Chapter 44

Penetration Safety

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1 Overview

Penetrations are defined generally as openings made by drilling, cutting, or otherwise piercing a wall, ceiling, or floor (see Section 4, “Definitions”).

1.1 Hazards/Impacts

The most common hazards associated with penetrations are

- Unidentified or misidentified utilities
  Workers may be exposed to hazards such as electric shock, suffocation, or explosions if they unexpectedly come in contact with utility lines.

- Waste material generated from the penetrations
  It may be a small amount of material, but it could contain lead, asbestos, or PCBs. (See hazard-related chapters."

2 Scope

Specific requirements are defined to ensure that the hazards of penetrations are evaluated and controlled to protect personnel. The penetration safety program and its requirements apply to all personnel, SLAC and subcontractor, performing penetrations at SLAC.

2.1 Exemptions

Excavations (see Section 4, “Definitions”) are not within the scope of this chapter.

The requirements of this program do not apply to the placement of thumbtacks, picture nails, or similar items in a hollow wall or ceiling that do not go beyond the thickness of the external material (that is, sheetrock, wood, plaster board).

2.2 Variances

Any variance to this procedure must be requested in writing to the electrical safety officer (ESO) or alternative authority as determined by the ESO, and written approval received prior to implementation.

3 Standards

Requirements for penetration safety are derived from the following standards for general safe work practices:

- **Title 29, Code of Federal Regulations**
- **National Fire Protection Association (NFPA) 70E-2004, “Standard for Electrical Safety Requirements for Employee Workplaces”**\(^4\)

4 Definitions

*Area hazard analysis (AHA).* A process for analyzing hazards, focused on the hazards an individual faces in his/her work area as opposed to hazards of individual work activities (see *job hazard analysis and mitigation*).

*Area responsible person.* All areas at SLAC (including buildings and facilities) have a responsible person designated by line management. Reference the appropriate area hazard analysis.

*Customer/requester.* Person or organization designee requesting the penetration

*Excavation.* Any man-made cut, cavity, trench, or depression in an earth surface formed by earth removal. This definition includes environmental characterization (for example, core drilling), jack hammering, and indoor drilling/digging operations that may contact soil. In general, excavations are operations where contact with soil is expected, such as trenching and removing soil to install foundation footings or exposing underground pipes for repair or replacement. (See *ES&H Manual*, Chapter 11, “Excavation Safety”\(^5\).)

*Electrical hazard control work plan (EWP).* A document that, at a minimum, defines the work, identifies the hazards associated with the work, and describes the controls needed to reduce the risk posed by the work to an acceptable level.

*Hidden hazard.* Unseen electrical lines, gas lines, waste lines, water lines, or other lines that, if disturbed, may injure personnel or damage equipment.

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4  See the SLAC Library, [http://www.slac.stanford.edu/library/](http://www.slac.stanford.edu/library/), for available standards. NFPA standards are available online from a SLAC login (see [http://www.slac.stanford.edu/library/eresources/slac.htm](http://www.slac.stanford.edu/library/eresources/slac.htm) for the link and instructions); some hard copies are also available.
**Job hazard analysis and mitigation (JHAM).** A tool used for analyzing hazards an employee faces and identifying measures to mitigate those hazards

- **Job hazard analysis and mitigation, non-routine.** A document or set of documents that includes identification of site hazards and controls, principal work steps, task hazards and controls, and necessary permits and training

**Non-destructive testing (NDT).** The examination of the internal structure of a solid material without using destructive forces. Examples of NDT methods are penetrating ionizing radiation, ground-penetrating radar, and magnetic, inductive, and conductive devices and methods.

**Penetration.** An opening made by drilling, cutting, or otherwise piercing a wall, ceiling, or floor. This does not include placement of thumbtacks, picture nails, or similar items in a hollow wall or ceiling that do not go beyond the thickness of the external material (that is, sheetrock, wood, and so on).

