Earthquake Protection for Fire Sprinkler Systems

You Now Have to Prove It's Not Required

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The fax machine spits out an invitation to bid. The job is in Waco, Texas, not that far away. It's a three-story hospital and in the process of going over the documents to arrive at a bid, someone raises a question about seismic bracing. A veteran designer – without even cracking the book – remembers that central Texas is mostly in Zone 0 on the seismic maps in the annex of NFPA 13 and conveys to the others that seismic bracing does not have to be included in the bid. A few months later, after sending the shop drawings in for review, the sprinkler contractor receives a letter from the AHJ making reference to the International Building Code (IBC) requirements for earthquake protection. If this happens to you (and it might), it will definitely ruin your day, probably your year, and possibly your career. To help you avoid having such a day, this article introduces the changes in the current building codes regarding seismic requirements. This will be a two-part article. This part will identify the methodology, and the related new terminology, for determining WHEN seismic protection is required.

Earthquake protection in sprinkler systems has traditionally been a fairly cut and dry "yes/no" issue. Either it is required or it is not. Contractors doing work in seismically active areas of the country know what to expect. But, contractors that have worked only in seismic Zone 0, may not know a thing about earthquake protection, because they've never had to do it. Seismic Zone 0 has traditionally been interpreted to mean zero acceleration or zero seismic activity. Guess what! When compared to the IBC's seismic acceleration maps, NFPA 13's Zone 0 is an approximate (the contour lines do not exactly coincide) region where the seismic activity is below a value of 0.10g. So, along comes the National Earthquake Hazard Reduction Program (NEHRP), the American Society of Civil Engineers (ASCE), and the IBC introducing a new methodology on earthquake protection, which is similarly applied by NFPA 5000™. NEHRP is funded by FEMA and promulgates earthquake protection criteria for structures. These criteria are adopted by ASCE and published in ASCE 7, Minimum Design Loads for Buildings and Other Structures. The text pertaining to earthquake protection in the IBC is based on criteria in ASCE 7. These organizations and their objectives may not be all that new to you if you're in the West and have a history with the Uniform Building Code. But, everyone else, hold on to your hat and make sure you're in a seated position before reading further.

If the IBC, 2000 edition, is the applicable building code for a project with which you are involved, regardless of geographical location (even if it's in Zone 0), an evaluation must be performed for each building project to determine whether earthquake protection is required. As dictated by IBC:1603.1.5, earthquake design data shall be shown in the construction documents, regardless of whether seismic loads govern the lateral design of the building. The responsible person should be on the building design team, such as the architect or the engineer. The responsibility for the evaluation on the sprinkler system, though, could trickle down and rest squarely on your shoulders as the designer/installer of that system. In doing an evaluation, there are only two exceptions exempting sprinkler systems from earthquake protection. One is when the ground acceleration at the building location is very low, which is determined in an initial step in the evaluation process. The other is for systems in buildings with a Seismic Design Category A or B, which can only be determined after all steps are completed. It is also important to note here that for buildings in Seismic Design Category B, earthquake protection is required for the building but not the sprinkler system.

As stated earlier, you previously either had to brace and restrain the system or you didn't. If you had to, you did it per NFPA 13 using a pre-determined factor times the weight of

water-filled pipe in each zone of influence to size the braces. Now, the methodology involves several variables and several steps in an evaluation to determine whether earthquake protection is required, and then data from the same evaluation is utilized in HOW to design the protection.

Unfortunately, the process is not straightforward and does not follow a logical sequence in the code text. The seismic criteria are located in chapter 16, which governs the structural design of buildings regulated by the IBC. To start off, 1614.1 requires every structure and portion thereof (which includes systems within the building) to be designed and constructed to resist effects of earthquake motions and assigned a Seismic Design Category. This category is assigned to a building based on its Seismic Use Group AND the severity of the design earthquake ground motion at the building site. (See 1615.1, which contains maps similar to the seismic zone maps from NFPA 13.) The Seismic Use Group classification assigned is based on the building's use. (See Table 1604.5.)

