and Abdurahim Rakhman, Beam Instrumentation & Experimental Technology	C-156
11:40 am–noon	20	A5	Stripper Foil R&D	Nick Evans, Accelerator Physics	C-156
12:00-1:00 pm	*60*		*Working Lunch / Long Range Plan for SNS*	*All*	*C-150*
1:00-1:20 pm	20	A6	Self-Consistent Beam Distribution	Jeff Holmes, Accelerator Physics	C-156
1:20-1:40 pm	20	A7	SCL Status, SRF Activities	Sang-ho Kim, Group Leader, Superconducting Linac Systems (SCLS)	C-156
1:40-2:00 pm	20	A8	Controls Status and Machine protection (MPS) Upgrade	Karen White, Group Leader, Control Systems	C-156
2:00-2:20 pm	20	A9	Status of Accelerator RF Systems	John Moss, Manager, High-Power RF	C-156

Wednesday, May 16, 2018 (cont.)					
Time	Length	ID	Event	Lead	Location
Accelerator Breakout Sessions (cont.)					
2:20-2:40 pm	20		Discussion	All	C-156
2:40-3:00 pm	*20*		*Afternoon Refreshment Break*	*All*	
3:00-3:20pm	20	A10	Beam Diagnostics Systems, Status and Upgrade	Sasha Aleksandrov	C-156
3:20-3:40 pm	20	A11	Status of Linac High Voltage Converter Modulator Upgrades	Dave Anderson, Manager, High Voltage & Pulsed Power	C-156
3:40-4:00 pm	20	A12	AC Power Distribution Systems	Kevin Norris, Manager, Electrical Power Systems, Accelerator & Target Support & Instrument Development; and Robert Eason, Engineering - Site Operations	C-156
4:00-4:55 pm	55		Discussion	All	C-156
4:55-5:35 pm	*40*		*Break*	*All*	
5:35-6:05 pm	30		Executive Session / Questions for SNS Management	Committee only, Others at Committee request	C-156
6:05-6:35 pm	30		Executive Session	Committee only, Others at Committee request	C-156
Target Breakout Sessions					
10:00-10:10 am	10	T1	Source Development and Engineering Progress	Mark Wendel, Group Leader, Source Development and Engineering	C-152
10:10-10:40 am	30	T2	PIE Update on Targets	David McClintock, Development	C-152
10:40-11:00 am	*20*		*Morning Refreshment Break*	*All*	
11:00 am-Noon	60	T3	Mercury Target Engineering	Drew Winder, Team Leader, Mercury Target Engineering	C-152
12:00-1:00 pm	*60*		*Working Lunch / Target Strain Mitigation Due to Gas Injection*	*All*	C-152
1:00-1:40 pm	40	T4	Remote Handling in Target Systems	Michael Dayton, Team Leader, Target Systems	C-152
1:40-2:20 pm	40	T5	Inner Reflector Plug Performance and IRP-3 Design	Jim Janney, Target Systems	C-152
2:20-2:50 pm	30	T6	Major Procurements Planning and Vendor Management	Peter Rosenblad, Team Leader, Manufacturing	C-152

Wednesday, May 16, 2018 (cont.)					
Time	Length	ID	Event	Lead	Location
Target Breakout Sessions (cont.)					
2:50-3:10 pm	20		Discussion	All	C-152
3:10-3:30 pm	*20*		*Afternoon Refreshment Break*	*All*	C-152
3:30-4:15 pm	45	T7	2 MW Target Development and PPU Upgrade Plans	Bernie Riemer, Team Leader, Development	C-152
4:15-4:45 pm	30	T8	Gas Injection Development	Charlotte Barbier, Development	C-152
4:45-5:15 pm	30		Discussion	All	C-152
5:15-5:35 pm	*20*		*Break*	*All*	
5:35-6:05 pm	30		Executive Session / Questions for SNS Management	Committee only, Others at Committee request	C-156
6:05-6:35 pm	30		Executive Session	Committee only, Others at Committee request	C-156
Thursday, May 17, 2018					
Time	Length	ID	Event	Lead	Location
8:00-10:30 am	2:30		Executive Session / Management Response to Questions	Committee Only	C-156
10:30 – 11:30 am	60		Closeout	All	C-156

