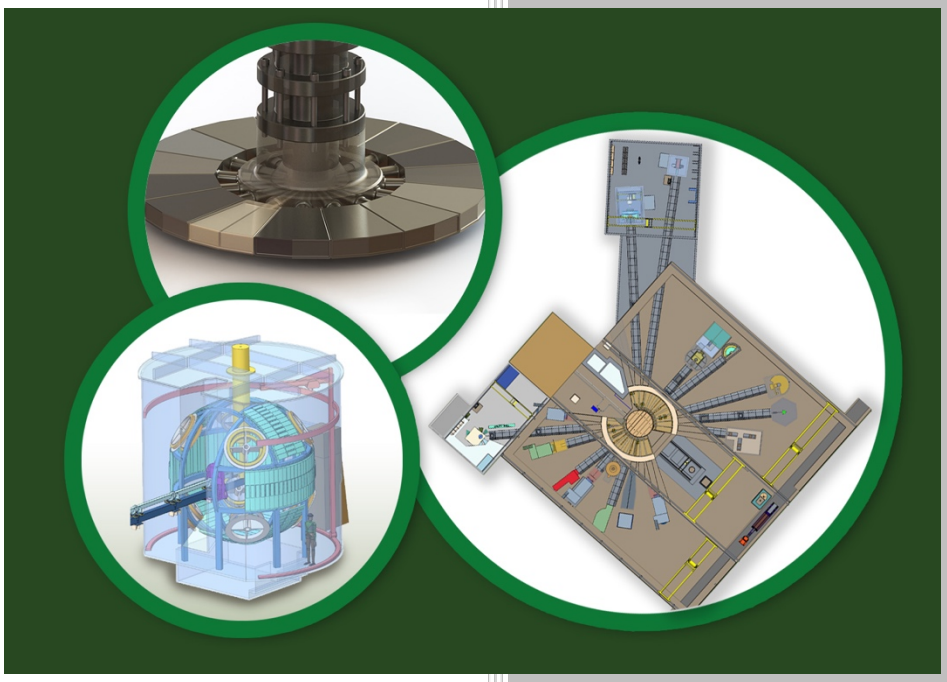
S03010000-SR0001 R01

SECOND TARGET STATION (STS) PROJECT

System Requirements Document for Target Systems



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November 25, 2020

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

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LEVEL 2 REQUIREMENTS DOCUMENT FOR TARGET SYSTEMS

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	Signature / Date					
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STS Project Director			John Haines John Haines Digitally signed by John Haines Date: 2021.05.28 06:00:51 -04'00'			
STS Project Manager			Graeme Murdoch Graeme Murdoch Digitally signed by Graeme Murdoch Date: 2021.05.27 15:02:27 -04'00'			
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Level 2 Manager	Peter Rosenblad	Nov. 30, 2020				

Revision	Description
00	Initial Release
01	Revision to STS L2 Requirements template format, addition of traceability to GRD requirements

CONTENTS

ACRONYMS

KPP	Key Performance Parameter
PPEP	Preliminary Project Execution Plan
PPU	Proton Power Upgrade
SNS	Spallation Neutron Source
STS	Second Target Station
TTOP	Transition to Operations Plan
WBS	Work Breakdown Structure

DEFINITIONS

Shall, must, will, may, and should are used to define each individual requirement. The definitions of these terms are as follows:

- *Shall* – is a requirement that is binding and must be implemented
- *Must* – is an absolute, binding alternative to "shall" or "requirement"
- *Will* – is used to inform intent or declaration of purpose
    - This is not a requirement; the author must use the word 'shall' to indicate that a requirement is binding and must be implemented
- *May* – is used to indicate a desire or goal of a requirement
    - This can also be interpreted 'as nice to have' and is not binding
- *Should* – is used to indicate a desire or goal of a requirement
    - This can also be interpreted 'as nice to have' and is not binding

"Not" is used in combination with the above terms to indicate the opposite; that is, "shall not" and "must not" describe prohibited

CD-2
DOE Critical Decision 2 – Approve Performance Baseline

CD-4
DOE Critical Decision 4 – Approve Start of Operations or Project Completion

1. INTRODUCTION

This Requirements Document serves to establish the requirements of the L2 Target Systems for the Second Target Station (STS). Subsystems within Target Systems will generate L3 or lower level requirements based on these requirements as applicable and will maintain those requirements in separate requirements documents.