When looking at earthquake ground motion, we have the option to use the general procedure or site-specific procedure, that is unless the site is classified as Site Class F, which mandates the site-specific procedure. Under the general procedure, two maximum earthquake spectral response accelerations must be considered and are obtained from the ground motion maps. One is the short period (0.2 seconds) response and the other is the 1.0-second response. Both variables must be separately accounted for in the evaluation. A Site Class of A through F is then determined based upon the soil at the site per 1615.1.1. Class A is hard rock and Class E is soft soil. This is a very important step because the Site Class has a tremendous impact on the evaluation. Simply using the default Site Class D could result in earthquake protection being required when it actually is not necessary. For instance, a Site Class A affords a reduction in the spectral response acceleration values possibly resulting in an exemption from earthquake protection. The response values are adjusted for site class effects using formulas in 1615.1.2. Then, the resulting values are further adjusted, resulting in the design spectral response accelerations. A general response spectrum must be determined in accordance with 1615.1.4 (draw a curve on a graph). Using the design response accelerations and the Seismic Use Group, Table 1616.3(1) gives the Seismic Design Category based on short period response accelerations and Table 1616.3(2) gives the Seismic Design Category based on 1.0 second period response accelerations. These categories also use a designation of A through F. The most severe Seismic Design Category is assigned to the building irrespective of the fundamental period of vibration. The final step is actually determining whether earthquake protection is required based on the assigned Seismic Design Category.

If your head is spinning at this point, just relax and take a deep breath because next we present a step-by-step procedure outline that, hopefully, will be easier to digest.

1. Compile information on the project.
   a. Building use
   b. Height
   c. Location
      i. County (Parish), or
      ii. Zip Code, or
      iii. GPS coordinates
2. Determine Seismic Use Group of the building – Table 1604.5.
   a. This has a significant impact on sizing of seismic bracing if required.
3. Determine site ground motion accelerations and coefficients. This outline presents the general procedure.
   a. Determine mapped maximum considered earth-

quake spectral response acceleration at short periods (Ss) and at 1-second period (S1).
   i. Use seismic maps from IBC - Figures 1615(1) through (10), or
   ii. Use Seismic Design Parameters software available from the International Code Council (ICC).
   iii. Look at exception to 1615.1 to see if the structure need only comply with 1616.4 which means sprinkler systems would be exempt from earthquake protection.
b. Determine Site Class for the project location – 1615.1.1
   i. This should already be determined by project civil engineer, but
   ii. Assume Class D, if no information available and Building Official agrees.
c. Determine site coefficients using site class with Ss and S1 – Tables 1615.1.2(1) and (2).
   i. Look up manually, or
   ii. Use Seismic Design Parameters software available from the ICC.
d. Determine adjusted maximum considered earthquake spectral response accelerations (SMS and SM1) using formulas in 1615.1.2.
   i. Calculate manually, or
   ii. Use Seismic Design Parameters software available from the ICC.
e. Determine design spectral response acceleration parameters (SDS and SD1) using formulas in 1615.1.3.
f. Develop response spectrum curve – 1615.1.4.
   i. Calculate and draw by hand, or
   ii. Use Seismic Design Parameters software available from the ICC.
4. Determine Seismic Design Category – Tables 1616.3(1) and (2).
   a. Apply the most severe Seismic Design Category to the building.

The software from the ICC to which we referred in the outline is free to ICC members. Non-members are only charged a small shipping and handling fee. For more information, access their web site at http://www.iccsafe.org.

In closing, if the IBC is applicable, an earthquake protection evaluation must be performed, regardless of the building's geographic location. If the project is in Minot, N.D., earthquake protection must be evaluated. If the project is in Tucumcari, N.M., earthquake protection must be evaluated. If it's in Bend, Ore.... you get the picture.

This article has focused on the methodology of determining whether earthquake protection is required for fire sprinkler systems according to the IBC. In an upcoming article we will discuss the actual design of earthquake protection for fire sprinkler systems by applying the criteria from the IBC and what impact it has on using the criteria from NFPA 13. We will also discuss the changes that have occurred in the 2003 edition of the IBC.

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