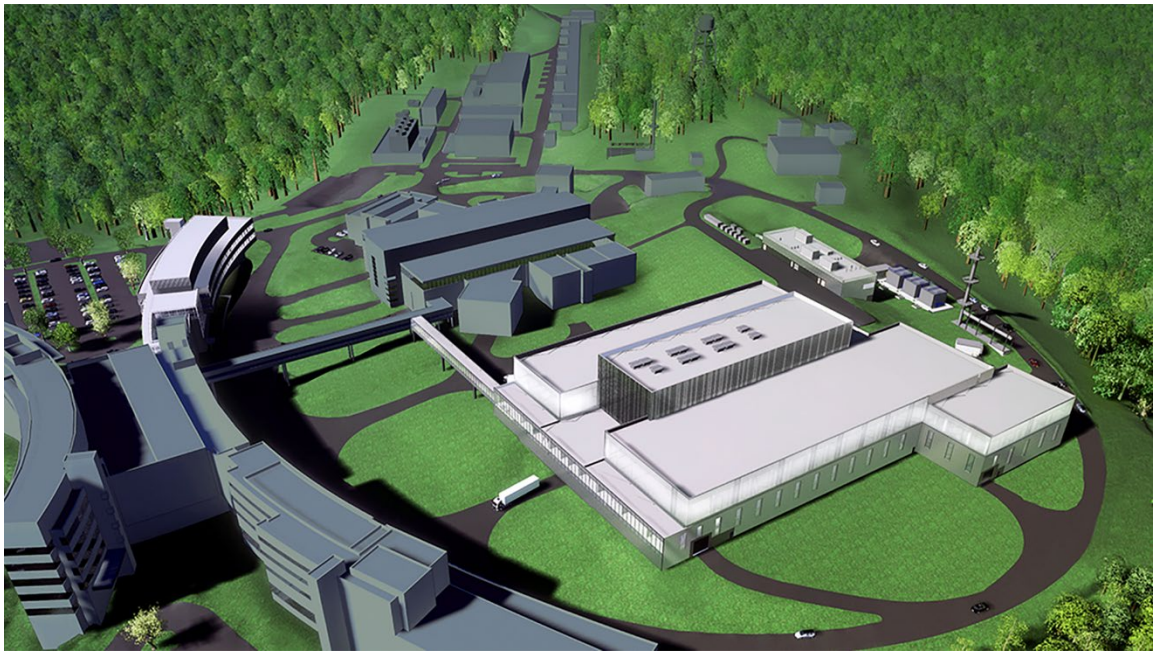
S03100500-TDO10001 R00

Second Target Station Project: MRA FDR – Remote Handling Overview



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OAK RIDGE National Laboratory

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MRA FDR – REMOTE HANDLING OVERVIEW

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Outline

INTRODUCTION

The Second Target Station (STS) project will upgrade the existing Spallation Neutron Source (SNS) that currently operates at Oak Ridge National Laboratory by delivering a new target station optimized for high brightness neutron production. At the heart of that system are several critical perishable components, including the moderator reflector assembly (MRA). The MRA is comprised of a structural stainless steel weldment containing aluminum vessels that contain beryllium, cryogenic hydrogen, and cooling water.

Due to the irradiated conditions of the components at the end of operational periods, it will be necessary to develop processes and tooling to facilitate removal and replacement of this item using remote handling techniques to provide adequate radiation protection to workers and the environment.

This document will provide an overview of the remote handling operations that will be employed to support the required maintenance operations for the MRA. Additionally, the procedures outlined also demonstrate compliance with the following MRA requirements:

- 2347: MRA shall be designed to be replaced in a 1400-hour maintenance outage
- 2331: MRA piping shall be designed for cutting above upper shield block
- 3589: MRA shall be capable of vertical removal from core vessel after the removal of 3 target segments
- 3590: MRA shall be capable of vertical installation after the removal of 3 target segments
- 2333: MRA shall fit within a liner designed to fit in the TN-RAM shipping cask after removal of piping above the upper shield block
- 2334: MRA mass for disposal less than 2400kg.