2. SCOPE

The scope for the STS Target Systems includes the design, procurement and installation of the equipment and associated technical systems necessary to generate cold neutrons using the pulsed proton beam delivered from the SNS accelerator and distribute those neutrons to twenty-two beamlines.

3. REQUIREMENTS

ID	Requirement	Traceability
S.3-R01	The Target Systems shall accept a pulsed proton beam of 700 kW, 1.3 GeV, 15 Hz from Accelerator Systems. *Note: Other parameters of the proton beam to be delivered to the Target by Accelerator Systems will be established during preliminary design.* *Accept Proton Beam Pulse from Accelerator Systems (Behavior)* *Target Assembly connection to Accelerator Systems (Interface)* *Accelerator Interface Components connection to Accelerator Systems (Interface)* *Vessel Systems connection to Accelerator Systems (Interface)*	R2
S.3-R02	The Target Systems shall convert the proton beam pulses into cold neutron pulses using high-brightness moderators that will meet or exceed the peak brightness of $2x10^{14}n/cm^2/sr/Å/s$ at the neutron wavelength 5Å. *Note: Additional instrument-specific needs may be established during preliminary design.* *Convert protons to neutrons (Behavior)* *Moderator Reflector Assembly connection to Instrument Systems (Interface)*	R3
S.3-R03	The Target Systems shall distribute neutrons to 22 beamlines. *Distribute Neutrons to Instrument Systems (Behavior)* *Vessel Systems connection to Instrument Systems (Interface)* *Target Station Shielding connection to Instrument Systems (Interface)* *Moderator Reflector Assembly connection to Instrument Systems (Interface)* *Process Systems connection to Instrument Systems (Interface)*	R6
S.3-R04	The Target Systems design shall consider instrument background. *Distribute Neutrons to Instrument Systems (Behavior)* *Vessel Systems connection to Instrument Systems (Interface)* *Target Station Shielding connection to Instrument Systems (Interface)* *Moderator Reflector Assembly connection to Instrument Systems (Interface)*	R4
S.3-R05	The Target Systems design shall allow for a lifetime of forty years of operation.	R7

