Chapter 44: Penetration Safety

Quick Start Summary

Product ID: 680 | Revision ID: 1845 | Date published: 7 June 2016 | Date effective: 7 June 2016
URL: http://www-group.slac.stanford.edu/esh/eshmanual/references/penetrationsQuickstart.pdf

1 Who needs to know about these requirements

The requirements of Penetration Safety apply to workers engaged in penetrations (drilling, cutting, or otherwise piercing) of a wall, ceiling, or floor, their supervisors, area and building managers, and the program manager; and the Radiation Protection (RP) Department. The requirements 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 Why

Penetrations may expose workers to hazards from unidentified utilities and materials affected by chemicals or radiation.

3 What do I need to know

Penetrations are classified as either Class 1 (made into hollow walls, ceilings, or floors or into solid materials to a depth of 2 inches or less) or Class 2 (deeper than 2 inches or all the way through solid material). A penetration permit is required for

- Class 2 penetrations
- Class 1 penetrations where the hazards and controls are not documented in a job safety analysis (JSA) (unless the supervisor has direct knowledge that a structure, wall, floor, or other surface does not contain electrical, gas, or other hazards)
- Any penetration within a radiologically controlled area (RCA), a radioactive material management area (RMMA), or into accelerator shielding

4 When

These requirements take effect 7 June 2016.

5 Where do I find more information

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)
- Chapter 44, “Penetration Safety”

Or contact the program manager.
Chapter 44

Penetration Safety

1 Purpose

The purpose of this program is to ensure that penetrations are conducted safely and in compliance with applicable regulations. It covers planning, approving, and performing penetrations. It applies to workers, supervisors, area and building managers, and the program manager; and Radiation Protection.

The requirements of this program do not apply to penetrations of earth, soil, or ground. For those penetrations, see Chapter 11, “Excavation Safety”.

1.1 Exemptions

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 Roles and Responsibilities

Functional roles and general responsibilities for each are listed below. More detailed responsibilities and when they apply are provided in the procedures and requirements.

The roles may be performed by one or more individuals and one individual may play more than one role, depending on the structure of the organizations involved. Responsibilities may be delegated.

2.1 Worker

- Follows the requirements of this chapter and its supporting materials before performing penetration operations
- Conducts hazard evaluations of the planned work
- Is familiar with the hazards and controls required to perform the work safely
- Is qualified in the correct use of personal protective equipment (PPE) required for the job and wears the required PPE
2.2 Supervisor

- Ensures that a hazard evaluation is performed in accordance with the requirements of this program and that required controls are in place before authorizing a penetration operation
- Authorizes penetration operations by reviewing and signing penetration permits and job safety analyses (JSAs)
- Discusses the hazards and controls with workers and verifies that the workers are trained and qualified to perform the work before authorizing the work
- Ensures that the causes of incidents or problems involving penetrations are identified and that corrective actions are implemented to prevent recurrence

2.3 Customer / Requester

- Participates in hazard evaluation of planned penetration operations when requested

2.4 Area / Building Manager

- Reviews and approves penetration permits for Class 2 penetrations
- Assists in the review of historical records, engineering plans, and as-built drawings that pertain to an area/location where a penetration is planned
- Participates in hazard evaluations of planned penetration operations when requested

2.5 Penetration Safety Program Manager

- Develops requirements and guidance as appropriate
- Provides guidance concerning program requirements
- Periodically monitors activities for compliance

3 Procedures, Processes, and Requirements

These documents list the core requirements for this program and describe how to implement them:

- Penetration Safety: Penetration Procedures (SLAC-I-730-0A23C-002). Describes processes for planning, approving, and performing penetrations

4 Training

There are no training requirements specific to penetration safety.

5 Definitions

Customer/requester. Person or organization 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 Chapter 11, “Excavation Safety”.)

Hazard, hidden. Unseen electrical lines, gas lines, waste lines, water lines, or other lines that, if disturbed, may injure personnel or damage equipment

Material, solid. 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

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

Testing, non-destructive (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.

