



ALS-U Seismic Design Criteria

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1 REVISION HISTORY

Rev.	CM Number	Description of Change
A	AL-1008-7759	Initial Draft

2 APPROVALS

The following individual(s) shall approve this document:

Approver	Project Role
Ken Chow	Chief Engineer
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3 ABBREVIATIONS AND ACRONYMS



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ALS	Advanced Light Source
ALS-U	Advanced Light Source Upgrade
ASCE	American Society of Civil Engineers
LBNL	Lawrence Berkeley National Laboratory
RI	Responsible Individual
RPM	LBNL Requirements and Policies Manual
SEOR	Structural Engineer of Record

4 INTRODUCTION

This document outlines the design and installation requirements for anchorage of equipment in the ALS. The requirements pertain to all equipment inside of the building, including research equipment, beamline units, Storage and Accumulator Ring equipment, and utility units (e.g. air handling units, electrical panels, etc.).

4.1 Equipment Anchorage Design Criteria

4.1.1 Governing Codes and Standards

The 2019 California Building Code is the governing code for anchorage of equipment in the ALS, effective January 1, 2020.

4.1.2 Anchorage Requirements for New ALS Equipment

1. The following equipment in the ALS must be anchored for seismic loads:
 - a. Any structure that personnel can enter, such as radiation hutches, shielding structures, or environmental test chambers.
 - b. All equipment that are more than 4 feet tall, regardless of weight.
 - c. All equipment sitting on the floor or a roof shielding block and weighing more than 400 pounds, including storage cabinets, laboratory equipment, mechanical components, and electrical components.
 - d. All equipment mounted to a wall or suspended from above and weighing more than 20 pounds.
 - e. All equipment sitting on a tabletop and weighing more than 100 pounds. The table would also need to be anchored.
 - f. All equipment and furnishings that could block doors or exit passages if they fall, regardless of height or weight.
 - g. 160 liter dewars and compressed gas cylinders.



- h. Mechanical and electrical distribution systems except for those listed as exceptions in ASCE 7-16 Section 13.6. These exceptions do not apply to fire protection sprinkler piping or to systems that contain hazardous materials.
- i. Any equipment, distribution system, storage cabinet, or container that contains hazardous materials.
- j. Exemptions: It is recommended that the following items be anchored for seismic loads. However, these items are exempt from the requirement for an anchorage design by a Registered Structural Engineer:
 - i. Temporary equipment that will be removed within 12 months of the initial placement.
 - ii. Equipment that is designed to be mobile during normal operations (e.g. carts)
 - 1. Note: Equipment that has wheels or casters are not to be automatically considered mobile.
 - iii. Mechanical and electrical components meeting all of the requirements of ASCE 7-16 Section 13.1.4 Item 6;
- 2. The ALS may elect to anchor equipment otherwise exempt from seismic anchorage if the unit needs to be secured from movement as part of its normal operation, such as beamline stands.
- 3. Please see Section D.6 of the Seismic Safety section in the RPM for additional information.
- 4. Re-Use of Existing Anchors with New Equipment:
 - a. Existing expansion anchors, concrete screws, and drop-in expansion anchors (e.g. Hilti HDIs) cannot be reused under any circumstances.
 - b. Existing epoxied threaded rods and epoxied threaded inserts can be reused if they are pull tested to verify their adequacy to resist the anticipated new loads.
 - c. The new loads will be calculated by Facilities Engineering and will be based on the governing code.

4.1.3 Anchorage Requirements for Existing ALS Equipment

- 1. Existing equipment that is not relocated or modified can be considered grandfathered in to compliance with the anchorage requirements.
- 2. Existing equipment that is relocated permanently must have its anchorage redesigned to the governing code requirements.
 - a. Exceptions:



