

Berkeley High School Little Theater

Berkeley, CA

MECHANICAL NARRATIVE

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Acoustics
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INTRODUCTION

We have prepared the following mechanical narrative for the Berkeley High School Little Theater Renovation project. Meeting the background noise goals with new mechanical systems will require low air velocities, in-line duct silencers, and/or internal duct lining for noise sensitive spaces being served.

MECHANICAL NOISE AND VIBRATION CONTROL

The existing mechanical system is comprised of a series of large supply and exhaust fans located in basement mechanical rooms. The 1941 drawings of the Community Theater show heating coils on the supply fans. Per our discussion with the user groups however, we understand that the heat is provided by radiators lining the rear wall of the Community Theater stage house.

The background noise level due to the mechanical system can be expressed as Noise Criteria (NC¹).

Table 1 summarizes our measurements of the background noise level in spaces throughout the building. It also lists the recommended maximum background noise levels.

Table 1 Existing and Recommended Background Noise Levels (NC)

Room	Existing NC	Recommended NC
Little Theater (Audience and Stage)	26 to 31	25
Lobbies	not measured	30 to 35
Dressing Rooms and Circulation	not measured	35 to 40

Table 2 lists the maximum air velocity in diffuser necks based on the noise criteria. Noise criteria in general are discussed in the ASHRAE System Handbook chapter titled, "Sound and Vibration Control." The air velocity should decrease at each duct branch from the fan discharge until the air velocity is reduced to that defined at the neck of supply and return air terminal devices. Final duct branch air velocities must not exceed the diffuser neck velocity criteria by more than 100 fpm. All ducts must be appropriately sized taking into consideration the thickness of the internal lining, to meet these criteria.

Table 1 Existing and Recommended Background Noise Levels (NC)

Noise Criteria	Air Velocity
NC 25	350 fpm
NC 30	425 fpm
NC 35	500 fpm
NC 40	560 fpm

Additional general layout recommendations are provided below for controlling noise and vibration from mechanical, air-handling systems, and plumbing systems.

1 NC (Noise Criteria) – A single-number rating defined by ASHRAE that quantifies a steady-state noise. It is based on a family of curves that includes noise from 63 Hz to 8,000 Hz. NC is typically used to rate the loudness of HVAC system noise in a room.

Air-Handling Systems

Support air-handling units on springs incorporating neoprene pads. Select isolators based on static and dynamic load including thrust and rotational inertia. Each isolator must be selected independently for the load distribution of the equipment. Specifications should require submittal of specific isolation hardware selections. Provide the following clearances:

- 15-inches above ductwork for spring hangers
- 2-inches clear under vibration-isolated equipment

Fans

1. Where centrifugal fans are specified, specify backward inclined (airfoil) blades. Where applicable, specify internal cabinet insulation. Allow enough room at the inlet and discharge for at least five equivalent duct dimensions of straight ducting to provide smooth flow conditions. Avoid using down discharge for roof-mounted air-moving devices.
2. The mechanical specifications should include octave band maximum sound power levels for each major piece of mechanical equipment.

Ducts

1. For spaces with noise criteria of NC 30 and less, provide internally lined sheet metal ductwork routed from the corridor. Avoid wall penetrations (i.e., locate all duct trunks over corridors and only branch into the room being served). Limit the length of flexible duct to three feet.
2. In spaces with noise criteria of NC 35 and less, provide a minimum of ten feet of internally lined ductwork prior to the diffusers/grilles.
3. Use radius duct turns, take-offs, and elbows over spaces having noise criteria of NC 30 and less. Use airfoil turning vanes at 90-degree duct turns.

Supply Air Ductwork

1. Connect ducts to fans using flexible connectors. Allow room for seven-foot silencers near fans. Allow for up to two-inch thick acoustical lining within 25 feet of the fan. Ductwork should have smooth transitions not exceeding 10 degrees. Avoid using bullhead tees. Turning vanes are to be the airfoil type.
2. Specify spring type vibration isolation hangers (Mason 30N) on high-pressure ductwork for a minimum of 60 feet from the fan. Neoprene hangers (Mason HD) are to be used on medium pressure ductwork for a minimum distance of 60 feet of linear duct distance from the fan.

