

PROTON POWER UPGRADE (PPU) PROJECT

CD-2/3 Lessons Learned



December 2020

Spallation Neutron Source - Proton Power Upgrade Lessons Learned for Post CD-2/3

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**Spallation Neutron Source - Proton Power Upgrade
Lessons Learned for Post CD-2/3**

Project Title: *Spallation Neutron Source (SNS) Proton Power Upgrade (PPU) Project*

Project Location: *Oak Ridge National Laboratory*

Description of Project: *The SNS PPU project is to design, build, install and test the equipment necessary to double the accelerator power from 1.4MW to 2.8MW and to deliver a 2.0 MW qualified target. PPU also includes the provision of a stub-out in the SNS accumulator ring to target tunnel to facilitate a rapid connection to a new proton beamline for the STS project. Doubling of the power will be achieved by increasing the proton beam energy by 33% and peak beam current by 50%, relative to current accelerator performance. The project also includes modifications to some buildings and services.*

PPU will accomplish the energy upgrade by fabricating and installing new superconducting RF cryomodules, with supporting RF equipment, in the existing linac tunnel and klystron gallery respectively. The High Voltage Converter Modulators (HVCM) and klystrons for some of the existing installed RF equipment will be upgraded to handle the higher beam current. The increased beam power of 2 MW will be enabled by the addition of a new high-volume gas injection system for pressure pulse mitigation in the mercury target and a redesigned mercury target vessel.

Cost at CD-2 Approval: \$271.6M

The PPU project has received CD-1, CD-3A, CD-3B, CD-2 and CD-3 approvals to-date. The project baseline was formally established at CD-2,, which was attained in October 2020. The following is the baseline established at CD-2:

OPC (\$M)	TEC (\$M)	Contingency (\$M)	TPC (\$M)
<i>11.8</i>	<i>197.1</i>	<i>62.7</i>	<i>271.6</i>

Schedule at CD-2 Approval:

The following table presents the actual and planned critical decision dates (as documented in the Project Execution Plan).

Critical Decision	Planned Date (Month / Yr)	Actual Date (Month / Yr)
<i>CD-0 - Approve Mission Need</i>		<i>January 2009</i>
<i>CD-1 - Approve Alternative Selection & Cost Range</i>		<i>April 2018</i>
<i>CD-3A – Long Lead Procurement</i>		<i>October 2018</i>
<i>CD-3B – Long Lead Procurement</i>		<i>September 2019</i>
<i>CD-2 – Approve Performance Baseline</i>		<i>October 2020</i>
<i>CD-3 - Approve Start of Construction</i>		<i>October 2020</i>
<i>CD-4 - Project Complete</i>	<i>Q4 FY2028</i>	

**Spallation Neutron Source - Proton Power Upgrade
Lessons Learned for Post CD-2/3**

<i>Schedule contingency</i>	42 months	
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Funding Profile at CD-2 Approval:

The following table presents the funding profile at the time of CD-2.

<i>\$M</i>	<i>Prior Years</i>	<i>FY 2018</i>	<i>FY 2019</i>	<i>FY 2020</i>	<i>FY 2021</i>	<i>FY 2022</i>	<i>FY 2023</i>	<i>FY 2024</i>	<i>FY 2025</i>
<i>Funding Profile</i>	<i>10.8</i>	<i>36.0</i>	<i>60.0</i>	<i>60.0</i>	<i>45.0</i>	<i>25.0</i>	<i>17.0</i>	<i>13.0</i>	<i>4.8</i>