1 APPLICABLE DOCUMENTS

- S030120100-TRT10015; Analysis of Second Target Station Target Segment Removal Dose Rates
- S03100400-TDO10000; Target FDR Remote Handling Overview

2 MAINTENANCE OVERVIEW

2.1 MRA

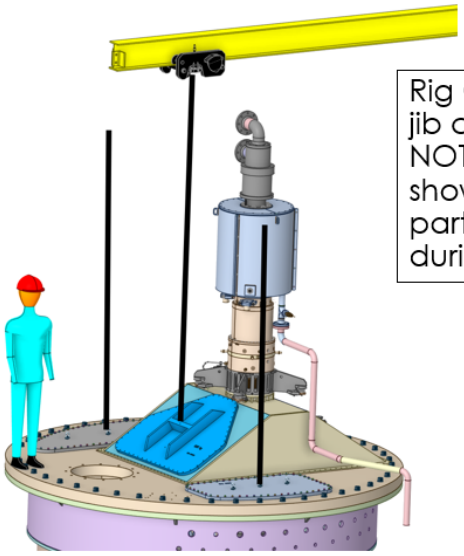
There is a single MRA installed in a fixed location inside the core vessel. Various piping runs that connect to the main building process utilities supply cooling water and the cryogenic hydrogen to the main MRA structure. The MRA design lifetime is 6 years. MRA replacement interval will be based on this design lifetime and actual operational hours incurred by the MRA. Preventive replacements are planned for MRA during scheduled facility downtimes. Alternate replacement intervals may be chosen upon entering operations. Regardless of interval, MRA replacement will be a regularly scheduled event performed by STS personnel.

To replace a MRA, the general sequence subsequently outlined will be followed. *Sequence of steps and estimated time durations are based on similar processes and experiences from SNS.

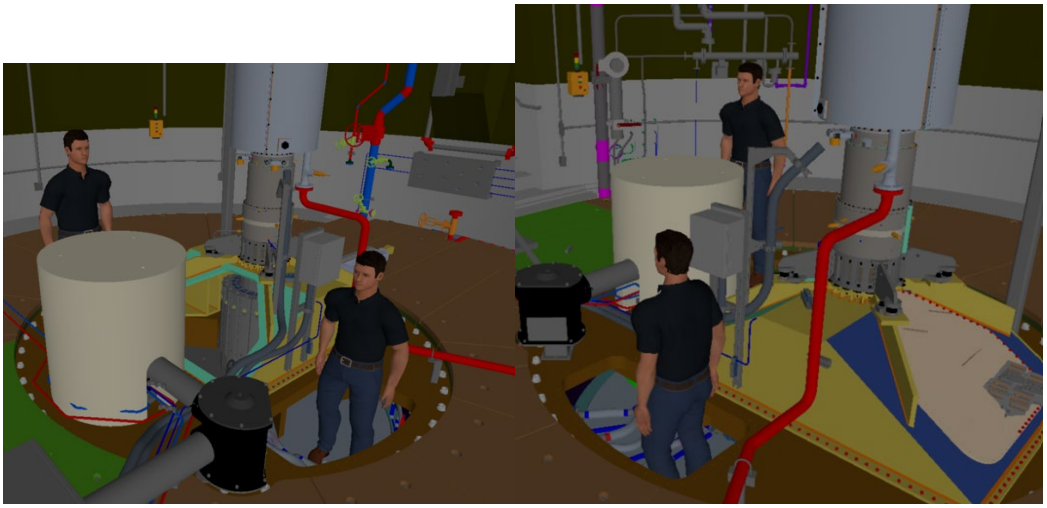
Prior to beginning any specific tasks related to the MRA, 3X target segments need to be removed from the core vessel following the prescribed procedure noted in document above (S03100400-TDO10000). All the preparatory work to remove target segments will also contribute to removing the MRA. This includes establishing beam-off conditions and allowing for decay time, venting the core vessel to atmosphere, removing hydrogen and making the MRA inert. Additionally, work to remove the specific TDR roof hatch that vertically aligns above the MRA access port can be completed during this time. Final preparations for MRA removal and replacement involve lifting, transferring, and installing the TDR gamma door and connecting it to the PLC controls cabinet and making sure it is operational. Lastly, water cooling loop #2 needs to be drained and have MRA water circuit partially blown down. Then connect loop #2 to process systems air supply and continuously flow air through the circuit.

