

Tower Shipping Readiness Review Report

December 2, 2022

Table of Contents

1. [Introduction](#)
2. [Review Charge](#)
3. [Responses to Review Charge Questions](#)

1. Introduction

Review Organizers: Richard Partridge, Mike Stoddart

Designated Reviewers: Tina Adair, Allan Barr, John Orrell, and Joel Sander (chair)

The Tower Shipping Readiness Review will assess the Project's readiness to ship completed Detector Towers to SNOLAB. At this time, all four towers have been assembled and successfully undergone functional testing in the Bluefors fridge. They are being stored in the SLC tunnel in an alcove area in the long dormant SLC tunnel where there is significant overburden providing excellent protection against cosmogenic activation.

A [tower shipping readiness review page](#) has been set up and includes a draft charge as well as lists of planned presentations, reference material, and some older presentations that may be of interest.

2. Review Charge

The charge for this review is to consider and respond to the following questions:

1. Are the plans for moving the towers out of the SLC tunnel and onto the FedEx truck appropriate?
2. Is the plan for shipping towers appropriate, including assessment of the shipping plan, the test shipment, and the routing of the shipment?
3. Are the plans for receiving the towers at SNOLAB and moving them underground appropriate?
4. Are the plans for moving the towers through the drift and into SNOLAB appropriate?
5. Are the plans for acceptance testing appropriate?
6. Are the written procedures clear and complete?
7. Have appropriate hold points been visually identified in the written procedures?
8. Does the Failure Modes and Effects Analysis (FMEA) appropriately identify possible failure modes and mitigations?
9. Are the go/no-go criteria for deciding to ship the towers well defined and appropriate?

10. Are the necessary resources (manpower, equipment, etc.) to support the shipment identified and available?
11. Is the work planning and control documentation and plan for work release appropriate?
12. Are we ready to ship the towers if we satisfy the go/no-go criteria on the target ship date (November 11 or if delayed December 2/9)?

The dedicated reviewers are requested to provide a written review report no later than two weeks following the completion of the review.

3. Responses to Review Charge Questions

1. Are the plans for moving the towers out of the SLC tunnel and onto the FedEx truck appropriate?
 - Yes. The reviewers request an assessment of the durations of cosmic ray exposure during tower testing to confirm our expectation that cosmic exposures are within the backgrounds budget and to more clearly define the remaining budget available should a shipping incident occur.
2. Is the plan for shipping towers appropriate, including assessment of the shipping plan, the test shipment, and the routing of the shipment?
 - Means should be identified to minimize the risk of the towers being over-delayed, especially at customs. This should include:
 - i. An estimate of the amount of potential delay at the site of the border crossing.
 - ii. A team ready and available to respond and mitigate the risk of substantial delays at customs.
 - iii. Understanding of the shipper's response time and actions in the event of an incident when the towers are en-route.
 - iv. The reviewers encourage following through with Richard's proposed idea of a trial shipment to test our border crossing expediency.
 - The reviewers suggest that a similarly sized/weighted test shipment be employed to test the full path from the SNOLAB warehouse to the underground car wash.
 - The "closer to SNOLAB" point should be defined as "After passing through El Paso, TX". This is a higher elevation point after which all subsequent elevations (El Paso to SNOLAB) are lower.
3. Are the plans for receiving the towers at SNOLAB and moving them underground appropriate?
 - The general plan seems fine, however SNOLAB should be given time to build a more detailed plan for staffing requirements and consider any special arrangements that may be required. SNOLAB's detailed plan should be compared with MP07 and the FMEA analysis for MP07 to ensure aligned expectations. The timing of the shipments should allow SNOLAB adequate time to develop and communicate the detailed plan.

- The written plans for receiving the towers should include the alternative underground storage location in Sudbury including the movement plan for the bringing towers to the alternative location.
 - The FMEA for MP07 would benefit from a bit more detail. The plan to deal with crossing rails is not solidified (perhaps setting a paver stone between the rails would work), and the minimum number of people and requisite qualifications is not specified.
 - i. Phase 1 anticipates a time period when a person remains alone with each tower crate in the drift while the forklift driver returns to pick up the second crate.
 - ii. Phase 2 anticipates one person holding both sides of double doors while the tower crate is rolled through.
4. Are the plans for moving the towers through the drift and into SNOLAB appropriate?
 - There is still some uncertainty in a few areas of the plans:
 - i. Dealing with how to minimize shocks over rails and other obstacles
 - ii. Formalizing a plan to deal with a call to refuge (including a fire).
 - iii. Analysis of existing (and future planned) accelerometer data.
 - The MP07 FMEA was not provided but is listed as “in progress”. The reviewers would like the opportunity to review and comment on it.
 5. Are the plans for acceptance testing appropriate?
 - We did not receive plans for acceptance testing. However, we do not see the lack of acceptance testing as a sufficient reason to prevent shipping.
 6. Are the written procedures clear and complete?
 - MP06 and MP07 are clear and will be deemed complete when amended to address the responses to questions 2, 3, 4, 9, 10 and 11.
 7. Have appropriate hold points been visually identified in the written procedures?
 - The hold points in MP06 and MP07 are identified and sufficient.
 8. Does the Failure Modes and Effects Analysis (FMEA) appropriately identify possible failure modes and mitigations?
 - The FMEA for MP07 is in Confluence and appropriately identifies possible failure modes and mitigations with some exceptions that are covered by the other responses herein.
 9. Are the go/no-go criteria for deciding to ship the towers well defined and appropriate?
 - Yes, except that Phase 0 step 2 should include obtaining written permission from SNOLAB’s Director of Operations (Allan Barr) to ensure SNOLAB has completed the detailed planning required on their end and are ready for receiving towers.
 10. Are the necessary resources (manpower, equipment, etc.) to support the shipment identified and available?
 - Yes after SNOLAB has developed a more detailed plan of their resources as they pertain to supporting the tower shipment. It is suggested that this review committee be given an opportunity to review SNOLAB's more detailed plan.
 11. Is the work planning and control documentation and plan for work release appropriate?
 - Yes

12. Are we ready to ship the towers if we satisfy the go/no-go criteria on the target ship date (November 11 or if delayed December 2/9)?
- The comments above should be addressed first and notably:
 - i. The customs issue should be vetted/addressed before shipping towers.
 - ii. SNOLAB's detailed receiving plan must be in place which will likely include using a similarly sized and weighted crate to exercise the SNOLAB end of receiving towers.
 - iii. The windy drift should be ready to accommodate tower transportation and enable SNOLAB to fully develop the receiving plan.
 - iv. Shipping organizers should work with SNOLAB to ensure adequate space in the warehouse for receipt of the towers.