Funding Profile Changes since CD-2, if there are changes: *N/A*

**Spallation Neutron Source - Proton Power Upgrade
Lessons Learned for Post CD-2/3**

Lessons Learned - Successes

Lessons Learned – Successes	Description, Impacts and Solutions
<i>Pro-Active Project Office</i>	<ul style="list-style-type: none"> • <i>Provide support and guidance to the technical teams in development of their schedules, cost estimates, risk identifications, and review preparations.</i> • <i>Open communication with staff through routine weekly meetings with Level 2 managers and monthly meetings with the project staff.</i> • <i>Close communications with DOE Program Office to ensure clear understanding of path forward and ensure early issue resolution.</i> • <i>Work with the Program Office and Federal Project Director (FPD), prior to the final cost and schedule development, to agree on a funding profile, Key Performance Parameters, and project contingencies for key project risks (e.g. COVID-19 pandemic risks). Program Office support of the these elements are key to a successful CD-2 and/or CD-3 approval.</i> • <i>Prior to CD-3, working with the FPD, ensure the Program Office supports the degree of design maturity and the plan for completing outstanding final design activities. For example, PPU had a cost weighted final design maturity of 92% at the time of the CD-2 review.</i>
<i>Assignment of Project Controls Staff</i>	<ul style="list-style-type: none"> • <i>Assign dedicated project controls analysts (PCA) to each Level 2 Work Breakdown Structure area to ensure clarity and consistency in communications between technical staff and project controls. As a result, the PCA’s have good understanding of the technical scope, and the technical staff has a good understanding of the project controls processes. These understandings provided assurances surrounding supporting baseline documentation. Further, it fosters a “team” mindset between the PCA’s and technical staff.</i>
<i>Utilize Tailoring of DOE Order 413.3B Requirements</i>	<ul style="list-style-type: none"> • <i>Long Lead Procurements</i> <ul style="list-style-type: none"> ○ <i>Early procurement of cryomodule components on the project critical path allowed the project to realize a one-year acceleration of the schedule.</i> ○ <i>Early procurement (site preparation) of klystron gallery construction reduced safety and technical concerns of having to perform both conventional</i>

Spallation Neutron Source - Proton Power Upgrade
Lessons Learned for Post CD-2/3

	<p><i>and radiofrequency work at the same time in the tight klystron gallery area.</i></p> <ul style="list-style-type: none">○ <i>Early procurements allow earlier ramp-up of beam power on target.</i>○ <i>Allowed project to address some project cost, schedule and technical risks early in the project.</i>● <i>Phased Critical Decisions</i><ul style="list-style-type: none">○ <i>Allowed project to receive CD-3A and CD-3B approval for early procurement of critical path items.</i>○ <i>Multiple CD-3 phase approvals allow the project to continue to advance and execute a technically limited schedule while a baseline and final designs are established. This allowed the project to receive CD-2 and CD-3 approval concurrently.</i>● <i>Final Design less than 100% (by cost) at CD-2/3 approval</i><ul style="list-style-type: none">○ <i>At CD-2/3 approval, remaining design work was past the preliminary design stage and appropriately supported the CD-2/3 request for approval.</i>○ <i>Prior to issuance of procurements and installation work, for the scope not at 100% design at CD-2/3 approval, the project demonstrates to the FPD that design is completed and that open action items from the design reviews have been resolved.</i>
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**Spallation Neutron Source - Proton Power Upgrade
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Lessons Learned - Improvements

Lessons Learned – Improvements	Description, Impacts and Solutions
<p><i>Understanding of Issues Associated with Matrixed Staffing</i></p>	<ul style="list-style-type: none"> • <i>Impacts: confusion among matrixed staff regarding their priorities and how to handle times when there are resource constraints.</i> • <i>Work with affected organizations and their management teams to clarify priorities and meet operations and project goals.</i> • <i>Availability of experienced staff is a significant advantage to the success of the project as past experiences can be applied.</i> • <i>Utilization of matrixed staff lessens the impacts to individuals as a result of lower than anticipated congressional project funding since they can perform operational work or other assigned work. Also, utilization of matrixed staff allows for less work force reduction at project completion.</i>
<p><i>Procurement Processes</i></p>	<ul style="list-style-type: none"> • <i>Impacts: procurement delays due to underestimation of needed durations of procurement processes.</i> • <i>Ensure adequate time is allocated in the schedule for the procurement process.</i> • <i>Necessary lead times for procurement awards will vary based on contract value, domestic or foreign vendor, competitive or sole-source procurement.</i> • <i>Work with technical staff to determine appropriate times for:</i> <ul style="list-style-type: none"> ○ <i>Prepare Statement of Work / Technical Specification</i> ○ <i>Management approval</i> ○ <i>Prepare / submit purchase requisition</i> ○ <i>Technical package to procurement</i> • <i>Work with procurement staff to determine appropriate times for:</i> <ul style="list-style-type: none"> ○ <i>Procurement review and preparation of request for proposals (RFP)</i> ○ <i>Issue RFP and the solicitation period</i> ○ <i>Evaluate bids and award contract</i> ○ <i>DOE review of procurement documents (RFP, contract, etc.), as applicable</i>

