

ESFR with High Clearance to Ceilings

While writing the 2013 edition of NFPA 13, the NFPA Committee on Sprinkler System Discharge Criteria took a bold step to improve the future use of ESFR sprinklers by eliminating the option to use K-14 ESFR sprinklers in buildings having a ceiling height of 40 ft when there are no in-rack sprinklers installed. This step was taken as part of a much broader plan to improve the performance of ESFR sprinklers in situations where there is a high clearance from the top of storage to the ceiling. It has caused a good deal of confusion for a number of reasons and this issue of TechNotes is intended to try and clear up that confusion. The subjects that will be addressed in this newsletter are:

- What is the background that led to the change?
- What exactly was changed in NFPA 13?
- What was the intent of the committee in making the change?
- Typos in the 2013 edition
- Application of the change to existing buildings
- Use of ESFR sprinklers with K-factors larger than 14

What is the background that led to the change?

In the early days of writing sprinkler protection rules for storage occupancies (1960's through 1990's), little attention was paid to ceiling clearance (distance from the top of the storage to the ceiling) as a variable in sprinkler system design. In fact, up through the 2007 edition of NFPA 13, most storage commodities could be protected with density/area criteria without considering the effect of ceiling height or ceiling clearance on the discharge requirements of the sprinklers.

The first edition of NFPA 13 that required density/area discharge requirements to consider ceiling clearance for all commodities was the 2007 edition. This change came after a significant loss in a warehouse where excessive ceiling clearance was thought to have played a role in the development of the fire and the inability of the sprinkler system to control the fire (although ceiling clearance was not the only problem that occurred in this fire). Since this fire, ceiling clearance has received renewed scrutiny in our industry for other sprinklers as well, not just density/area sprinkler design.

During the course of evaluating a specific storage protection sprinkler for a listing with a high ceiling (greater than 35 ft), Underwriters Laboratories (UL) discovered a specific test scenario with a combination of an ignition location (offset between two sprinklers) and a ceiling clearance (20 ft) that turned out to be more challenging than any of the other fire scenarios that they had applied to test the sprinkler. They began to have some concern

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that this same challenging combination of ignition location and high ceiling clearance might be a problem for ESFR sprinklers, which have many of the same characteristics as the storage sprinkler they were evaluating.

UL officials shared their concerns with the manufacturers of fire sprinklers (through the NFSA/UL/FM Liaison Committee) and proposed that the offset ignition test with 20 ft ceiling clearance be added to the list of tests that are performed for all ESFR sprinklers in order to achieve a listing in accordance with UL 1767. If UL were to require this new test, all ESFR sprinklers would need to be re-evaluated by UL using this new test in order to maintain their listing.

The manufacturers immediately questioned the need to re-evaluate the K-14 ESFR sprinkler. They believed that this sprinkler is the most tested of all ESFR sprinklers and that it would not need to be re-evaluated under this new test. They believed that the K-14 had already been tested under its most stringent conditions and did not need further evaluation. After discussion, it was agreed that one manufacturer's K-14, which was most representative of all of the K-14 ESFR sprinklers, would be tested using the offset ignition and 20 ft ceiling clearance test. Two tests were actually conducted with this representative K-14 ESFR sprinkler. In the first test, at 75 psi, 17 sprinklers opened. In the second test, at 100 psi declining to 75 psi as more than four sprinklers opened, 18 sprinklers ended up opening before the test was over. Both of these tests are considered failures since more than 9 sprinklers opened, which is the acceptable limit for ESFR sprinklers referenced in the Standard for Early Suppression Fast Response Sprinklers, UL 1767, with a 12 sprinkler design area.

In September of 2010, UL decided to add the new test to their list of tests in UL 1767. There was general agreement between UL and the manufacturers of sprinklers that the K-14 sprinklers would not do well in the test, so UL agreed not to require the re-evaluation of the K-14 sprinkler if the manufacturers would support a change to NFPA 13 to eliminate the use of K-14 ESFR sprinklers (without in-rack sprinklers) in buildings with a ceiling height of 40 ft.

For the other K-factor ESFR sprinklers, UL gave the manufacturers four years (until September of 2014) to comply. This means that the manufacturers had to resubmit their ESFR sprinklers with K-factors greater than 14 for evaluation using this new test.

What exactly was changed in NFPA 13?

In the 2013 edition of NFPA 13, the option to use K-14 ESFR sprinklers for ceiling only protection was eliminated in ten tables in the portions of the tables dealing with 40 ft ceilings. Specifically, Proposal 13-397 was accepted by the committee to remove the rows of the tables that allow K-14 ESFR sprinklers to be used at 40 ft ceilings at a pressure of 75 psi.

The tables listed in the change were:

1. Table 12.12.1.2(c)
2. Table 12.12.2.1 (which has since been renumbered as 12.12.2.2.3 in 2013)
3. Table 14.4.1
4. Table 15.4.1
5. Table 16.2.3.1
6. Table 16.3.3.1
7. Table 17.2.3.1
8. Table 17.3.3.1
9. Table 18.4(d)



10. Table 19.1.2.3

In the official committee ballot on this item, 20 members voted in the affirmative, 1 member voted in the negative and 1 member abstained. The committee action, substantiation, and comments on the ballot can be found in the NFPA Report on Proposals (ROP) for the 2012 Annual Revision Cycle, which is available for free on the NFPA website if people are looking for verification of this action.

