3rd Workshop on Particle Accelerator Upgrade, Removal, and Installation
18-20 March 2024 | Trieste, Italy

Infrastructure considerations for a complete linear accelerator removal and installation

J. Erikson
Canadian Light Source Inc., Saskatoon, Canada

Introduction

The Canadian Light Source is undergoing a complete replacement of its electron source, linear accelerator and associated RF and mechanical services starting in April 2024. This creates several logistical challenges due the age of parts of the facility and how building and safety codes have evolved.

Figure 1. The CLS electron source and linear accelerator in 2023.

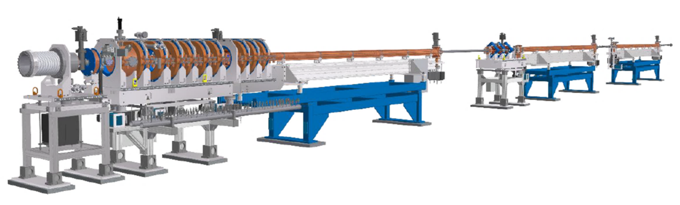

Figure 2. Model of the new electron source and linear accelerator.

Background

The Canadian Light Source (CLS) is a 3rd Generation Light Source built on top of a 1960s linear accelerator facility, the Saskatchewan Accelerator Laboratory (SAL), on the University of Saskatchewan campus in Saskatoon, Saskatchewan.

Figure 3. The above ground SAL building in around 1994.

The SAL was built in 1963 and underwent several expansions before the CLS was built onto it in 2000. The CLS integrated many SAL technical systems, including the electron source and linear accelerator. Electrons from the linear accelerator are steered up to ground level and into the CLS booster ring via a transfer line.

In 2018 the electron source failed resulting in a six month outage while spare parts were found and repairs completed. Ongoing concerns about the system's age, reliability, and availability of support and spare parts led to funding approval for a new system in 2020.

Table 1. Specification Comparison

	Old	New
Electron Source	250 kV in oil	90kV in air
Linac Output Energy	250 MeV	250 MeV
Frequency	2856 MHz	3000 Mhz
Accelerator Sections	6	3
RF Units	6	2

The new linac was designed with a frequency of 3000 MHz, which better matches BR/SR frequency of 500 MHz for improved booster capture rate.

Objectives

1. Improved reliability for increased uptime.
2. Improved booster capture due to improved synchronization and timing.
3. Opportunity for future performance enhancements.

Means of Egress in the Subbasement

The subbasement level is served by three enclosed exit stairs and four egress paths not considered exits as defined by the National Building Code of Canada (NBCC). The nearest exit is required to be located so that it is within a maximum permitted distance of travel of 30m for most unsprinklered occupancies. Modifications to the layout and function of the subbasement have made it noncompliant with this requirement and so equivalent levels of safety are achieved by programmatic restrictions and procedures. These include limits to occupant loads, controlling transient combustible material, and limits on hot work in the space.