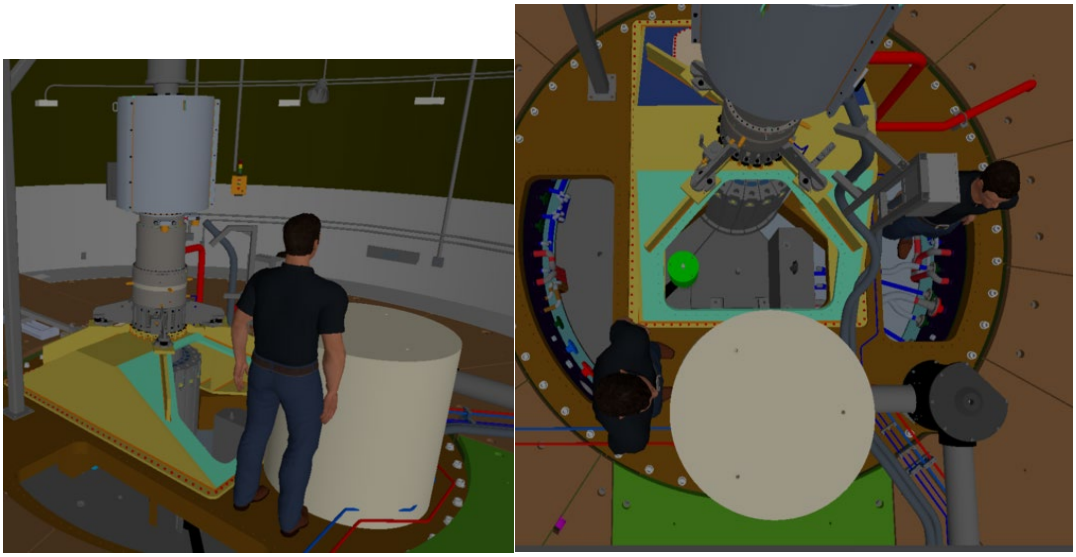
Upon personnel entering the TDR, the initial set of tasks to be performed all occur working above the core vessel lid or at the top of the core vessel shield stack. All tasks are accomplished via hands-on techniques. During this operation, the main water supply and return lines shall stay connected and water will remain flowing through the target assembly. Optionally, Herculite® may be placed on the floor on/around the target drive assembly to help control contamination risk potential during the maintenance operations.

Unbolt and remove shroud pieces completely	2 hr
Rig jib crane to CV tent hatch covers & alternate CV access hatches	1.5 hr
Unbolt CV tent hatch cover (66X) & alternate hatch access covers	1 hr
Lift and transfer CV covers in TDR	1 hr
Rig and remove MRA pipe chase supplemental shield blocks and seismic restraints	2 hr
Disconnect water joint flanges	3 hr
Cut hydrogen transfer line	2 hr
Attach lifting straps/lanyards to water pipes and transfer line	2 hr



Rig CV hatch covers to jib crane & trolley/hoist. NOTE: TVP doghouse not shown for clarity. Actual part will be in position during operations.



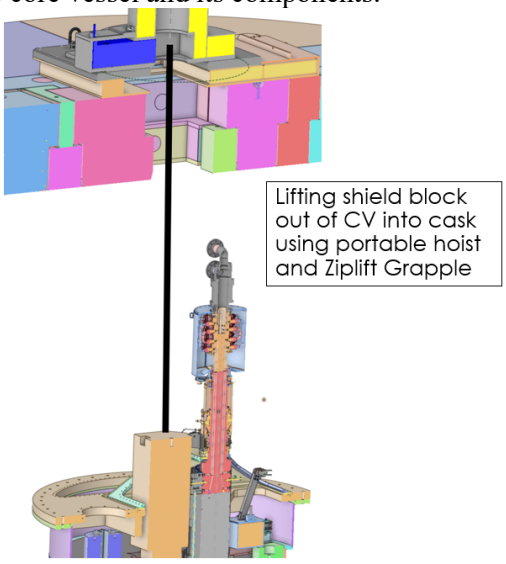


Some potential risks associated with performing these steps include difficulty in removing all CV tent hatch cover screws or flange bolts or damaging the seal or sealing faces during hatch removal.