Return Air

Return air should be fully ducted from inlets in spaces with noise criteria of NC 30 or less. Allow for return air duct branches to be lined with a minimum of one-inch-thick acoustical lining as required. At theaters, return air plenums below seats are acoustically acceptable.

Variable Volume, Terminal Boxes, and Fan Coil Units

Do not exceed 1.25 inches of static pressure at VAV box inlets. Fan-powered boxes and fan-coil units must not be located above spaces having noise criteria less than NC 40. All boxes that serve spaces having noise criteria of NC 30 or less should be located in adjacent corridor and storage areas and be oversized to minimize noise. All boxes require a minimum of ten feet of acoustically lined duct downstream prior to the diffuser. Oversize VAV boxes to help reduce radiated and discharge noise. Locate ceiling-mounted air-moving devices above toilet, kitchen, lobby, or storage spaces; do not locate above spaces having criteria of NC 30 (including roof top equipment).

Dampers

Do not place dampers directly behind the face of the terminal units; locate a minimum of 10 feet upstream from diffusers. Avoid using "extractor" type dampers and opposed blade dampers in spaces that are NC 35 or less. Where possible in spaces with criteria of NC 25 or lower, use equal duct lengths and "static regain" duct sizing to avoid using dampers.

Diffusers, Registers, and Gills

Specify diffusers with an NC rating five points below the noise criteria of the room in which it serves (See **Table 1**). Do not use registers with integral dampers. Select supply and return air outlets to meet the noise criteria.

PLUMBING SYSTEMS

Regulate domestic water line pressure to 50 psig and size branch piping for a maximum velocity of 6 ft./sec. Specify spring-loaded check-valves and water-hammer arrestors.

Sprinkler piping is to be routed along corridors with a single penetration into each space.