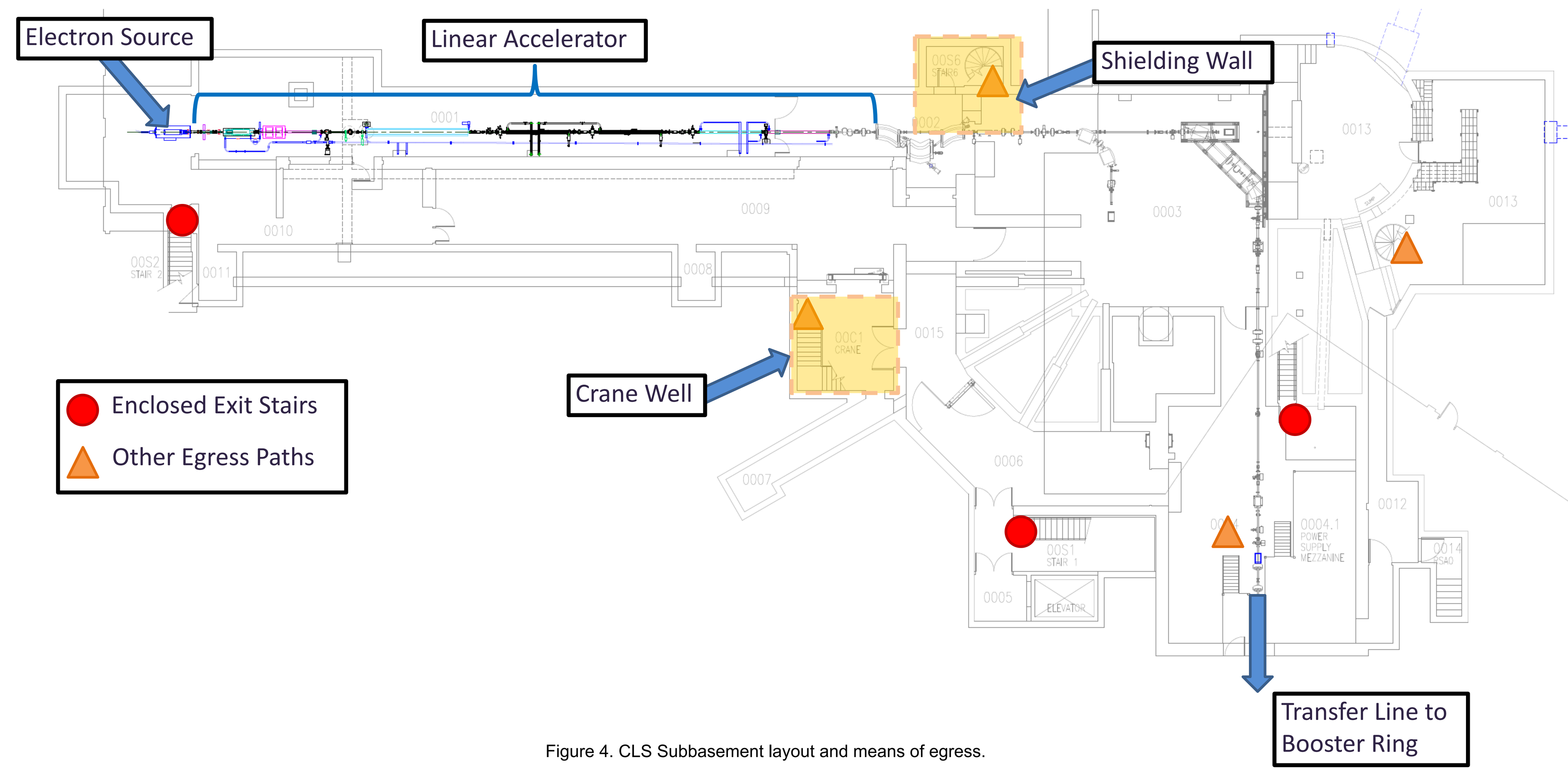

Figure 4. CLS Subbasement layout and means of egress.

Crane Access to Subbasement

An overhead crane will be used to lower the new equipment down to the subbasement. The crane well has a set of removable steel stairs wrapping around the perimeter walls. Due to the length of the accelerator sections, there were two options: remove the stairs, or tilt the accelerator sections.

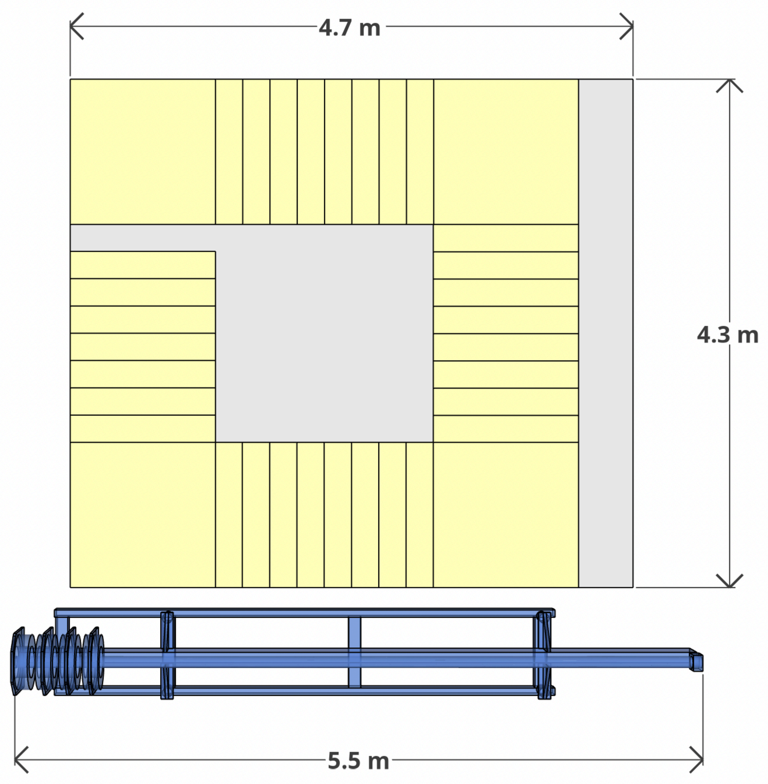

Figure 5. Crane well and accelerator section ACC1 dimensions.