Appendix C: AAC / TAC Recommendations

1. Keep producing and analyzing the high-quality performance metrics that have proved so useful up to now.
2. Make room available to the BTF to fully utilize its potential. This BTF offers the possibility to expand SNS beam physics, collaboration and outside funding contributions.
3. Consider moving SNS operations to the external antenna ion source as soon as reasonably possible to obtain the benefit of longer lifetime and reduce vulnerability. This new design will not only benefit SNS but the community.
4. Consider ordering an RFQ spare after verification of performance to guarantee long-term operations.
5. In order to assure the full use of the SCL test facility during the PPU construction, e.g. for power coupler testing and conditioning, the use of the RF power source independently from the beam test facility is necessary. We recommend a dedicated HVCM for the SCL test facility klystron.
6. To com ply with the R&D goal to probe SRF surfaces, a clean chemistry bench for BCP and EP sample treatment is recommended.
7. A figure of merit for charge exchange foil must developed for 2.8 MW beam power.
8. The IRP design and associated manufacturing initiative should be given high priority by Directorate management to deliver IRP-3 on a reasonable time scale.
9. Be sure to look at all issues which may determine the lifetime of the IRP, and not just the moderator poison thickness.
10. A robotic laser-line scanning system for determining the thickness of the walls of the target nose is a very useful improvement and should be fully deployed and utilized in the service bay.
11. The flowrate of the orifice gas injection system should be checked at the manufacturer prior to shipment to SNS in order to be corrected if some blockage has occurred.
12. A new exchange flask for the lower part of the IRP should be designed in such a way that photo-neutrons coming from the reflector material are better shielded in the future.
13. Make an effort to understand the mechanism of the erosion in the case of T16 jet-flow target.
14. Continue to collaborate with the J-PARC team, particularly in the area of vane bubbler development.
15. Continue pursuing all beneficial design features in the PPU 2 MW target design while keeping in mind the potential for interferences between the techniques as well as considering methods to possibly mitigate any such interferences.
16. After establishing 1.4+ MW reliable operation, proceed with plans for early operation of the PPU 2 MW target before the long shut-down, coordinating and integrating the plan with 1.4 MW operations to achieve a balanced TMP.
17. Operations funds should be provided ASAP to develop 2nd source for 5 MW klystron.
18. PPU funds should be provided ASAP to develop source for 3 MW klystron.
19. Request funding from ORNL management to upgrade SNS infrastructure to be compatible with the new ORNL standard (Schneider Electric ION).
20. The priority for AC power system upgrades and obsolescence replacements should be evaluated using the project prioritization process.

21. The facility must look ahead to forecast network requirements post PPU and invest in network renewal to meet those requirements. The network is a foundation. It important to ensure network infrastructure provides adequate capability for the PPU.
22. The group is over-subscribed; consider ways of adding to this group approaching the PPU.
23. Monitor RFQ performance for any deterioration at full operational parameters.
24. Give due consideration to RFQ spares provision.
25. Continue to implement and refine the outage planning process as it was developed. This should include implementing lessons learned identified from the long winter outage.
26. The team should review the effectiveness of the three outages per year operating strategy at regular intervals to ensure it remains optimal.
27. Put all AIPs through the project prioritization process. Those that rise enough and that fit AIP funding rules should be funded as AIPs.
28. The committee recommends that NScD advocate for a strategic ORNL initiative in Accelerator R&D.
29. Continue to evaluate and revise the TMP on a regular basis as new information is learned.
30. Ensure the target, IRP, and the Proton Beam Window (PBW) manufacturing program is successful by providing the required resources.
31. Consider ways to utilize ORNL expertise to support the success of SNS and PPU, such as leveraging advanced manufacturing for complicated target components (e.g. 3D printing of metal structures).