- **Class 1 Penetration.** Any penetration that is made into hollow walls, hollow ceilings, or hollow floors, or a penetration into solid materials to a depth of 2.0 inches or less
- **Class 2 Penetration.** A penetration that is deeper than 2.0 inches or is all the way through solid materials

**Personal protective equipment (PPE).** Safety equipment, such as hard hats, safety glasses, safety shoes, dielectric gloves, that is worn to protect personnel from hazards

**Responsible line manager.** A manager or supervisor who is responsible for directing the day-to-day activities of employees under his/her supervision

**Solid material.** A floor, slab, wall, roof, or ceiling consisting of cast-in-place or pre-cast concrete, brick, gypsum drywall, plaster, wood, or masonry block materials

## 5 Requirements

### 5.1 General

#### 5.1.1 Penetration Permit

Penetration work will require a permit, subject to the conditions below. (See Penetration Safety: Penetration Permit.  

#### 5.1.1.1 Class 1 Penetrations

A penetration permit is required for Class 1 penetrations unless the activity and subsequent hazard analysis and controls are documented in a routine or non-routine JHAM.  

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All penetrations within a radiologically controlled area (RCA), a radioactive material management area (RMMA), or part of accelerator shielding (for example, the Accelerator Housing Structure, End Station A Hall, Klystron Gallery Floor) require a penetration permit.

**Note** If a responsible line manager or designee has direct knowledge that a structure, wall, floor, or other surface does not contain electrical, gas, or other hazards, and this structure, wall, or floor is not part of or within an RCA, RMMA, or accelerator shielding, then these requirements do not apply and a Class 1 penetration may be authorized without a hazard evaluation or documentation.

5.1.1.2 Class 2 Penetrations

A penetration permit is required for all Class 2 penetrations. The activity and subsequent hazard analysis and controls shall be documented on the permit, unless they have already been documented in a routine or non-routine JHAM, in which case the permit will reference that documentation.

5.1.2 Pre-job Briefing

The responsible line manager/designee will conduct a pre-job briefing, in accordance with work control or safe work practices, prior to performing any work that requires penetrations. The briefing will cover the hazards and controls associated with the work and the correct use and care of PPE required to perform the work safely.

5.1.3 Stopping Work

If any unexpected conditions are encountered while performing a penetration, the operation must be stopped and the responsible line manager must be informed. Examples of unexpected conditions are unexpected or unusually slow drilling or cutting, overheating and/or rapid dulling of drill bits or saw blades, metal shavings where drywall is expected. (See Chapter 2, “Work Authorization”.

In addition, work must be stopped if any of the following conditions occur before or during the penetration:

- Penetration area boundaries change.
- Additional penetration work beyond the scope of the original work is required.
- Site conditions change that affect the location of the penetration or interfere with the penetration in some way.

5.1.4 Structure and Equipment Specific

Penetrations into specialized structures, such as radiological shielding or hazardous material confinement structures, may require review and approval by other organizations. For example, Radiation Protection Department approval is required for all penetrations into radiological shielding structures.

5.1.5 Recordkeeping

- Penetration permits and non-routine JHAMs for penetration operations will be available at the job site.

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Penetration permits and non-routine JHAMS that are part of a facility work package or programmatic work will be maintained in accordance with the requirements of that facility.

5.1.6 Roles and Responsibilities

5.1.6.1 Penetration Safety Program Manager
- Develop requirements and guidance as appropriate
- Provide line management and workers with guidance concerning program requirements
- Periodically monitor activities for compliance

5.1.6.2 Line Management Responsibilities
- Ensure that a hazard evaluation is performed in accordance with the requirements contained in this chapter and that required controls are in place before authorizing a penetration operation
- Authorize penetration operations by reviewing and signing penetration permits, activity hazard analyses (JHAMS), and/or hazard control plans (EWPs)
- Ensure that the causes of incidents or problems involving penetrations are identified and that corrective actions are implemented to prevent recurrence
- Discuss the hazards and controls with workers and verify that the workers are trained and qualified to perform the work prior to authorizing the work