Dismantling and reinstalling the stairs is a slow process and would also restrict access to the elevator so we worked with RI to modify the support frame and lifting points to handle lifts at an angle. By tilting the section 60 degrees it can be spiralled around the stairs down to the subbasement.

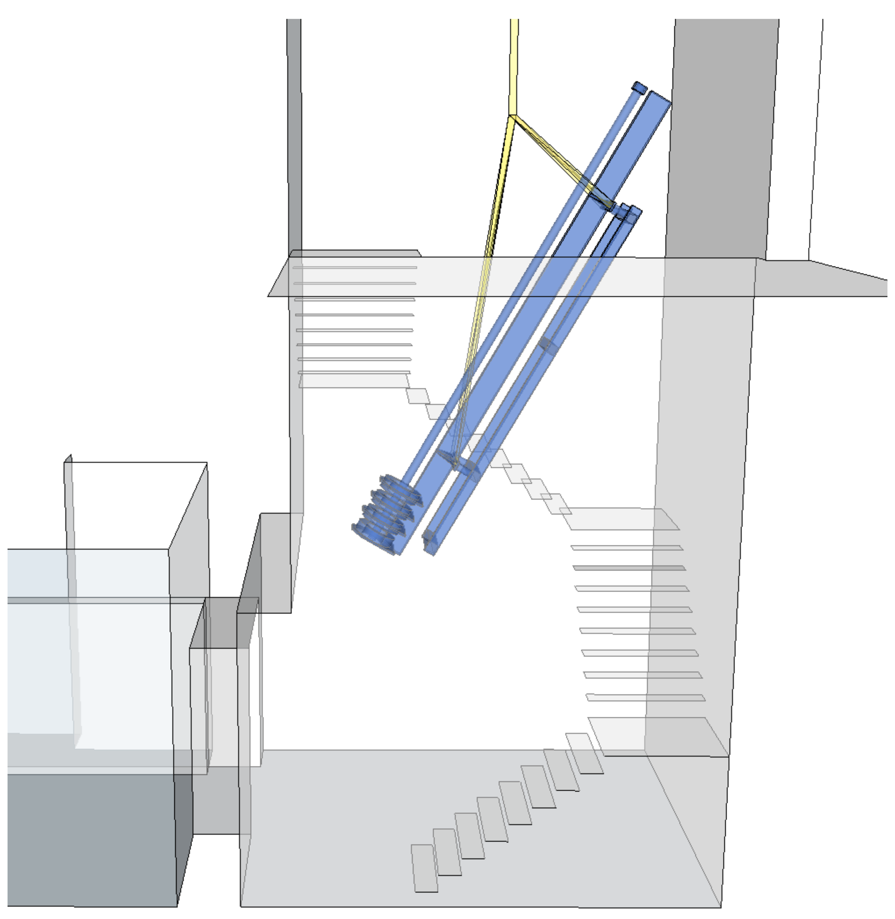

Figure 6. Model of crane well and accelerator section lift.

Test Lift

As a proof of concept, a wooden mock up of the largest accelerator section was built and a test lift was successfully completed.

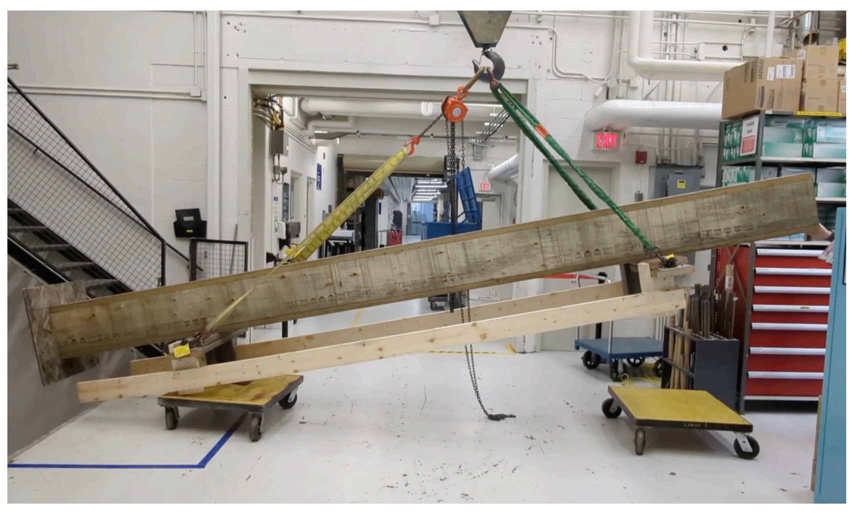

Figure 7. Test lift with wooden accelerator section mock up.

