ALS-U Cable Plant Design, Installation progress and lessons learned

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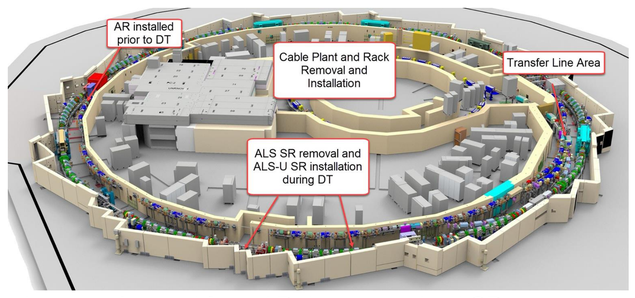
Abstract

The LBNL ALS-U project is delivering major facility upgrades to install a new Accumulator Ring (AR) and Storage Ring (SR), requiring cable plant infrastructure to support approximately 12,000 Long-Haul cables in a highly congested and space-constrained environment. This work demands strong coordination between design, AHJ compliance, and field execution to ensure constructability and schedule performance.

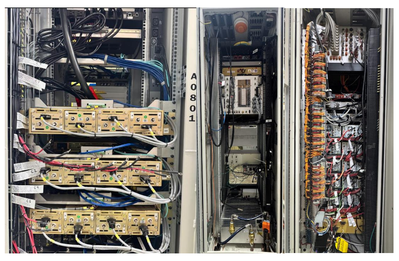


Lessons learned from AR drove a revised SR approach to improve design coordination and installation readiness. Key changes include engaging an experienced A&E firm, transitioning to Revit-based design, finalizing cable requirements earlier, and adding spare tray capacity to reduce rework and simplify installation.

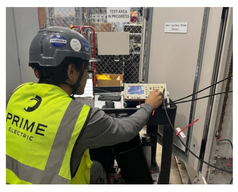
AR Cable Plant Progress

AR Cable Plant design complete, 58/59 racks installed, Infrastructure complete for 6/12 sectors, 2 sectors in progress, cable pulls and terminations in progress 29% pulled,13% terminated and tested. Functional testing started for first sector. All installation expected to be complete by Nov'26

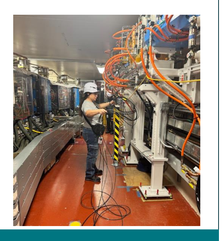
Completed prototype sector



First completed Power Supplies, Vacuum and control Racks



Subcontractor performing BPM cable testing

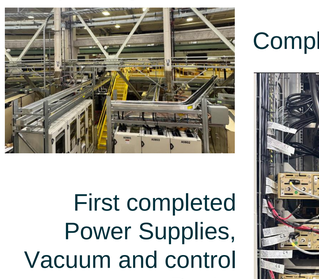


LBNL team dressing cables before termination

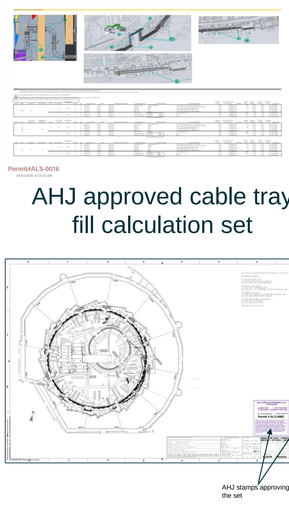
Design QA

A structured design review process was implemented, incorporating thorough reviews with SMEs, AHJ, and the installation team. Design validations were conducted at 30%, 60%, 90%, and IFP stages to ensure progressive maturity and issue resolution. The final design package undergoes formal review and approval by the AHJ.

60% review set with comments



AHJ Stamped final sector installation design



AHJ approved cable tray fill calculation set

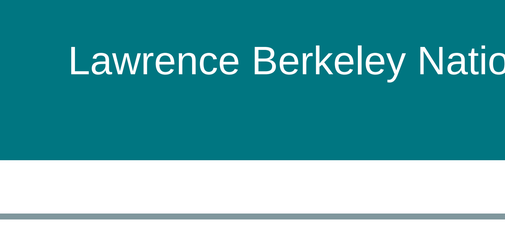
Cable Plant Design challenges

- Creo Modelling and CAD approvals- Currently it takes 3-5 months to complete an installation package due to complex design and modelling requirements in Creo.
- Drawing LoD requirements for AR - In-house trades require highly detailed drawings for every installation
- AHJ Approvals - Electrical AHJ can not offer any guidance on acceptance criteria for designs, until designs are mature. Requirements for installation design and inspections are not clearly defined and In-house design efforts lacked A&E–level construction package maturity, driving insufficient detail and multiple AHJ-driven design revisions.