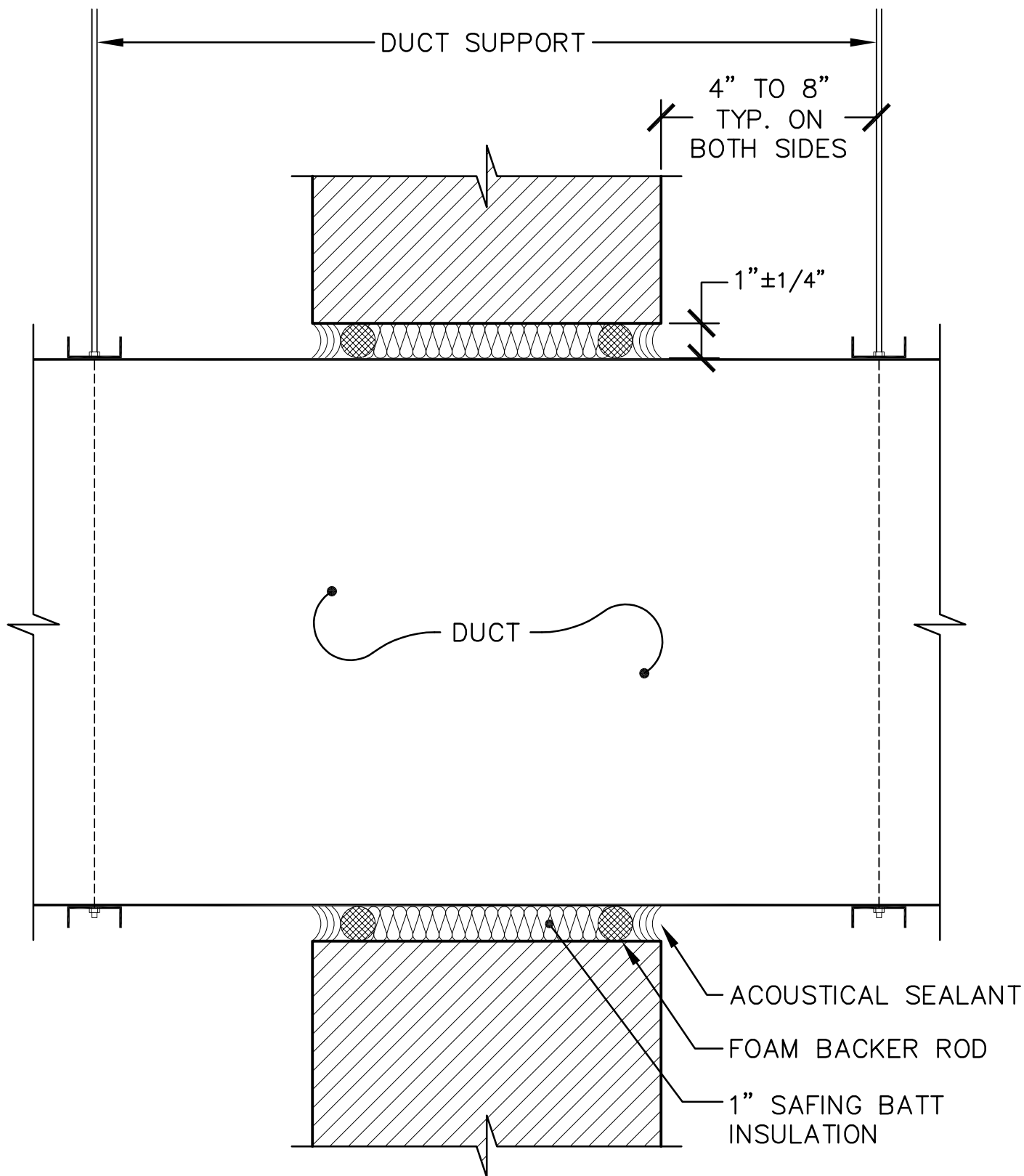
Penetrations

Ducts penetrating sound-rated wall and floor/ceiling assemblies should be in an insulated sleeve between independent constructions. Ducts penetrating the building structure should have a clear distance of 1-inch \pm 1/4-inch around the perimeter as shown in **Figure 1**. This perimeter void must be packed with glass fiber batts at both ends and caulked airtight with a non-shrinking, non-hardening flexible acoustical sealant. A backer rod should be used to caulk against.

Piping penetrations less than a three-inch diameter are to be sealed with acoustical sealant as shown in **Figure 2**. Larger pipes penetrations should be treated as shown in **Figure 3**.

Piping Isolation

1. Vibration isolate all pipes adjacent to noise sensitive spaces (NC 35 or lower) except vent stacks, gas and sprinkler lines. Do not allow vent stacks to contact gypsum wallboard.
2. Avoid rigid metal-to-metal contact between pipes, supports, framing or structure. Pipes should not contact or be mounted from gypsum board surfaces. Vertical plumbing piping one inch or greater should be isolated as shown in **Figure 4**.
3. Small pipes (less than three inches in diameter) require neoprene mount or hanger isolation for the first 100 feet from a prime mover (i.e., Mason isolators ND or HD).
4. Small pipes beyond 100 feet require resilient sleeves at the point of attachment (i.e., neoprene condensation insulation, or preformed glass-fiber, or insulated hangers similar to Semco Trisolator).
5. Large pipes (3-inch diameter and greater) require spring isolators with neoprene pads for the first 100 feet from a prime mover (i.e., Mason isolators SLR or 30N).
6. Large uninsulated pipes beyond 100 feet require neoprene mount or hanger isolation (i.e., Mason isolators ND or HD).
7. Waste pipes and rainwater leaders are to be attached using neoprene mounts or resilient sleeves. Waste pipes are to be isolated using neoprene insulated clamps and resilient waffle pads under supports. Only cast iron waste pipe is recommended.
8. Domestic water lines less than one-inch diameter should use proprietary resilient attachments such as Tech Specialties Acousto-Plumb or treat as (c) above.
9. Use flexible piping connections at all vibration isolated rotating equipment attachment points.
10. Where pipes are routed in double wall framing attach to one side only.



