

## 6.4 Mechanical, Electrical, and Plumbing Components

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### 6.4.3 Pressure Piping

#### 6.4.3.2 In-Line Valves and Pumps

This category covers equipment that is in-line with pressure piping. These items may be valves or pumps and may be suspended, floor-mounted, roof-mounted, or wall-mounted. They may be mounted with or without vibration isolation.

### Provisions

#### BUILDING CODE PROVISIONS

Seismic loads for equipment that is in-line with pressure piping are determined using ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010), Chapter 13. The principal objective of the code provisions is to prevent the component from falling, sliding or overturning. The design approach is dependent on the mounting configuration of the in-line equipment.

- Seismic loads for suspended in-line pumps are determined using the ASCE/SEI 7-10, design coefficients for pumps, not piping. Pumps must be independently supported for gravity loads. Pumps in Seismic Design Categories D, E, and F weighing 20 pounds or less do not require lateral bracing if the component Importance Factor  $I_p = 1.0$ .
- Seismic loads for suspended in-line valves are determined using the ASCE/SEI 7-10, design coefficients for piping. Design coefficients may be reduced based on the construction of the valve. For example, in a steel piping system the in-line valves may be cast iron, increasing the design seismic load by at least 50 percent. Valves should be independently supported for gravity load if they weigh more than 20 pounds. Valves weighing 20 pounds or less do not require lateral bracing if the component Importance Factor  $I_p = 1.0$  for the piping system.
- In-line valves and pumps in Seismic Design Categories D, E, and F that are mounted at 4 ft (1.22 m) or less above a floor level and weigh less than 400 pounds or less do not require lateral bracing if the component Importance Factor  $I_p = 1.0$  for the piping system.
- Items that are exempt from the anchorage requirements noted above are still required to be positively anchored to the structure. The anchorage need not be designed or

detailed on the construction documents. Flexible connections between the equipment and associated pipes, or conduits must be provided.

- Unbraced piping attached to in-line equipment must be provided with flexibility adequate to accommodate seismic relative displacements.
- The seismic design force for vibration isolated pumps is doubled if the “air gap” (the distance between the equipment support frame and the restraint) is greater than 0.25 inches.

## RETROFIT STANDARD PROVISIONS

In ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) equipment that is in-line with pressure piping classified as force controlled, meaning that the principal objective is to prevent the component from falling if suspended, or sliding or overturning if floor-mounted. ASCE/SEI 41-06 requires compliance with the anchorage provisions of the standard when:

- The performance level is Immediate Occupancy.
- The performance level is Life Safety in high seismicity areas, if
  - The item is part of an emergency power system.
  - The items weighs more than 400 pounds and is 6 feet or more in height,].
  - The item is unanchored, weighs over 100 pounds, is 6 feet or more in height, and is subject to overturning. These items may be exempt if they have a factor of safety greater than 1.5 against overturning when design loads are applied.
  - The item weighs over 20 pounds and is mounted over 4 feet above the floor.

## Typical Causes of Damage

- Poorly restrained in-line valves or equipment may fall. Pumps may be damaged if not properly restrained; these items may slide or fall. Movement of the in-line equipment may result in damage to the attached piping at the connection or at adjacent pipe joints. Equipment or piping damage may result in leaks.

## Seismic Mitigation Considerations

- Details shown are for overhead restraints for items in-line with suspended piping. Generally, seismic restraint in the form of typical pipe bracing is provided on each side of the connected item.

- Details for other conditions such as equipment in-line with floor- or wall-mounted piping can be found in FEMA 414 *Installing Seismic Restraints for Duct and Pipe* (2004). Section 6.4.1.5 also includes general details for suspended equipment.
- Many vendors supply specialized hardware for seismic anchorage of piping including load rated anchorage assemblies, spring loaded hangers, and pipe dampers.
- In-line pumps on vibration isolators require special consideration.
  - Although the code exempts smaller pumps on vibration isolators from bracing requirements, even small pumps should be carefully evaluated, since vibration isolators tend to amplify the seismic response of the component.
  - The “air gap”, or distance between the snubber and the pump should be limited to less than 0.25 inches, to avoid significant dynamic amplification when the pump contacts the snubber.
  - Metal-to-metal contact between snubbers and the supporting frame, or the isolator housing and the mounting bolt to the pump, should be avoided. The snubbers should have an elastomeric or resilient surface to lessen the impact effects during strong shaking. For housed springs, an elastomeric grommet will prevent hard surface impact.
  - Flexible connections should be provided for conduit and piping.

## MITIGATION EXAMPLES



Figure 6.4.3.2-1 In-line pump mounted on independent concrete inertia pad with vibration isolation and seismic snubbers (Photo courtesy of Mason Industries).