**Spallation Neutron Source - Proton Power Upgrade
Lessons Learned for Post CD-2/3**

	<ul style="list-style-type: none"> • <i>Communicate with vendors to ensure expectations are understood and to monitor progress during the period of performance.</i>
<i>Risk Identification and Analysis</i>	<ul style="list-style-type: none"> • <i>Impacts: accurate risk identification and analysis supports the needed cost and schedule contingency to ensure project success.</i> • <i>Conduct risk workshops with the technical teams to assist in identifying potential risk events within their scopes of work.</i> • <i>Utilize an external workshop leader.</i> • <i>Consider outside experts in attendance for additional feedback.</i> • <i>Encourage continuous risk identification and analysis throughout the life of the project through monthly risk meetings, etc.</i>
<i>Klystron Gallery Construction</i>	<ul style="list-style-type: none"> • <i>Impacts: unfamiliarity with the Building Information Modeling (BIM) design methods and tools may introduce inefficiencies in the handoff from design to construction.</i> • <i>Provide training for project staff on BIM utilization and best practices.</i> • <i>Rather than issue separate contracts for design and construction, consider awarding a single design/build contract if possible.</i> • <i>If using separate design and construction contracts, be careful to not include too much detail in the BIM model as the construction contractor will likely need to modify the details later, thus resulting in some duplication of design effort.</i> • <i>Engage early in vendor outreach to ensure a sufficient number of bidders.</i>

Lessons Learned - Other

Lessons Learned – Other	Description, Impacts and Solutions
<i>CD-x Prerequisite Materials</i>	<ul style="list-style-type: none"> • <i>Establish list of prerequisite materials for the critical decision reviews and assign responsible staff for creating or locating these materials.</i>
<i>General Review Approach</i>	<ul style="list-style-type: none"> • <i>Always listen and learn from past reviews.</i> • <i>Participate in other project reviews and apply lessons learned appropriately.</i>

**Spallation Neutron Source - Proton Power Upgrade
Lessons Learned for Post CD-2/3**

	<ul style="list-style-type: none"> • <i>Ensure all staff is informed of what is expected of them.</i> • <i>Stay humble in front of the reviewers – confident but humble.</i> • <i>The project office provides PowerPoint templates to ensure uniformity and completeness of presentations.</i> • <i>Dry run every review presentation. Critical presentations deserve additional attention.</i> • <i>Conduct a Director’s Review prior to DOE reviews to ensure polished presentations and a good outcome.</i>
<p><i>COVID-19 Pandemic Response (successes)</i></p>	<ul style="list-style-type: none"> • <i>Due to limited ability to travel, hire known resources at partnering institutions or subcontractors to perform oversight of work conducted by non-local vendors</i> • <i>During times of limited resources or situations that result in an inability to meet in person, make a special effort to stay connected via one-on-one or small team phone calls and/or online meetings.</i> • <i>Maintain frequent contact with vendors and track procurement status (e.g. status, anticipated delay, estimated delay impact, etc.)</i>

**Spallation Neutron Source - Proton Power Upgrade
Lessons Learned for Post CD-2/3**

Submitted by:

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Date

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Date