NOTE: APPLICABLE AT ALL SOUND-RATED CONSTRUCTION, INCLUDING INTERIOR INSULATED ASSEMBLIES

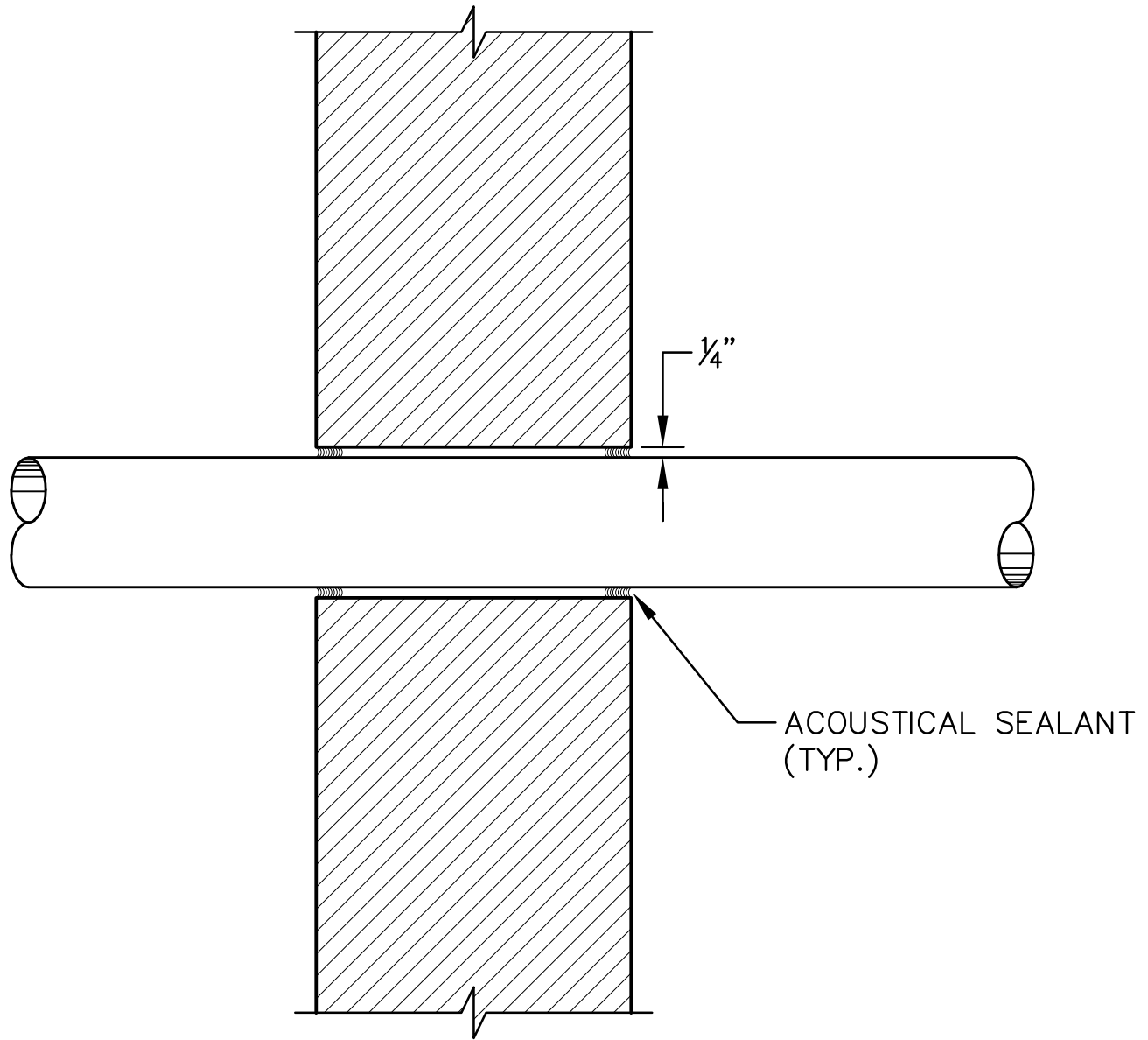
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TYPICAL DUCT PENETRATION THROUGH SOUND-RATED CONSTRUCTION

FIGURE 1

1148
3.1.2

DRS
11.05.02



(PIPE OR CONDUIT LESS THAN 3" DIAMETER)