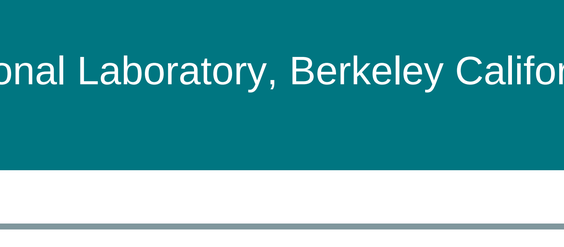
Duration to do in-house design in Creo

Duration to design by subcontractor all schedule is met

Deliverables	Duration	Weeks	Estimated Dates
30% one sector (S5) design package	1 week	1	3/31/2026
30% one sector (S5) review	1 week	1	4/7/2026
60% one sector (S5) design package	2 weeks	2	4/21/2026
60% one sector (S5) review	1 week	1	**4/28/2026**
90% one sector (S5) design package	2 weeks	2	5/12/2026
90% one sector (S5) review	1 week	1	**5/19/2026**



Creo Model (3D)



Revit Model (3D)

Cable Plant installation challenges/ Lessons Learned

Challenges:

- Pit installations strained in-house labor due to limited availability and limited experience with large-scale installation projects
- Increased risk of schedule delays when relying solely on in-house resources
- Delays on inputs and material handoffs from subsystem

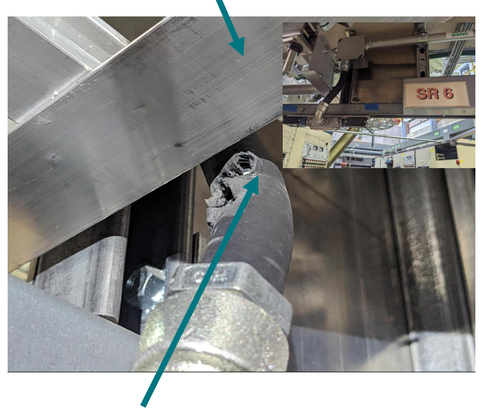
Applied Learning:

- Subcontracting remaining AR work reduces schedule risk by leveraging specialized installation expertise
- Lessons learned from the first three cable plant sectors have removed key roadblocks and improved execution for remaining AR scope
- Subcontracting AR strengthens readiness and planning discipline for upcoming SR installation

Rack door closed on cables, resulting in damage.

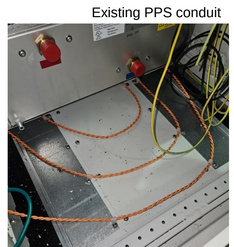
Stepping on cabinet by installers to pull and terminate cables damaged the Rack

New Cable Tray



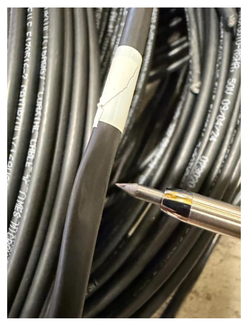
Damage to existing PPS conduit while installing new tray

Corrective Action: No blind work. Moving forward if you cannot see both sides of the work or task you are to perform, then it's a hold point. The work is to be discussed with foreman, subcontractor and the lab CM (if needed), before that work can continue. Or until access to both sides of the work is available.



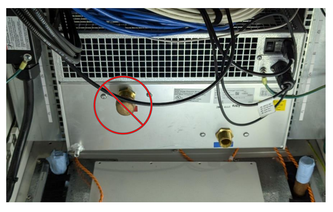
Avoid drilling or cutting on the rack or have some means and method to avoid falling of metal shavings in the rack

Clean up after work



BPM Cable damaged due to stepping on the cable

Secure the area of work to avoid human traffic.

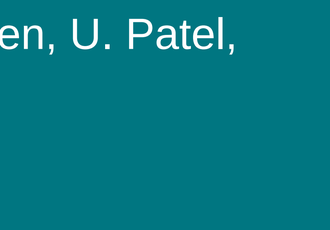


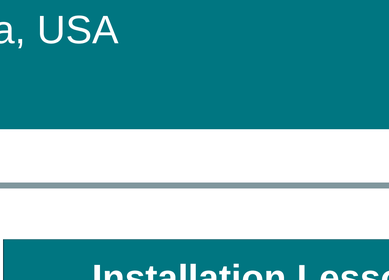
Check on fitting to make connections in this case connectors are BPT not NPT

Installation Lesson Learned

Vacuum Gamma cable terminations - Gamma cables multiple cables failed testing
Cause: Connector failure caused by the cable twisting as the cable collet is tightened. Specifically, this caused the white wire to rub against the edge of the crimp, causing a pinhole in the wire's insulation

Path Forward: Train installers by doing bench fitting of this connector installation and removal to ensure the instructions provided by vendor are well understood and followed correctly.





Network testing equipment out of calibration

Issue: The network team did several cable tests where all results were submitted as passed and results were provided to subsystem owner for acceptance. It was identified from the test reports that device was last calibrated 10 years ago

Possible solutions: Buy / rent new calibrated testing device, calibrate existing device

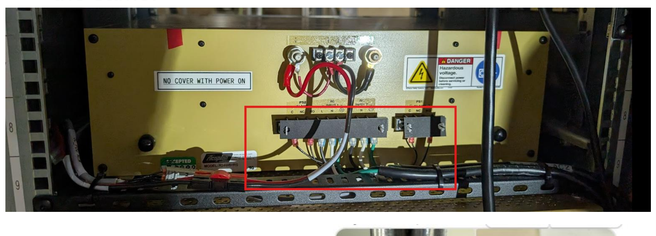
Path forward: All network cable tests are paused until a calibrated device is obtained.

Rack Energization

A vacuum rack was energized following AHJ approval. During subsequent inspections of additional racks for energization, the AHJ identified that some installed equipment was not finger-safe.

Possible solutions:

- Install plexiglass on all devices that are not finger safe
- Racks must be worked on by QEW individuals only. That entails that all subsystem testing will be done by QEW individuals and labels added to the racks to state the same.



When working on unique connectors, use the correct tool for the job!

Pause work if something doesn't look right and contact SME.

BPM cable failed functional TDR test after passing TDR test during termination. No physical damage seen on cable

ALS-U ADVANCED LIGHT SOURCE

ENGINEERING