## MITIGATION DETAILS

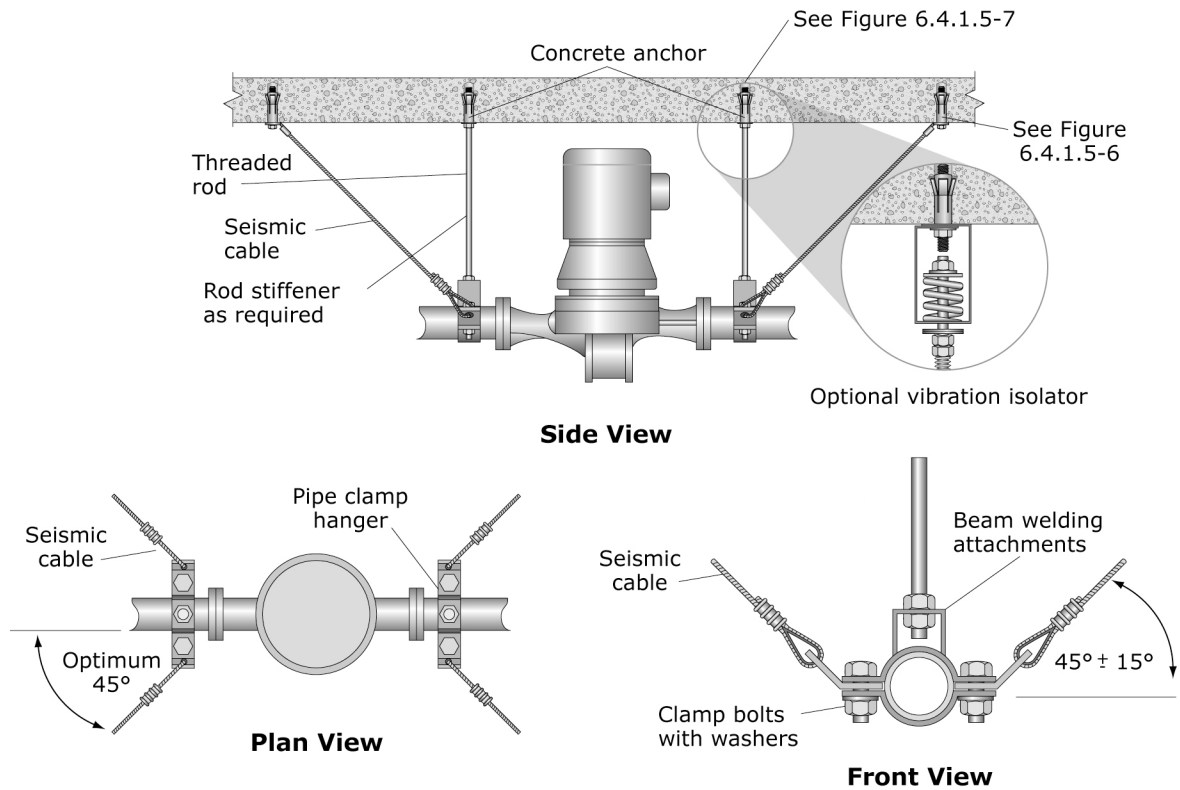


Figure 6.4.3.2-2 In-line valves and pumps (ER).