NOTE: APPLICABLE AT ALL SOUND-RATED CONSTRUCTION INCLUDING INTERIOR INSULATED ASSEMBLIES

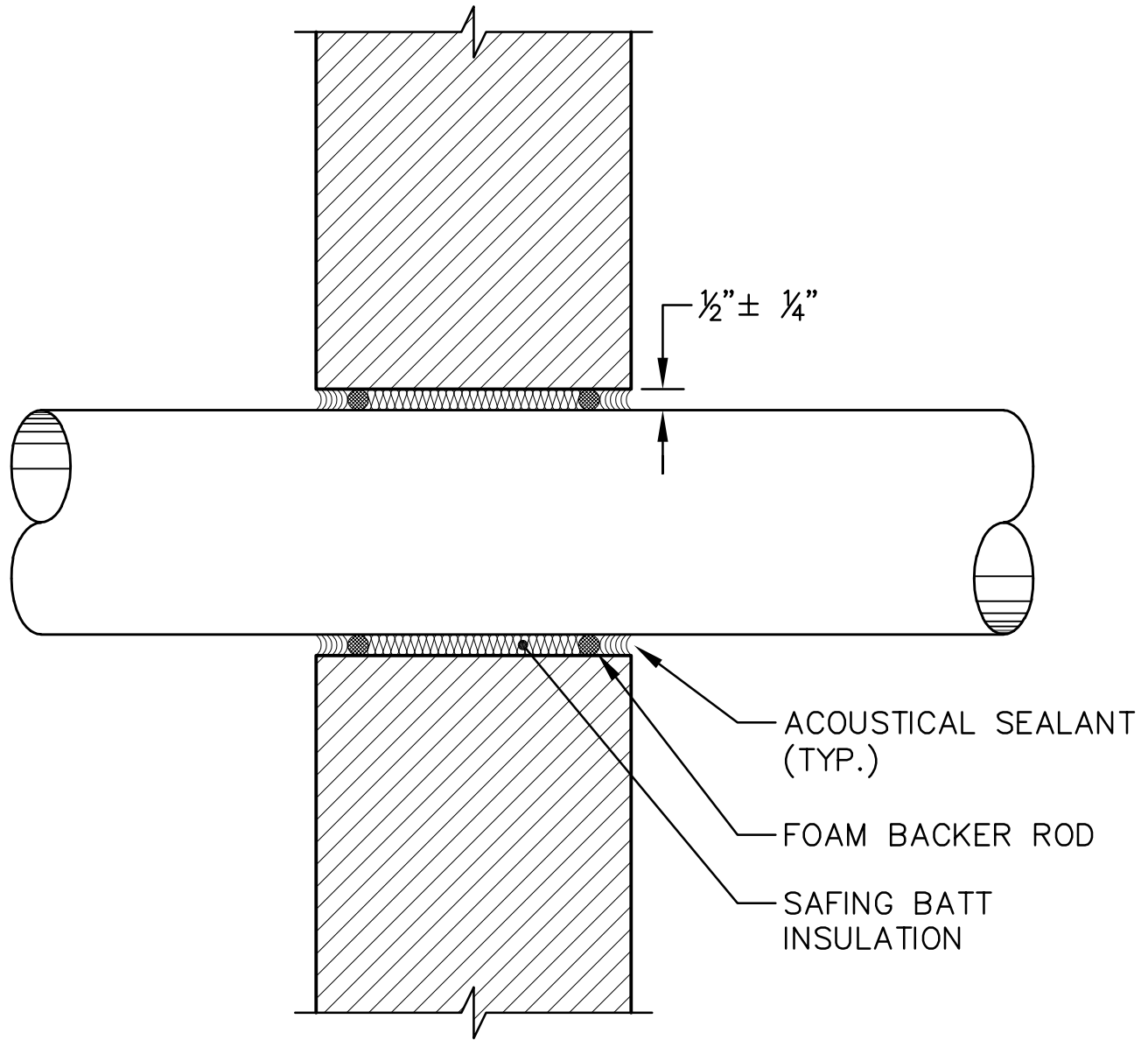
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TYPICAL PIPE OR CONDUIT PENETRATION THROUGH SOUND-RATED CONSTRUCTION

FIGURE 2

182
3.1.1, 3.1.3

EBM
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(DUCT, PIPE, OR CONDUIT 3" DIAMETER OR GREATER)