- i. Existing equipment that is permanently relocated 6 mm (1/4 in) or less from its original location can reuse its existing anchors without re-design provided that:
 1. The base plate geometry can accommodate the existing anchor locations;
 2. The existing anchors are either epoxied threaded rods or epoxied threaded inserts;
 3. The equipment weight and/or center of gravity height has not changed as described in Section 4.1.3 Item 4.
 - ii. Existing equipment that is placed at a temporary location for 12 months or less does not need to be anchored at the temporary location unless it is located directly adjacent to a pedestrian exit path.
3. Existing equipment that is relocated and then returned to its original location can be considered grandfathered into compliance provided that the existing anchors can be reused (as described in Section 4.1.2 Item 4) and the equipment weight and/or center of gravity height has not changed as described in Section 4.1.3 Item 4.
 4. Existing equipment that remains in place but is modified such that the weight and/or the center of gravity height has increased must have the loads to the anchors recalculated for the new equipment configuration using the governing code prescribed seismic forces.
 - a. If the loads to the anchors do not exceed 110-percent of the original anchor design force, then the existing anchors can be reused without modification.
 - b. If the loads exceed this value, then the anchors must be checked for the governing code prescribed seismic forces. Additional anchors may be required.
 - c. ALS-U will be responsible for providing the mass and center of gravity location for the modified equipment.
 - d. Facilities Engineering will perform the anchor load calculations.

4.1.4 Anchor Location Requirements

1. Anchors must be located at least 6 inches (15.2 cm) away from any live electrical conduit, including conduit embedded in concrete slabs.
2. Anchors must be located to avoid the existing concrete reinforcement, unless permission to drill through the rebar has been granted by the LBNL Facilities Structural Engineer.
3. Anchors are not allowed over any existing concrete grade beam, with the following exceptions:



- a. Anchors that are in holes 2" deep and less;
 - b. Anchors in the topping slab that are solely within the topping slab depth (6").
4. Proximity of New Anchors to Abandoned Anchors and Anchor Holes:
- a. New anchors shall be located at least three times the new anchor hole diameter away from abandoned (unloaded) drop-in anchors and threaded inserts.
 - b. If the abandoned anchor hole is filled with grout, then new anchors can be located up to 1.5 times the new anchor hole diameter away from the filled-in anchor.
 - c. Existing wedge and epoxied anchors that have been cut off should be treated as abandoned anchors with unfilled holes.
 - d. Holes in the concrete (for pipe penetrations, etc.) should not be considered as abandoned anchors but instead as concrete edges when determining the anchor capacity.
 - e. This policy applies to both expansion and epoxied anchors manufactured by Hilti, Simpson, and Powers.

4.1.5 Design Procedure for Anchoring Into the Topping Slab

1. When anchoring to the topping slab below the Storage Ring (see Figure 4-1), one of the following two design approaches must be used:
 - a. The concrete topping slab can be considered integral with the structural slab only if the distances to trench edges and slab cuts are considered in the anchor design. In this case, trench edges and slab cuts must be considered as concrete edges.
 - b. Alternatively, the topping slab can be considered as non-load bearing grout. In this case, the trench edges and topping slab cuts do not need to be considered in the design. However, the required anchor embedment would be into the concrete structural slab only, such that the specified anchor hole depth would be the required anchor embedment **plus** the thickness of the topping slab.

4.1.6 Data Required for Engineering

1. The following information must be provided to the structural engineer as part of a request for equipment anchorage design:
 - a. The weight of the equipment (in either pounds or kilograms).
 - b. The overall height, width, and depth of the unit.
 - c. The dimensioned location for the equipment's center of gravity (height and in plan), if known.



- d. Dimensions to any edges in the concrete slab or wall that the equipment will be anchored to that are within 18 inches of the edge of the anchor base. Examples of edges include trenches, slab cuts, and shielding block joints.
- e. The layout of the equipment base, including dimensioned locations and diameters for predrilled anchor holes in the base.
- f. The base thickness and material type (e.g. steel, aluminum, granite, etc.).
- g. The required conditions below the equipment base, such as:
 - i. If grout will be placed below the base, identify the grout thickness;
 - ii. If there needs to be an air gap between the base and the concrete, provide the minimum required dimension for the depth of the gap;
 - iii. Identify if the base will bear directly on the concrete.
- h. Identify if the equipment needs to be isolated from vibration.
- i. The magnitude and location of all vacuum loads on the equipment.
- j. The dimensioned location of any existing anchors that are anchoring equipment and will be within 24 inches of any new anchor.