5.1.6.3 Worker Performing Penetration Operation
- Follow the requirements contained in this chapter and its supporting materials before performing penetration operations
- Conduct hazard evaluations of the planned work
- Be familiar with the hazards and controls required to perform the work safely
- Be qualified in the correct use of personal protective equipment required for the job and wear the required PPE
- Stop work immediately if any of the follow occur:
  - There are any safety concerns that are not mitigated.
  - Any unidentified or unexpected utilities, materials, or equipment problems occur or are observed.
  - Any other unexpected condition is detected that places the worker at risk.

5.1.6.4 Area Responsible Person
- Review and approve penetration permits for Class 2 penetrations
- Assist in the review of historical records, engineering plans, and as-built drawings that pertain to an area/location where a penetration is planned
- Participate in hazard evaluations of planned penetration operations when requested

5.1.6.5 Customer / Requestor
- Participate in hazard evaluation of planned penetration operations when requested
5.2 Procedures and Specific Requirements

5.2.1 Penetration Permit

Form and instructions for obtaining a penetration permit (see Penetration Safety: Penetration Permit⁹)

5.3 Training

There are no training requirements specific to penetration safety.

6 Exhibits

- “Job Hazard Analysis”¹⁰
- Penetration Safety: Penetration Permit (SLAC-I-730-0A23R-002)¹¹

7 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)¹²
- Chapter 2, “Work Authorization”¹³
- Chapter 8, “Electrical Safety”¹⁴
- Chapter 11, “Excavation Safety”¹⁵
- Chapter 19, “Personal Protective Equipment”¹⁶

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¹⁰ http://www-group.slac.stanford.edu/esh/general/hazanalysis/jham.htm
¹¹ http://www-group.slac.stanford.edu/esh/forms/
¹² http://www-group.slac.stanford.edu/esh/eshmanual/
¹³ http://www-group.slac.stanford.edu/esh/general/work_authorization/policies.htm
¹⁴ http://www-group.slac.stanford.edu/esh/hazardous_activities/electrical/policies.htm
¹⁵ http://www-group.slac.stanford.edu/esh/hazardous_activities/excavations/policies.htm
¹⁶ http://www-group.slac.stanford.edu/esh/general/ppe/policies.htm
8 Implementation

The requirements of this chapter are effective upon publication unless otherwise noted here.

9 Ownership

Department: Electrical Safety Support Group

Program: Penetration Safety

Owner: Program Manager
Chapter 44: Penetration Safety

Penetration Permit

Product ID: 282 | Revision ID: 1393 | Date Published: 15 May 2012 | Date Effective: 15 May 2012
URL: http://www-group.slac.stanford.edu/esh/forms/penetrationpermit.pdf

Instructions

A penetration permit is required for all Class 2 penetrations and for those Class 1 penetrations where the hazards and controls are not documented in a job safety analysis (JSA) or similar work authorization document.¹

*Class 1 penetrations* are defined as any penetration made into hollow walls, hollow ceilings, or hollow floors, or a penetration into solid materials to a depth of 2 inches or less; *Class 2 penetrations* as any deeper than 2 inches or all the way through solid materials.

All penetrations within a radiologically controlled area (RCA), a radioactive material management area (RMMA), or part of radiation shielding (for example, the Accelerator Housing Structure, End Station A Hall, Klystron Gallery Floor) require a penetration permit with the “Radiological Safety” section of the permit completed by the Radiation Protection Department in ESH. Please allow two days for Radiation Protection Department review.