6 References

6.1 External Requirements

The following are the external requirements that apply to this program:

- National Fire Protection Association (NFPA) 70E, “Standard for Electrical Safety in the Workplace” ([NFPA 70E](#))

6.2 Related Documents

[SLAC Environment, Safety, and Health Manual](#) (SLAC-I-720-0A29Z-001)

- Chapter 2, “Work Planning and Control”
- Chapter 8, “Electrical Safety”
- Chapter 11, “Excavation Safety”
Chapter 44: Penetration Safety

Penetration Procedures

1 Purpose

The purpose of these procedures is to ensure that penetrations are conducted safely and in compliance with applicable regulations. They cover planning, approving, and performing penetrations. They apply to workers, supervisors, ESH coordinators, and area and building managers; and Radiation Protection.

These procedures do not apply to penetrations of earth, soil, or ground. For those penetrations, see Chapter 11, “Excavation Safety”.

2 Procedures

Penetrations require a permit, as described below.

2.1 Penetration Planning Procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Person</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Supervisor</td>
<td>Classifies penetration:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- A Class 1 penetration is one made into hollow walls, hollow ceilings, or hollow floors or into solid material to a depth of 2 inches or less. A penetration permit is required unless the activity and associated hazard analysis and controls are documented in job safety analysis (JSA). (See Chapter 2, “Work Planning and Control”.) If the supervisor has direct knowledge that a structure, wall, floor, or other surface does not contain electrical, gas, or other hazards, these requirements do not apply and a Class 1 penetration may be authorized without a hazard evaluation or documentation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- A Class 2 penetration is one deeper than 2 inches or all the way through solid material. A penetration permit is required for all Class 2 penetrations. The activity and subsequent hazard analysis and controls must be documented on the permit, unless they have already been documented in a JSA, in which case the permit will reference that documentation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- All penetrations within a radiologically controlled area (RCA), a radioactive material management area (RMMA), into accelerator shielding (for example, the Accelerator Housing Structure, End Station A Hall, Klystron Gallery Floor), or involving the use of a radiation generating device (x-ray generating device, etc.) for non-destructive testing (NDT) require a penetration permit, including review by the Radiation Protection Department.</td>
</tr>
</tbody>
</table>
## 2.2 Penetration Procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Person</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Supervisor</td>
<td>Ensures hazards and controls are communicated to workers</td>
</tr>
<tr>
<td>2.</td>
<td>Worker</td>
<td>Performs work, implementing all required controls</td>
</tr>
</tbody>
</table>

## 3 Forms

The following forms are required by this procedure:

- [Penetration Safety: Penetration Permit Form](SLAC-I-730-0A23J-007). Form for documenting review and approval of penetrations

## 4 Recordkeeping

The following recordkeeping requirements apply for this procedure:
Upon completion of the work the supervisor must retain the permit for at least 12 months.

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)
- Chapter 44, “Penetration Safety”
- Chapter 2, “Work Planning and Control”
- Chapter 11, “Excavation Safety”

Other SLAC Documents
- None

Other Documents
- None
A penetration permit is required for all Class 2 penetrations; for those Class 1 penetrations where the hazards and controls are not documented in a job safety analysis (JSA) (unless the supervisor has direct knowledge that a structure, wall, floor, or other surface does not contain electrical, gas, or other hazards); and for any penetration within a radiologically controlled area (RCA), a radioactive material management area (RMMA), or into accelerator shielding.

Any deviation from the scope of work identified on this permit requires re-approval of this permit. Permit expires 30 days after issuance.

The completed permit must be kept at the worksite during the work. Upon completion of the work the supervisor must retain the permit for at least 12 months. (See Penetration Safety: Penetration Procedures [SLAC-I-730-0A23C-002].)

Work request number (if applicable):  Date permit submitted:

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):

Requester:  Phone number:  Organization:

Penetration Classification

Penetration is into hollow walls, hollow ceilings, or hollow floors, or a penetration into solid materials to a depth of 2 inches or less? If yes, complete “Class 1 Penetration Checklist”.

Penetration is deeper than 2 inches or all the way through solid materials? If yes, complete “Class 2 Penetration Checklist”.

Radiological Review Determination If any of the following are checked, submit permit to Radiation Protection to complete “Radiological Safety”.

Penetration is within a radiologically controlled area or a radioactive material management area?

Penetration is part of accelerator shielding (for example, the Accelerator Housing Structure, End Station A Hall, Klystron Gallery Floor)?

Penetrations that meet any of the conditions below require a radiation safety work control form (RSWCF) and approval from Radiation Physics.