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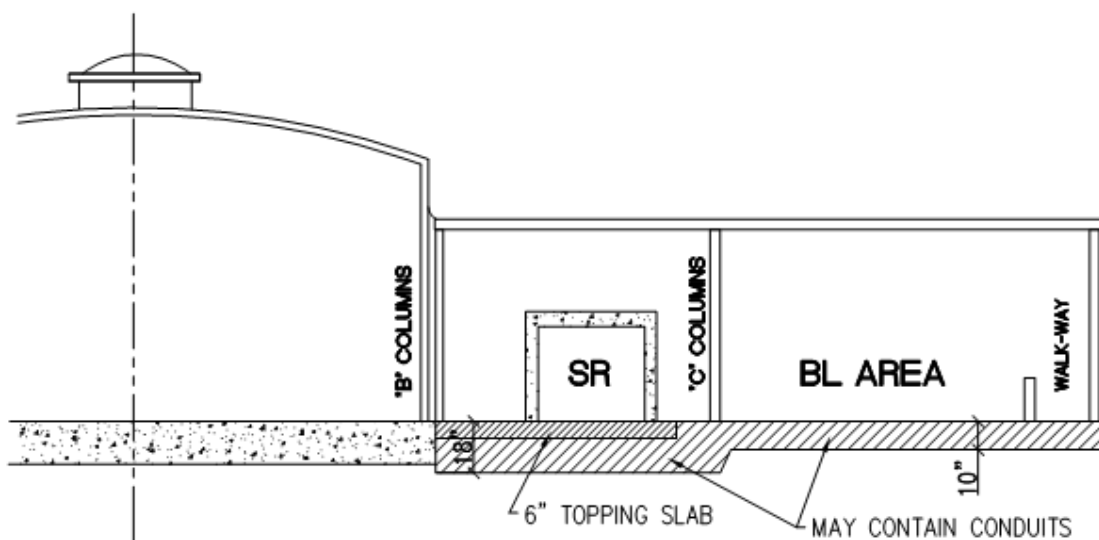


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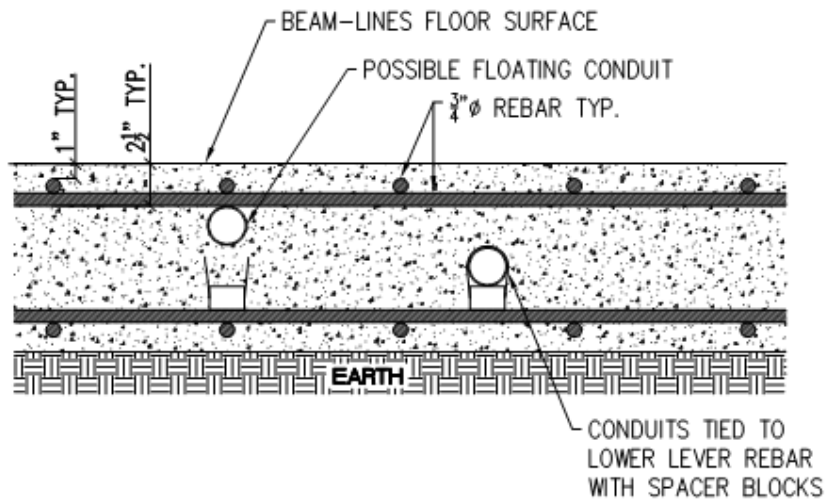
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ALS FLOOR REGIONS



SECTIONAL VIEW OF ALS BEAM-LINES FLOOR

Figure 4-1: Typical Slab Section in the ALS



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4.2 Equipment Anchorage Installation Criteria

4.2.1 Concrete Scanning Requirements

Except in cases where the new anchors will be in holes 2" or less in depth (as specified in the "Memorandum of Understanding and Request for PUB-3000 Variance"), the concrete surface must be scanned to locate existing conduit and rebar prior to installation of the anchors. Preferably, the scanning should be done prior to the anchor design.

