for the equipment seismic qualification in order to maintain the integrity of the seismic load path from the equipment to the structure or seismic restraint system and should be provided in the manufacturer's instructions. Where such guidance does not exist, it is the responsibility of the engineer-of-record or authority having jurisdiction to ensure that appropriate reinforcement is provided.

C13.6.5.6 Conduit, Cable Tray, and Other Electrical Distribution Systems (Raceways)

The term *raceway* is defined in several standards with somewhat varying language. As used here, it is intended to describe all electrical distribution systems including conduit, cable trays, and open and closed raceways. Experience indicates that a size limit of 2.5 in. can be established for the provision of flexible connections to accommodate seismic relative displacements that might occur between pieces of connected equipment because smaller conduit normally possesses the required flexibility to accommodate such displacements. Where rod hangers are less than 12 in. in length, they may be exempted from design only if they will not experience bending moments, i.e., by the provision of a swivel at the top of the rod. Where this is not done and where braces are not provided, the rod hangers (and, where applicable, the anchors) must be designed for the resultant bending forces.

C13.6.8 Piping Systems

Due to the typical redundancy of piping system supports, total collapse of pipes in earthquakes are rare; however, pipe leakage resulting from excessive displacement or overstress often results in nonstructural damage. Loss of fluid containment (leakage) normally occurs at discontinuities such as threads, grooves, geometric discontinuities, or locations where incipient cracks exist, such as at the toe or root of a weld or braze. Numerous building and industrial national standards and guidelines address a wide variety of piping systems materials and applications. Construction in accordance with the national standards referenced in these provisions is usually effective in limiting damage to piping systems and avoiding loss of fluid containment under earthquake conditions.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) *A Practical Guide to Seismic Restraint* and the Manufacturers Standardization Society (MSS) standard SP-127, *Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application*, are derived in large part from the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) standard *Seismic Restraint Manual: Guidelines for Mechanical Systems*. These documents may be appropriate references for use in the seismic design of piping systems. As the SMACNA standard does not refer to pipe stresses in the determination of hanger and brace spacing, however, a supplementary check of pipe stresses may be necessary when this document is used. The American Society of Mechanical Engineers (ASME) B31E *Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems* applies specifically to ASME piping, but could conservatively be applied to other cases as well. Code-compliant seismic design manuals prepared for proprietary systems may also be appropriate references.

Table 13.6-1 entries for piping previously listed the amplification factor related to the response of piping systems as rigid (a_p = 1.0) and values for component response modification factors lower than in the current table. However, it was realized that most piping systems are flexible and that the amplification factor values should reflect this fact; thus, a_p was increased to 2.5 and the R_p values adjusted accordingly such that a_p/R_p remains roughly consistent with earlier provisions.

Although seismic design in accordance with Section 13.6.8 generally ensures that effective seismic forces will not fail piping, seismic displacements may be underestimated such that impact with near structural, mechanical, or electrical components could occur. In marginal cases it may be advisable to protect the pipe with wrapper plates where impacts could occur, including at gapped supports. Insulation may in some cases also serve to protect the pipe from impact damage. Piping systems are typically designed for pressure containment, and piping designed with a factor of safety of 3 or more against pressure failure (rupture) may be inherently robust enough to survive impact with nearby structures, equipment, and other piping, particularly if the piping is insulated. Piping having less than standard wall thickness may require the evaluation of the effects of impact locally on the pipe wall and may necessitate means to protect the pipe wall.

It is usually preferable for piping to be detailed to accommodate seismic relative displacements between the first seismic support upstream or downstream from connections to other seismically supported components or headers. This may be achieved by means of pipe flexure or flexible supports. Piping not otherwise detailed to accommodate such seismic relative displacements must be provided with connections having sufficient flexibility to avoid failure of the