In addition, a radiation safety work control form (RSWCF) is required for all penetrations that meet any of the following conditions:²

- Into or through non-concrete radiation shielding
- Into concrete radiation shielding, with penetration exceeding 2 inches in diameter
- Into concrete radiation shielding, with penetration exceeding 6 inches deep
- Into concrete radiation shielding where penetration is not refilled with a dense material (for example, concrete or steel)
- All the way through concrete radiation shielding
- Into FEH hutch roof concrete radiation shielding, with penetration exceeding 3 inches deep

Contact the area safety coordinator for more information on possible shielding concerns.

The completed penetration permit must be kept at the worksite during task. Upon completion of work send the penetration permit to the electrical safety officer, Mail Stop 84.

Pre-planning

Workers will evaluate hazards and controls as required for the penetration work to be performed.

- Check behind walls, under floors, or through false ceilings to attempt to locate hidden utilities or other hazards (such as asbestos). In most industrial environments, electric wiring is run in metal conduit. However, it is possible for Romex cable or other soft-surfaced electrical wiring to be present within hollow walls of some buildings, especially in some portable buildings.
- Verify metal stud locations by measuring from adjacent studs or by using detection equipment to determine that the metal is not an electric conduit or gas pipe.
- If it is suspected that hidden hazards exist at the point of penetration, relocate the work if possible. If the work cannot be relocated, use non-destructive testing (NDT) devices (ground penetrating radar, x-ray, magnetic, induction, conductive, or other devices and methods) to determine whether additional hazards exist. For hollow structures a pilot hole may be useful to look for

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¹ Work Planning and Control: Job Safety Analysis Form (SLAC-I-730-0A21J-034) (pdf or Word); see “Job Safety Analysis” for additional guidance.

² Guideline 14, “Configuration Control of Radiation Safety Systems”, SLAC Guidelines for Operations (SLAC-I-010-00100-000), contact area safety coordinator for area- and system-specific forms.
hidden utilities. If the penetration is to be made into a solid load-bearing wall, use NDT before performing the penetration to ensure that it does not interrupt wall reinforcement.

- Do not use unfiltered portable vacuums to remove wallboard or concrete dust from drilling or chipping operations. Unfiltered vacuums used for wet or dry mineral dust can create dust clouds that cause false fire alarms. Before vacuuming mineral dusts or slurries, ensure that the appropriate filter is installed in the vacuum and verify that fire technicians have bypassed any local smoke detectors.
General Information

Area / location: Date(s) work will be performed:

Job description (location of penetration, material to be penetrated, tools, etc):

Other information (depth of penetration, etc):

Responsible line manager or designee: Phone number: Organization:

Class 1 Penetration Checklist

Hollow walls, ceilings or floors, or 2 inches or less into solid material

<table>
<thead>
<tr>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Checked other side of walls, under floors, or through false ceilings for hazards?
- Verified stud locations?
- Non-conductive tools to be used?
- Masonry bits and hand tools to be used for initial penetration?
- Drill bit stops or short drill bits (2 inches or less) to be used for solid material?
- Electrical tools equipped with GFCIs or double insulated?
- GFCIs tested?
- Appropriate PPE specified (see “Controls”) and obtained?
- PPE inspection(s) up to date?
- Penetration is within a radiologically controlled area or a radioactive material management area? If yes, submit to Radiation Protection to complete the “Radiological Safety” section.
- Penetration is part of accelerator shielding (for example, the Accelerator Housing Structure, End Station A Hall, Klystron Gallery Floor)? If yes, submit to Radiation Protection to complete the “Radiological Safety” section.

Penetrations that meet any of the conditions below require a radiation safety work control form (RSWCF) and approval from Radiation Physics (If yes to any, submit to Radiation Protection to complete the “Radiological Safety” section):

- Into or through non-concrete radiation shielding
- Into concrete radiation shielding, with penetration exceeding 2 inches in diameter
- Into concrete radiation shielding, with penetration exceeding 6 inches deep
- Into concrete radiation shielding where penetration is not refilled with a dense material (for example concrete or steel)
- All the way through concrete radiation shielding
- Into FEH hutch roof concrete radiation shielding, with penetration exceeding 3 inches deep