NOTE: APPLICABLE AT ALL SOUND-RATED CONSTRUCTION INCLUDING INTERIOR INSULATED ASSEMBLIES

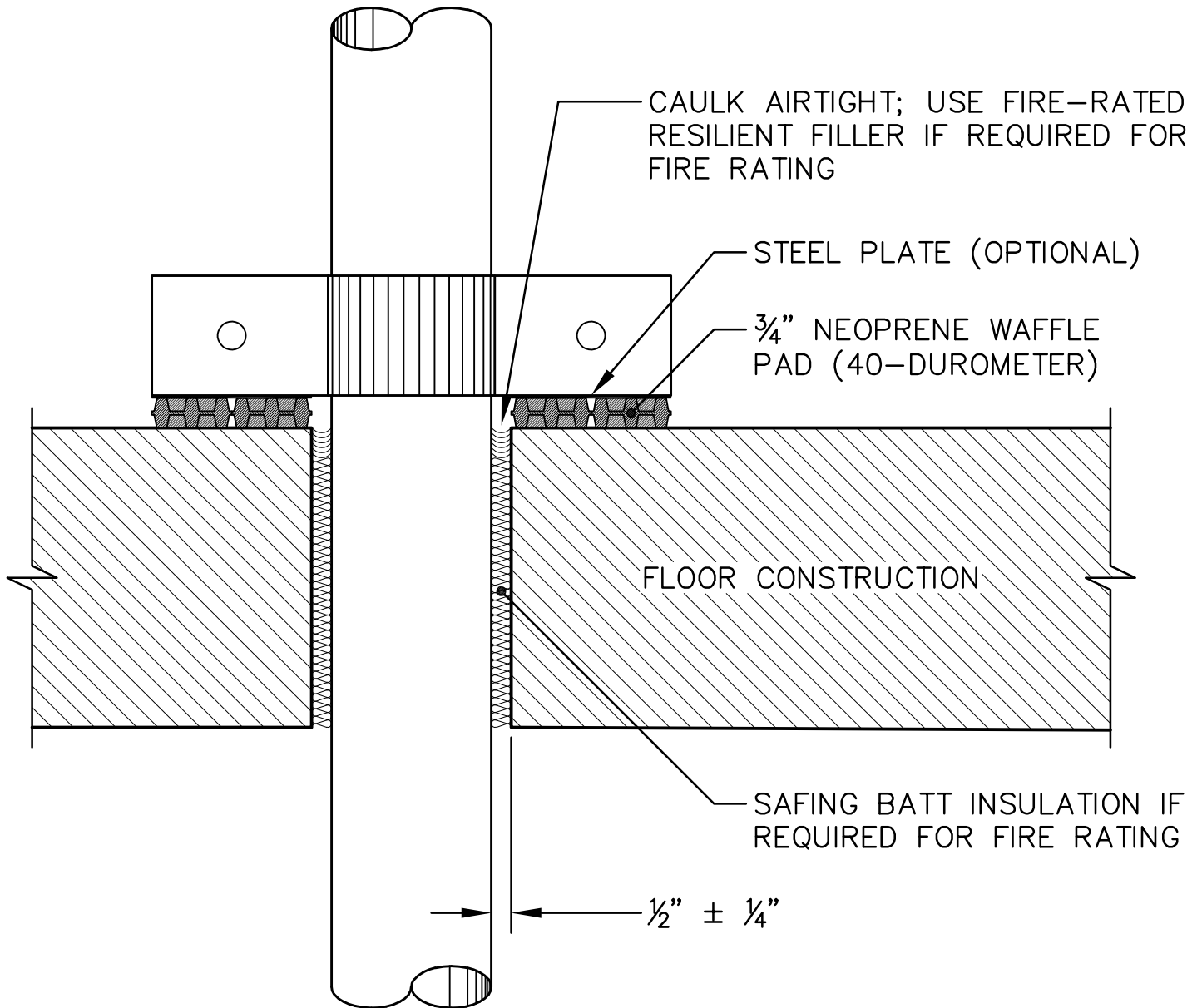
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TYPICAL DUCT, PIPE, OR CONDUIT PENETRATION THROUGH SOUND-RATED CONSTRUCTION

FIGURE 3

181
3.1.1, 3.1.2, 3.1.3

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03.14.17



NOTE: IF PIPE IS SUSPENDED FROM-OR DIRECTLY ATTACHED TO-STRUCTURE OR OTHER BUILDING ELEMENTS, USE $\frac{3}{8}$ " THICK FELT, OR 40-DUROMETER NEOPRENE AS SLEEVE BETWEEN PIPE AND PIPE HANGER

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PIPE RISER ISOLATION

FIGURE 4

53
3.1.1, 8.3

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