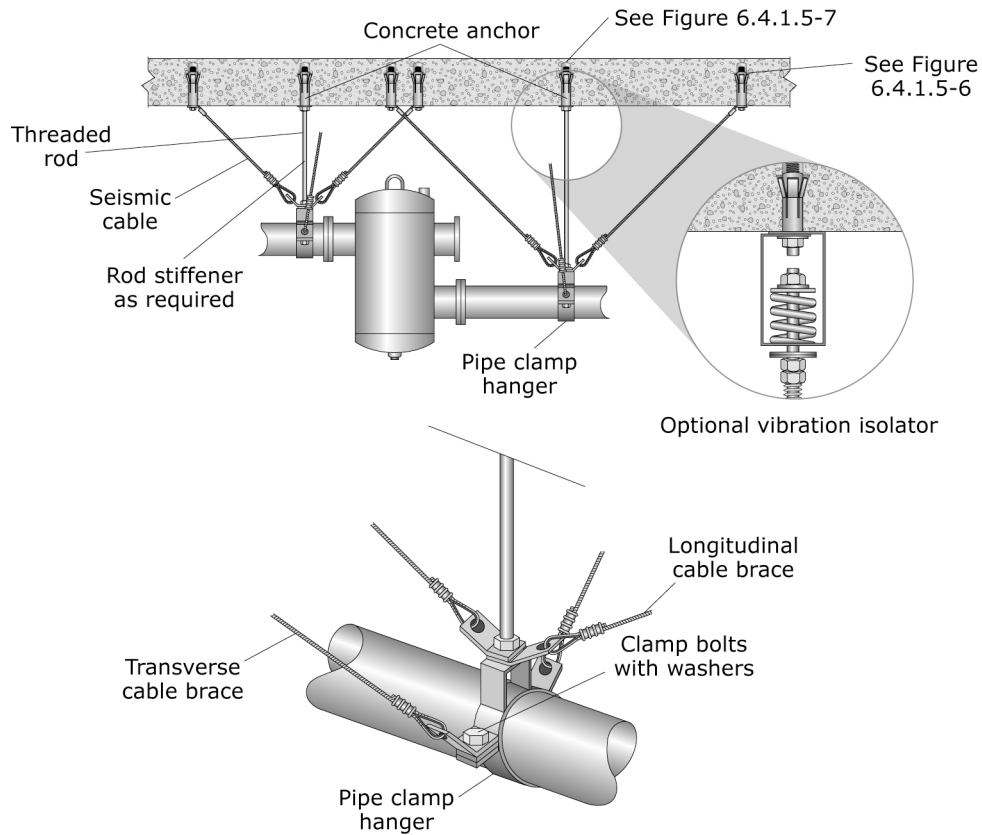


Figure 6.4.3.2-3 In-line valves and pumps (ER).

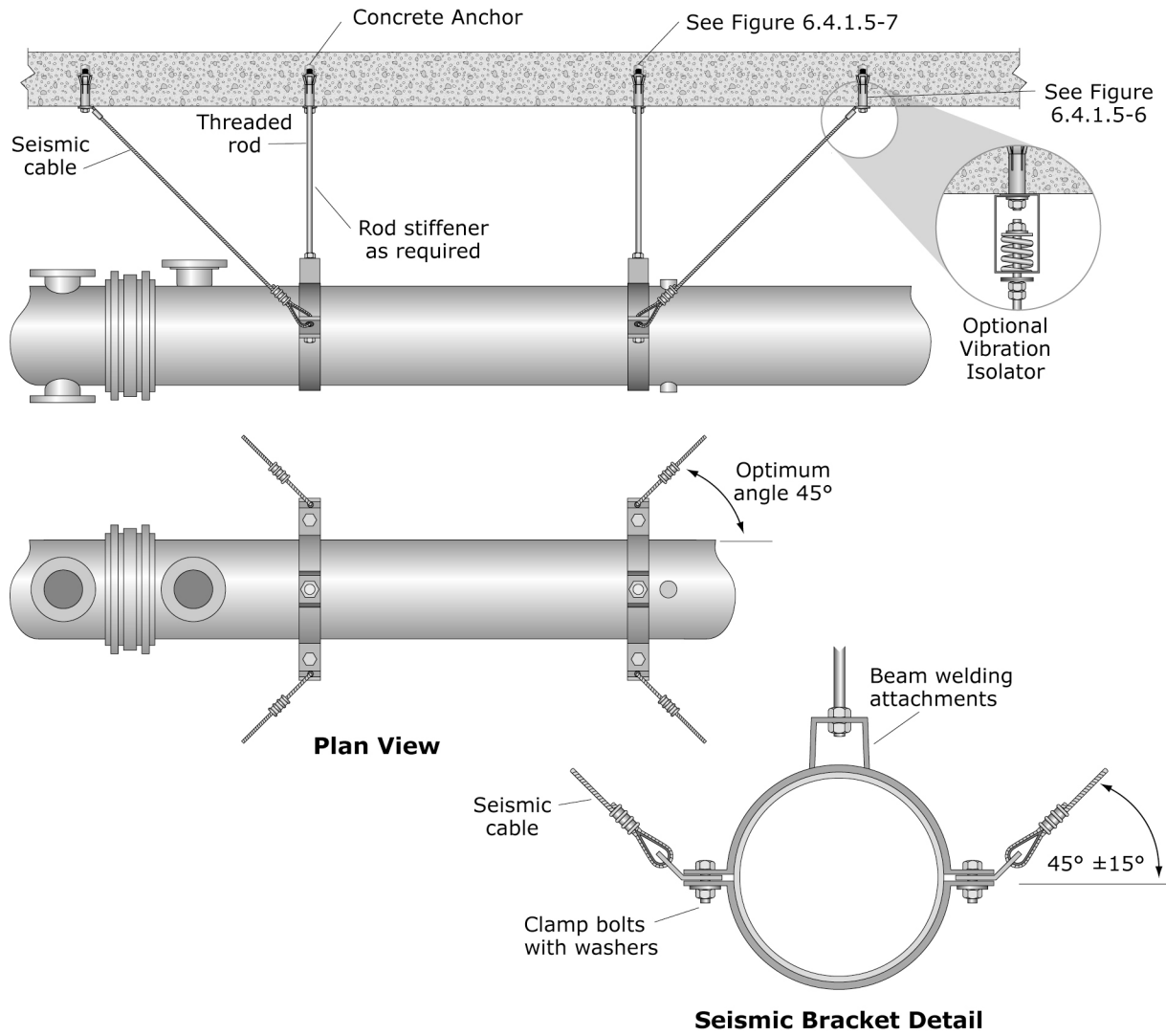


Figure 6.4.3.2-4 In-line valves and pumps (ER).