Checklist completed by: Date:

Complete “Hazards and Required Controls” section.
# Class 2 Penetration Checklist

*Greater than 2 inches into solid material*

<table>
<thead>
<tr>
<th>Reviewed historical records, engineering plans, and drawings?</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area responsible person/designee, customer/requester, or other personnel consulted?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Visually inspected proposed location of penetration?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Checked other side of walls, under floors, or through false ceilings for hazards?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>De-energized and locked/tagged-out energy sources as required?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>NDT used to determine if additional hazards exist? If yes, list results in the “Hazards and Required Controls” section.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>NDT involves the use of a radiation generating device (x-ray generating device, etc.)? If yes, submit to Radiation Protection to complete the “Radiological Safety” section.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>NDT used to determine wall reinforcement?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Electrical tools equipped with GFCI or double-insulated?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>GFCIs tested?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Appropriate PPE specified (see “Controls”) and obtained?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>PPE inspection(s) up to date?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Short drill bits used or equipment marked to limit penetration depth?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Penetration is within a radiologically controlled area or a radioactive material management area. If yes, submit to Radiation Protection to complete the “Radiological Safety” section.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Penetration is part of accelerator shielding (for example, the Accelerator Housing Structure, End Station A Hall, Klystron Gallery Floor)? If yes, submit to Radiation Protection to complete the “Radiological Safety” section.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Penetrations that meet any of the conditions below require a radiation safety work control form (RSWCF) and approval from Radiation Physics (If yes to any, submit to Radiation Protection to complete the “Radiological Safety” section.):</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ Into or through non-concrete radiation shielding</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ Into concrete radiation shielding, with penetration exceeding 2 inches in diameter</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ Into concrete radiation shielding, with penetration exceeding 6 inches deep</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ Into concrete radiation shielding where penetration is not refilled with a dense material (for example concrete or steel)</td>
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<td>☐</td>
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<tr>
<td>▪ All the way through concrete radiation shielding</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>▪ Into FEH hutch roof concrete radiation shielding, with penetration exceeding 3 inches deep</td>
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</tbody>
</table>

Checklist completed by: ___________________________  Date: ___________________________

*Complete “Hazards and Required Controls” section.*
Hazards and Required Controls

May reference JSA or area hazard analysis (AHA) if hazards / controls are documented there.

Hazards

Type and size of energy sources present (including results from NDT, if used):

Hazards specific to the tools that will be used:

Work environment hazards (such as moisture, lead, asbestos, etc.):

Other hazards:

Controls

Procedural requirements:

Types and classification of PPE:

Other controls:
Radiological Safety

This section, if applicable, must be completed by Radiation Protection, Field Operations (RPFO). See the penetration checklist to determine if this permit requires RPFO approval. Please allow two days for review.

<table>
<thead>
<tr>
<th>Radiation Protection, Field Operations (RPFO) ext. 4299</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-work survey required?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Radiological HEPA vacuum cleaner required?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Radiation safety work control form (RSWCF) required? If yes, Radiation Physics must review (below).</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Additional requirements for this penetration? If yes, describe:</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Reviewed by: ___________________________ Date: ____________

Review of penetration permit by Radiation Protection, Radiation Physics (RPRP)

Required for any penetrations that require a radiation safety work control form (RSWCF)

Reviewed by: ___________________________ Date: ____________

Review, Approval, and Authorization

Any deviation from the scope of work identified on this permit requires revalidation of this permit. This penetration permit expires 30 days after issuance.

Class 1 and 2 Authorizations

I have discussed the hazards and controls with the workers and verified that they are trained / qualified to perform the work.

<table>
<thead>
<tr>
<th>Responsible line manager / designee:</th>
<th>Date:</th>
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</table>

Additional Authorization for Class 2

<table>
<thead>
<tr>
<th>Area responsible person (area or building manager):</th>
<th>Date:</th>
</tr>
</thead>
</table>