Lift Procedure:

- Set slings to lift section at 30 degree tilt.
- Move section over crane well
- Use chain hoist to increase tilt to 60 degrees.
- Lower section down crane well, guiding it to avoid stairs.
- Set onto caster platforms and remove rigging.

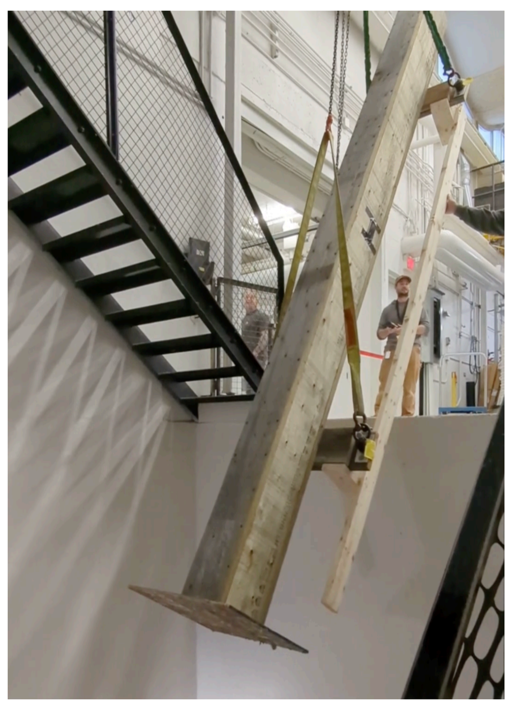

Figure 8. Test lift with wooden accelerator section mock up.

Based on this test lift several recommendations are being implemented:

- VFD upgrade to crane for smoother motion
- Remote-controlled electric chain hoist
- Custom built caster carts
- Additional technicians guiding section during lift

Crane Restrictions

While the crane is in use, barricades are erected that block access to one of the three enclosed egress stairs. To comply with safety requirements, several zones in the subbasement need to be evacuated during lifts.

Plan to primarily use elevator for dismantling work.

Egress Enhancements

A 915mm thick shielding wall separates the linear accelerator hall from the transfer line area. This was necessary when the SAL operated at much higher gun frequencies and produced more radiation but is no longer needed.

Figure 9. Shielding wall at end of linac.

The top third of the wall was removed in the 1980s. To improve egress, the remaining wall is scheduled to be removed immediately prior to the start of the dismantling phase. This will also allow for equipment lockouts to occur earlier than originally planned.

Fire Safety and Hot Work

The original electron source power supply is in a large tank filled with oil. This area was protected by a CO_2 fire suppression system. This system represented a significant risk to anyone working in the area if it was ever set off and so it was removed in early 2023.

Combustible material in the subbasement is strictly controlled and all transient material brought into the area is tracked. Special attention will be required during the dismantling and installation phases.

Any hot work in the subbasement requires the evacuation of the entire level by those not involved in the work. Frequent hot work is expected during the dismantling phase of the project and alternative measures and administrative controls are being reviewed by a 3rd party as well as CNSC to minimize the disruption to other workers in the area.

Space Inventory and Storage

Space for equipment storage and staging within the CLS is limited. A space inventory for the facility was compiled to identify staging locations for new linac components and storage space for equipment harvested from the old linac. The CLS Space Allocation Committee and several beamlines have worked to clear areas approved for Linac storage.

Shipping containers will be rented for additional, overflow storage for items that don't require a controlled climate.

A colour coded tagging system is being used to direct dismantled components. This is being integrated with the radiation surveying plan to ensure that activated components are not removed for the radiologically controlled area.

Figure 9. Dismantling tags.

Acknowledgements

Special thank you to the CLS Linac Upgrade Project Team; Health, Safety and Environment group; OTS Technicians; and Space Allocation Committee.