- 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

Non-destructive testing (NDT) involves the use of a radiation generating device (x-ray generating device, etc.)?
### Silica Control Determination

<table>
<thead>
<tr>
<th>Penetrating concrete? If yes, then complete following checklist:</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry penetrations</strong> (rotary hammer, drills, etc.)?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>1. Equipped with commercially available shroud or cowling with dust collection system?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2. Tool operated and maintained in accordance with manufacturer’s instructions to minimize dust emissions?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3. Dust collector compliant with drill tool manufacturer recommendations, with a filter-cleaning mechanism, and a filter efficiency of 99% or greater?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>4. Using HEPA filtered vacuum cleaner when cleaning holes?</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

If yes to all four questions (1-4) then no further silica analysis is required. If no to any of them then follow [Chapter 56, "Respirable Crystalline Silica".](#)

<table>
<thead>
<tr>
<th>Wet core drilling?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Core drill equipped with integrated water cooling and sufficient water flow to eliminate visible dust?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>6. Using wet vacuum cleaner or other method to collect /contain all concrete slurry before slurry dries out?</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

If yes to both questions (5 and 6) then no further silica analysis is required. If no to either question then follow [Chapter 56, "Respirable Crystalline Silica".](#)

If performing other concrete dust-generating activities (saw cutting, jack-hammering, chipping, etc.) then follow [Chapter 56, "Respirable Crystalline Silica".](#)
### Class 1 Penetration Checklist

*Complete for penetrations into 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>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Caution:** for roofing work, electrical raceways (conduit) may be recessed or painted the same color as the interior ceiling. Use supplemental lighting and binoculars, or a man lift or scissor lift for a closer approach to the area of inspection, if necessary to positively confirm the presence or absence of electrical raceways.

- 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?

**Checklist completed by:**  
**Date:**

---

### Class 2 Penetration Checklist

*Complete for penetrations greater than 2 inches into solid material*

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

**Caution:** for roofing work, electrical raceways (conduit) may be recessed or painted the same color as the interior ceiling. Use supplemental lighting and binoculars, or a man lift or scissor lift for a closer approach to the area of inspection, if necessary to positively confirm the presence or absence of electrical raceways.

- Reviewed historical records, engineering plans, and drawings?
- Area responsible person/designee, customer/requester, or other personnel consulted?
- Visually inspected proposed location of penetration?
- Checked other side of walls, under floors, or through false ceilings for hazards?
- De-energized and locked/tagged-out energy sources as required?
- NDT used to determine if additional hazards exist? If yes, list results in the “Hazards” section.
- NDT used to determine wall reinforcement?
- Electrical tools equipped with GFCI or double-insulated?
- GFCIs tested?
- Appropriate PPE specified (see “Controls”) and obtained?
- PPE inspection(s) up to date?
- Short drill bits used or equipment marked to limit penetration depth?

**Checklist completed by:**  
**Date:**
Hazards and Required Controls

Complete for all penetrations. May reference JSA or similar work authorization document 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, concrete dust (silica), etc.): |
| Other hazards: |

Controls

| Procedural requirements: |
| Types and classification of PPE: |
| Other controls: |
**Radiological Safety**

*This section, if applicable (see Radiological Review Determination in “General Information”), must be completed by Radiation Protection, Field Operations (RPFO). 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>Radiological safety work control form (RWWC) required?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>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

Name:  
Signature:  
Date:  

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

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

Reviewed by

Name:  
Signature:  
Date:  

**Approval and Authorization**

**Supervisor**

*Required for Class 1 and Class 2 penetrations*

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

Name:  
Signature:  
Date:  

**Area / Building Manager**

*Required for Class 2 penetrations*

Name:  
Signature:  
Date:  

Sample form, see URL at top of page
Additional Requirements

- 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-surfac ed electrical wiring to be present within hollow walls of some buildings, especially in some portable buildings.

- Pay particular attention to roofing penetration operations. Electrical raceways (conduit) on the interior ceiling may be particularly difficult to detect visually, especially if the raceway is recessed or painted the same color as the ceiling. Use supplemental lighting and binoculars, or a man lift or scissor lift for a closer approach to the area of inspection, if necessary to positively confirm the presence or absence of electrical raceways.

- 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 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.

- Before vacuuming mineral dusts or slurries verify that fire technicians have bypassed any local smoke detectors.