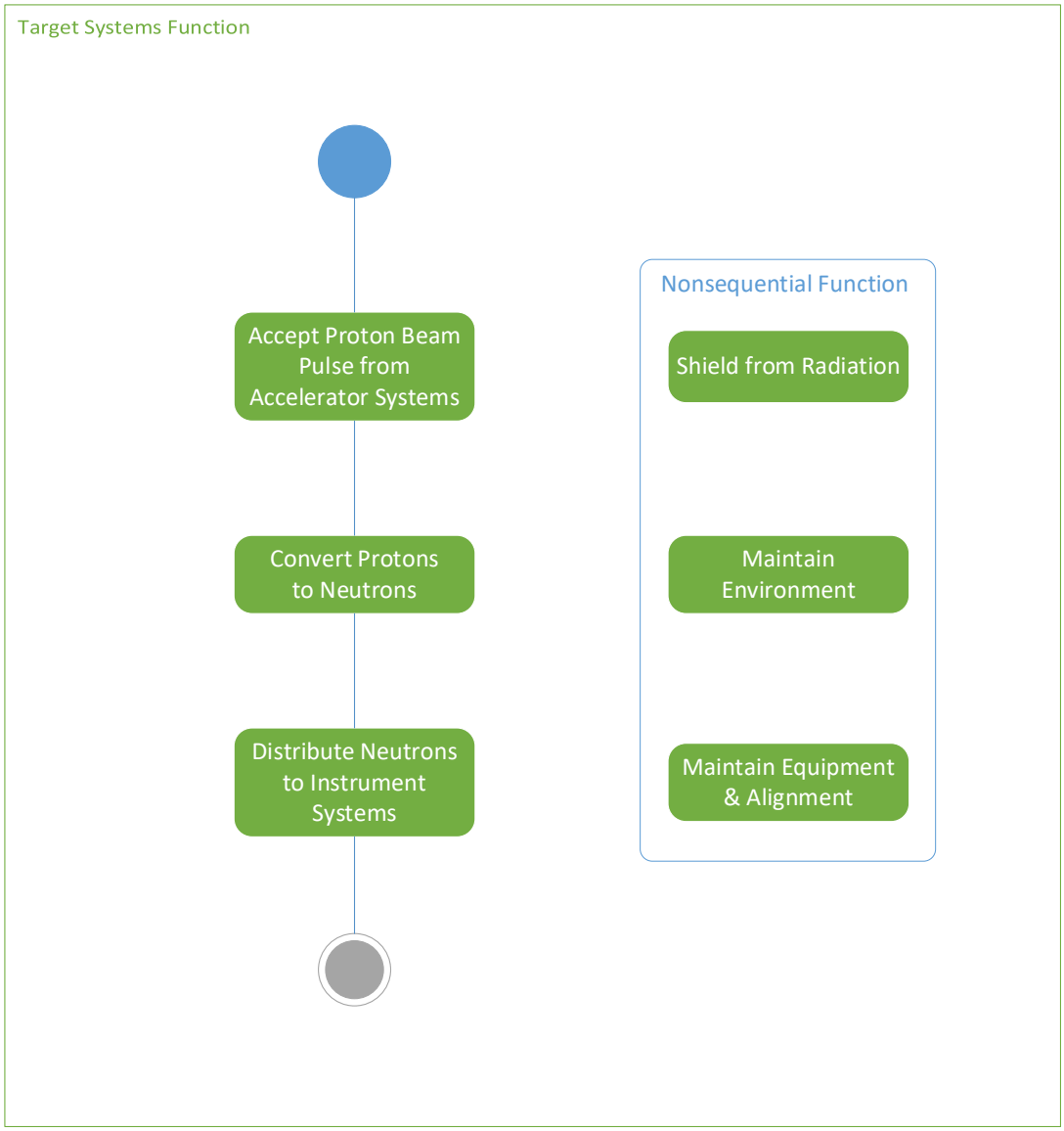
	Note: Components of the Target Systems that are not expected to be operational for the specified lifetime must be identified by the design. *Maintain Equipment & Alignment (Behavior)*	
S.3-R06	The Target Systems design shall allow for greater than five thousand hours of proton beam on target per year with accommodation for maintenance intervals in accordance with the STS operating schedule. *Note: The SNS operating schedule anticipates continuous operation for two full weeks (twenty-four hours per day, seven days per week) followed by a biweekly maintenance period. At least once per month, operation will pause for three days. Approximately every four months, operation is interrupted for planned machine downtime. The design will minimize the duration of maintenance activity to conform to that schedule. Specifically:* *Biweekly maintenance must be accomplished within one eight-hour shift.* *Monthly maintenance must be accomplished within one forty-eight-hour period.* *Extended maintenance must be accomplished within a one-month period.* *The STS operating schedule may be distinct from the current SNS FTS schedule.* *Maintain Equipment & Alignment (Behavior)*	R8
S.3-R07	The Target Systems design shall allow for greater than 95% availability. *Note: The global requirement for availability on the entire STS facility is >90%. Because this availability depends on the performance of all STS systems, a 95% limit is applied to the Target Systems individually.* *Maintain Equipment & Alignment (Behavior)*	R9
S.3-R08	The Target Systems design shall allow safe operation. *Note: Safe is defined as responding to the safety analysis that will be conducted in conjunction with ESH&Q during design to mitigate or eliminate risk.* *Shield from Radiation (Behavior)* *Maintain Equipment & Alignment (Behavior)*	R11
S.3-R09	The Target Systems design shall prevent release of contamination and limit exposure ALARA in accordance with the STS Radiation Safety Policy and Plan. *Note: This will be accomplished in combination with shielding also provided by Conventional Facilities.* *Shield from Radiation (Behavior)* *Target Station Shielding connection to Conventional Facilities (Interface)*	R11
S.3-R10	The Target Systems design shall include a replacement scheme and disposal path for all perishable components. *Note: Perishable components are defined as those elements of the Target Systems that are not expected to remain operational for the full forty-year lifetime of the Second Target Station. Service or replacement must include the ability to confirm equipment location is consistent with that at which the*	R7, R8, R9, R11