After completion of preparatory work both within the TDR and in the high bay, then work to remove the primary components out of the core vessel shall begin. This work will involve personnel working at the top of the shield stack housed within the core vessel as well as at the high bay floor elevation. For this work, some tasks are hands-on while others are performed remotely using customized tooling. These tasks focus on removing the MRA shield block, which is an irradiated but reuseable component.

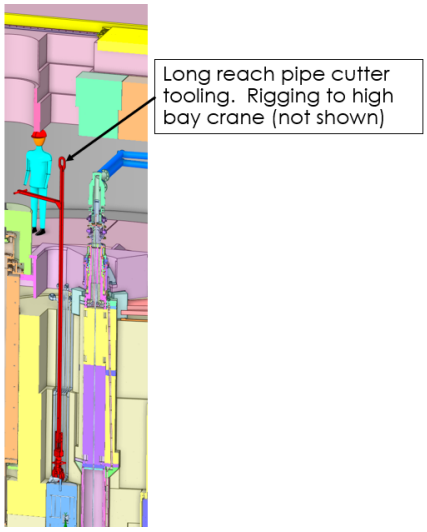
Lift, transfer and install shield block cask adjacent to TDR gamma door. Unbolt cask bottom plate.	1.25 hr
Lift, transfer and install cask onto TDR gamma door	0.5 hr
Lift, transfer and install portable hoist onto cask. Connect hoist utilities. Verify function.	2 hr
Lower chain from hoist and attach Ziplift grapple to shield block	0.5 hr
Retract shield block out of CV into cask	0.75 hr
Disconnect Ziplift from shield block. Remove hoist from cask.	2 hr
Lift cask off TDR gamma door and install onto bottom plate. Secure bottom plate. Transfer cask to temporary storage area	1.5 hr

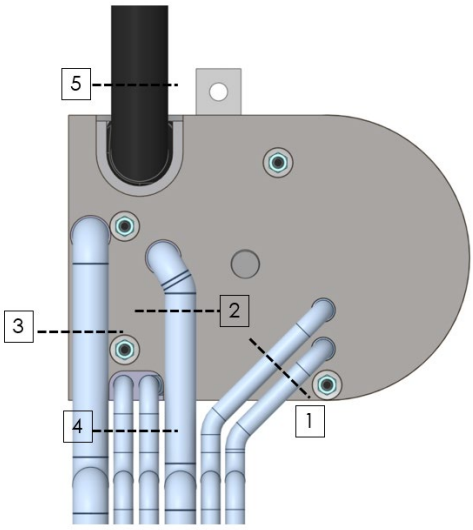
As part of the use of the portable hoist, the TDR gamma door will be opened/closed in various configurations during different parts of the process to minimize radiation exposure effects originating from the core vessel and its components.