4.2.2 Special Inspection Requirements

1. The hole drilling must be inspected by a qualified special inspector. The inspector must verify that 100-percent of the holes comply with the engineered design and the specifications of the anchor manufacturer.
2. The anchors shall be tension tested after installation per the requirements specified below. Expansion anchors may be torque tested instead of pull tested with the approval of the SEOR. Concrete screw anchors do not require pull or torque testing.
3. Test 25 percent of torque controlled mechanical anchors (expansion anchors) installed on a given day, unless more frequent tests are specified in the Contract Documents. Either torque test the anchors to the installation torque or pull test to 150% of the calculated load capacity. Anchors specifically noted on the drawings as "No test required" do not require tension testing.
4. Test 25 percent of threaded rod dowels and threaded inserts installed with epoxy on a given day in tension using pullout procedure, unless more frequent tests are specified in the Contract Documents. Test to 150% of the calculated load capacity. Dowels specifically noted on the drawings as "No test required" do not require tension testing.
5. Where less than 100 percent of the anchors are specified to be tested, if the failure rate of anchors or dowels exceeds 10 percent, testing shall be increased to 100 percent of that day's installation of similar anchors or dowels. Testing can then be reduced to 25 percent of that day's installation when the failure rate is reduced to 10 percent or less.
6. Failed anchors and dowels shall be replaced. When the anchors are installed by a Subcontractor, they shall be replaced at no additional cost to LBNL and the Subcontractor shall reimburse LBNL for the cost of additional testing.
7. Please see Facilities Master Specification Section 031500 for additional inspection requirements.

4.2.3 Procedure for Installing Anchors into the Concrete Shielding Blocks



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1. There are no known electrical conduits in the concrete shielding blocks. However, the blocks are to be scanned to locate the rebar so that the Structural Engineer of Record (SEOR) can determine whether the structural integrity of the shield block is not being compromised.
2. The anchors are to be located to avoid hitting rebar if possible.
3. If hitting rebar cannot be avoided, then the SEOR shall be notified and told where the rebar would be hit. The SEOR would evaluate the blocks, determine if the rebar can be cut through or not, and notify the installers.
4. The ALS Responsible Individual (RI) is responsible for the radiation protection integrity of the shield block.
5. Please see the document "LBNL Advanced Light Source Upgrade, Storage Ring Shielding, ASCE 41-13 Tier 1 & Tier 2 Evaluation, Part 3: New Penetrations Assessment in the Cast-in-Place Concrete Inner Shielding Ring Wall" for the requirements for locating penetrations through the shielding block walls.

4.3 Additional Requirements

1. If an air gap is needed between the equipment and the anchorage brackets in order to maintain vibration isolation, then the gap must not exceed 1/4" (6.5 mm).
2. Please see Engineering Note AL2016-11072-A for requirements pertaining to the specification of the holes in equipment base plates for the anchors.
3. Please see Engineering Note AL0010-10902-B for requirements pertaining to the structural design of hutches and enclosures.
4. Please see Facilities Master Specification Section 031500 for requirements pertaining to post-installed anchors to concrete.
5. Note that there are additional requirements for anchoring to the mezzanine floor. Please contact the LBNL Facilities Structural Engineer for these requirements.

5 APPLICABLE DOCUMENTS

This section identifies applicable documents that are considered to be a part of this document. All information contained in an applicable document shall be valid to the full extent, unless specifically noted within this document. Applicable documents shall be obtained from the LBNL Document Control Center (DCC).

Document Number	Title
AL-0010-10902 Rev. B	Enclosure Structural and Seismic Specifications
AL-2016-11072 Rev. A	ALS Beamline Component Seismic Anchoring Methodology



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6 REFERENCES

Documents listed in this section are considered reference documents that can be used to better describe, clarify intent, or provide information where the information was obtained from.

American Society of Civil Engineers, "ASCE 7-16: Minimum Design Loads and Associated Criteria for Buildings and Other Structures", 2017

California Building Standards Division, "2019 California Building Code", 2019.

LBNL Facilities, Master Specification Section 031500, "Concrete Accessories".

"Memorandum of Understanding and Request for PUB 3000 Variance between the LBNL Advanced Light Source Division, the Facilities Division, and the EH&S Division," September 2011.

Rutherford + Chekene Structural Engineers, "LBNL Advanced Light Source Upgrade, Storage Ring Shielding, ASCE 41-13 Tier 1 & Tier 2 Evaluation, Part 3: New Penetrations Assessment in the Cast-in-Place Concrete Inner Shielding Ring Wall", August 30, 2019.



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