	instruments have been tuned. Components that are not expected to be replaceable should be identified by the design. *Maintain Equipment & Alignment (Behavior)* *Remote Handling connection to Conventional Facilities*	
S.3-R11	The Target Systems design shall allow for fifty years of operation for remote handling equipment. *Note: Additional lifetime is expected to accommodate decommissioning following operational life of the facility.* *Maintain Environment (Behavior)* *Maintain Equipment & Alignment (Behavior)*	R7
S.3-R12	The Target Systems shall provide connection to the Accelerator Systems upstream of the Target Station Monolith for transport of the proton beam to the Target. *Accept Proton Beam Pulse from Accelerator Systems (Behavior)* *Accelerator Interface Components connection to Accelerator Systems (Interface)* *Accelerator Interface Components connection to Conventional Facilities (Interface)*	R2
S.3-R13	The Target Systems shall isolate the Target environment from the Accelerator Systems beamline environment. *Accept Proton Beam Pulse from Accelerator Systems (Behavior)* *Maintain Environment (Behavior)* *Accelerator Interface Components connection to Accelerator Systems (Interface)* *Vessel Systems connection to Accelerator Systems (Interface)*	R2
S.3-R14	The Target Systems shall provide the means to measure proton beam position and profile delivered by the Accelerator Systems. *Note: The scope of design responsibility will be established by Interface Control documentation during preliminary design.* *Accept Proton Beam Pulse from Accelerator Systems (Behavior)* *Accelerator Interface Components connection to Accelerator Systems (Interface)* *Accelerator Interface Components connection to Integrated Control Systems (Interface)*	R2
S.3-R15	The Target Systems design shall provide for monitoring and operation and will accommodate timing triggers provided via the SNS control system, *Note: This will include beam-on operation as well as recovery from a beam-off event, whether scheduled or not. Beginning, or return to, beam-on operation should not require controls intervention in Target Systems components; i.e. Target Systems must function independently from the status of other STS systems, which will be dependent on Integrated Control Systems design.* *Accept Proton Beam Pulse from Accelerator Systems (Behavior)* *Convert protons to neutrons (Behavior)*	R1

	Distribute Neutrons to Instrument Systems (Behavior) *Maintain Environment (Behavior)* *Maintain Equipment & Alignment (Behavior)* *Target Assembly connection to Integrated Control Systems (Interface)* *Accelerator Interface Components connection to Integrated Control Systems (Interface)* *Moderator Reflector Assembly connection to Integrated Control Systems (Interface)* *Vacuum Systems connection to Integrated Control Systems (Interface)* *Cryogenic Moderator Systems connection to Integrated Control Systems (Interface)* *Process Systems connection to Integrated Control Systems (Interface)*	
S.3-R16	The Target Systems shall be designed to make use of lifting capacity, power, chilled water and other utilities within the limits made available by Conventional Facilities where such service would be necessary for operation and maintenance. *Note: Target Systems development will inform the design of such services, as well as provisions to be made in Conventional Facilities design for access, routing, penetrations and support, but Target Systems design should confirm Target Systems' needs do not exceed or compromise Conventional Facilities capabilities.* *Accept Proton Beam Pulse from Accelerator Systems (Behavior)* *Convert protons to neutrons (Behavior)* *Distribute Neutrons to Instrument Systems (Behavior)* *Shield from Radiation (Behavior)* *Maintain Equipment & Alignment (Behavior)* *Vacuum Systems connection to Conventional Facilities (Interface)* *Target Station Shielding connection to Conventional Facilities (Interface)* *Accelerator Interface Components connection to Conventional Facilities (Interface)* *Cryogenic Moderator Systems connection to Conventional Facilities (Interface)* *Process Systems connection to Conventional Facilities (Interface)* *Remote Handling connection to Conventional Facilities (Interface)* *Process Systems connection to Instrument Systems (Interface)*	R2, R3, R6, R7, R8, R9

APPENDIX A. TARGET SYSTEMS FUNCTIONAL AND STRUCTURAL ANALYTICAL DIAGRAMS

BEHAVIORAL ANALYSIS



STRUCTURAL ANALYSIS