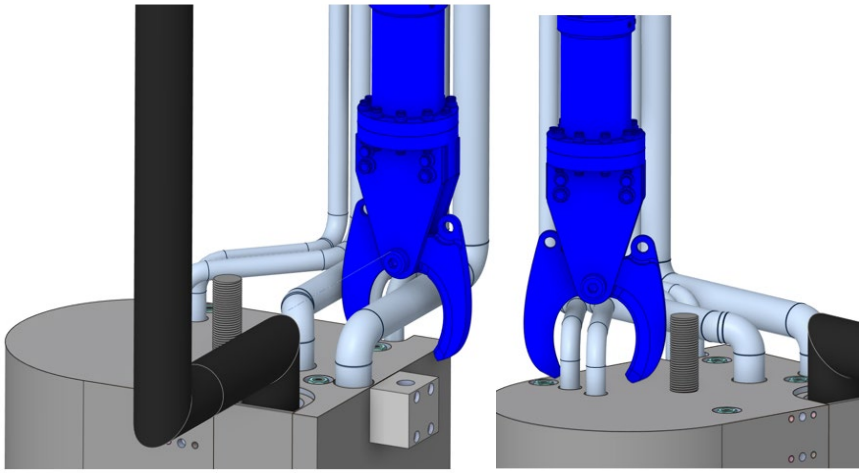


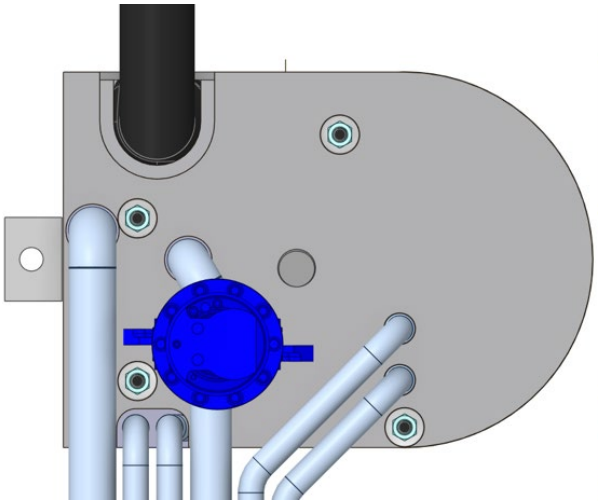
Potential risks associated with these steps include rigging and removing the shield block into the cask. Potential binding or misalignment as the shield block is removed or installed could require multiple attempts to complete these steps. Additional alignment and guiding features will continue to be developed for this operation.

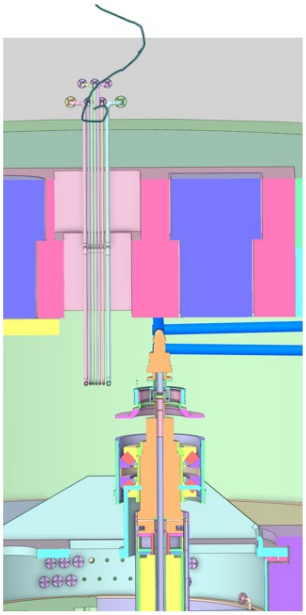
Rig, transfer and function check long reach hydraulic pipe cutter into TDR	2 hr
Perform cutting on transfer line and water pipes and extract individually from CV	9 hr
Rotate target drive shaft to position 3X segment void directly under MRA	1 hr
Lift, transfer, and install MRA cask to TDR gamma door	1 hr
Lift, transfer and install portable hoist onto cask. Connect hoist utilities. Verify function.	1 hr
Lower chain from hoist and attach Ziplift grapple to MRA	0.5 hr
Retract MRA out of CV into cask	0.75 hr
Disconnect Ziplift from MRA. Remove hoist from cask.	3 hr
Transfer cask to temporary storage area	0.5 hr











Potential risks for performing these steps include MRA blowdown not complete or takes more time than anticipated resulting in spilling water into core vessel during pipe cutting operations, pipe cutting and removal difficulties regarding tooling, access, visibility or radiation protection, gamma doors unable to open/close as required, and rigging and removal of the MRA into the cask. Potential binding or misalignment as the MRA is removed or installed could require multiple attempts to complete these steps. Additional alignment and guiding features will continue to be developed for this operation.

Total time to remove MRA is currently estimated to be completed in less than 270 hours. *NOTE: Operational steps outlined above do not include any radiological survey activities that will be part of the maintenance procedures.

Installation of a new MRA follows much the reverse process for removal. The time to install a single new MRA is estimated to be completed in less than 280 hours. This time includes welding and leak testing of transfer lines, connecting and leak testing water lines, completing installation of 3X new target segments, cleaning up of all equipment within TDR, re-installation of TDR roof

hatch plug and TDR supplemental shielding, turning on all utilities, re-establishing CV vacuum conditions, re-establishing cold hydrogen boundary within MRA, and finally turning beam on.

Based on the planned operations, tooling, and estimated time durations outlined above all requirements are satisfied initially assuming 10-hour workdays, 7 days per week during maintenance outage period.

3 CONCLUSION

Remote handling tooling and operations are deemed necessary and essential to support MRA maintenance operations of removal and replacement. This document has provided a summary overview of the planned remote handling operations at the time of the MRA final design review (FDR). Additional planning and development will continue beyond FDR. A mockup test stand (MUTS) is also within the remote handling scope and is expected to be constructed prior to beam-on operations of the facility. This MUTS will be used to develop, test, and practice all remote handling operations.
The remote handling scope and methodology appears reasonable for supporting these maintenance operations. The requirements associated with maintenance operations are satisfied.

4 WASTE DISPOSAL PREPARATION

After removal of the MRA from the core vessel post beam operations, it will be transferred to the service cell for waste disposal preparation activities. The scope of these activities is the responsibility of Remote Handling (S.03.10). These activities are required to be performed on every MRA to facilitate the ability to ship this item offsite and be received at an appropriate waste disposal facility. These activities include temporary storage for decay, dewatering and drying of MRA, and waste disposal loading. Temporary storage will be provided in the service cell to allow the irradiated MRA to decay (cool down) to reach acceptable activation/dose rate levels to facilitate processing. Dewatering and drying will be performed to evacuate any residual water from the MRA after completing the blowdown procedure. Waste disposal loading of the MRA will be completed in the service cell. This process will package a MRA in a waste disposal liner and subsequently load into an appropriate shipping container to transfer to the disposal site. Current estimated mass of MRA prepared for waste disposal is less than 2400kg and the disposal liner assembly as shown is less than 2000kg.

The MRA piping components that were remotely cut as noted earlier shall be packaged separately from the main MRA structure. These may be handled hands-on or with some minimal long reach tooling to facilitate loading them into a disposal shipping container. Additionally, further downsizing may be required based on the disposal container selection. Storage for decay for these items can be provided within the service cell, although it is not necessarily required due to the much lower activation/dose rate levels originating from these items. No additional waste disposal preparation is required to be completed on the piping components prior to shipment.

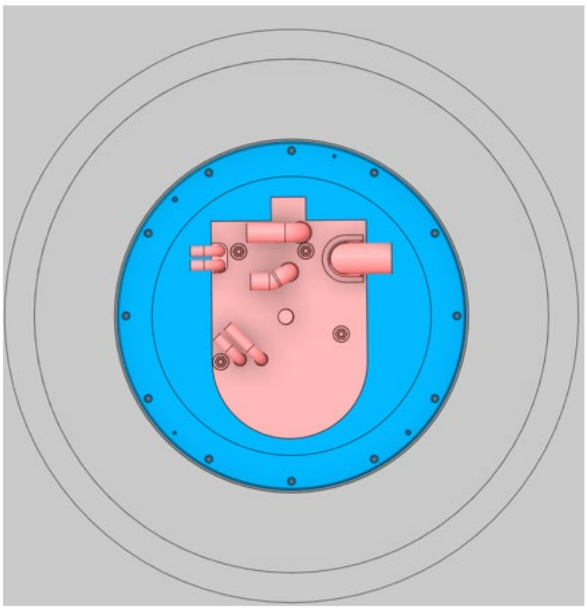


Figure 1: MRA inside Disposal Liner in Decay Pit

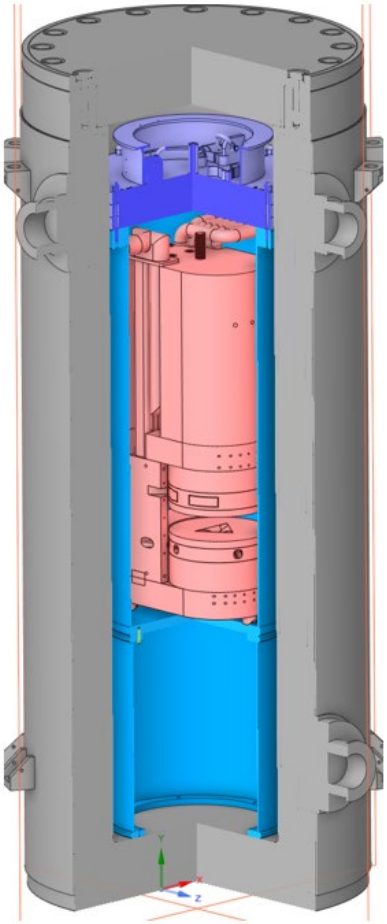


Figure 2: MRA Waste Disposal Package inside Shipping Container