During the comment stage of the revision process, the committee discussed the situation and reaffirmed its position that the option to use the K-14 sprinklers in this particular manner should be eliminated for future new sprinkler systems, which is all that the scope of NFPA 13 permits them to address. When the 2013 edition of NFPA 13 was printed, the standard should have had the K-14 row(s) eliminated from the ten tables listed above in the ceiling only protection options. The protection options for the use of the K-14 ESFR sprinkler at 90 psi with a row of in-rack sprinklers for buildings with a ceiling height up to 45 ft have not been affected by this change and continue to be acceptable options for the protection of rack storage.

What was the intent of the committee in making the change?

Before going deeper into the discussion of the committee's intent, it is important to understand that K-14 ESFR sprinklers are excellent fire protection products that are appropriate for use in a wide range of fire protection scenarios. K-14 ESFR sprinklers have successfully been used in many buildings for years with many different ceiling heights and the action of the committee in the 2013 edition of NFPA 13 was not intended to be an expression of the lack of faith in K-14 sprinklers in buildings with ceiling heights of less than 40 ft.

The intent of the committee was to apply this decision to only new systems, not to make the decision retroactive. Like many situations in fire protection, we change the codes and standards to make them more stringent for new installations, but we don't force people to go back and retroactively change existing situations. The decision improves fire protection as we move forward without putting an onerous condition on owners of existing buildings.

This decision for ESFR sprinklers is analogous to the decision that was made back in 1991 to increase the density/area criteria as follows:

- Ordinary Hazard Group 2 was increased from 0.19 gpm per sq ft over 1500 sq ft to 0.2 gpm per sq ft over 1500 sq ft.
- Extra Hazard Group 1 was increased from 0.29 gpm per sq ft over 2500 sq ft to 0.3 gpm per sq ft over 2500 sq ft.
- Extra Hazard Group 2 was increased from 0.37 fpm per sq ft over 2500 sq ft to 0.4 gpm per sq ft over 2500 sq ft.

When these changes were made to the 1991 edition of the standard, there was no intent to make them retroactive, and owners of buildings with Ordinary Hazard Group 2, Extra Hazard Group 1 and Extra Hazard Group 2 systems were not required to go back and recalculate their systems and add extra water supplies. Instead, the intent was to improve fire protection moving forward. Today, more than 20 years later, there are significant



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numbers of sprinkler systems that have been designed under these new rules and the older systems that were designed for lesser flows are in the minority.

The committee intended this change for ESFR sprinklers to be the same as the change in densities. Existing systems were intended to be left alone. **Even if an ESFR sprinkler does not continue to be listed by UL, those sprinklers manufactured prior to September 2, 2014 will continue to be "listed" sprinklers and can still be used in existing systems and can even be installed in new systems.**

Typos in the 2013 edition

Unfortunately, when the NFPA published the 2013 edition of NFPA 13, all of the changes approved by the committee did not get made to the text. There are four typographical errors that we are aware of in the ESFR tables. These errors are:

1. In Table 16.3.3.1, the 5th row of the table should not have been printed.
2. In Table 16.3.3.1, the 13th row of the table should not have been printed.
3. In Table 18.4(d), the 11th row should not have been printed.
4. In Table 19.1.2.3, the 7th row should not have been printed.

Note that these typographical errors are where the K-14 ESFR sprinkler is being used at a pressure of 75 psi with no in-rack sprinklers. The option to use the K-14 ESFR sprinkler at 90 psi with a single row of in-rack sprinklers in buildings up to 45 ft in height is still a viable option under NFPA 13 and does not need to be eliminated from the tables.

These typographical errors have added to the confusion regarding the K-14 ESFR situation. The NFPA has acknowledged the error and has promised to publish an errata on the subject. In an e-mail dated January 22, 2014, the staff liaison for NFPA 13 indicated that the errata was moving forward and that it would be published very soon. A future issue of TechNotes will be devoted to informing everyone of the corrections that they NFPA is making to the standard in this manner.

Application of the change to existing buildings

As stated earlier in this newsletter, there was no intent on the part of the committee to apply this rule retroactively to existing buildings. Section 1.4.1 of NFPA 13 specifically states, "Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive."

Since the provisions of the ESFR rules do not specifically say to retroactively apply the change to the K-14 ESFR situation, the rules are not intended to be retroactively applied. Section 1.4.2 goes on to say, "In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate." **Although the AHJ has the authority to retroactively apply the standard if there is an**

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unacceptable risk, the excellent field record of the K-14 ESFR sprinkler is evidence that the retroactive application of this requirement is not necessary.

FM Global is aware of the testing that resulted in the concern over the K-14 ESFR sprinkler and they have chosen not to put the offset ignition 20 ft clearance test in their approval standard for ESFR sprinklers. This means that FM continues to permit the use of K-14 ESFR sprinklers in buildings with 40 ft ceiling heights, even in new systems. While FM's installation and discharge criteria rules are different from NFPA 13's, this does show that the situation with the existing K-14 sprinkler is not so dire as to require an immediate replacement of all existing K-14 ESFR sprinklers in buildings of 40 ft in height.

Use of ESFR sprinklers with K-factors larger than 14

Everyone needs to be aware that any K-16.8, K-22.4 or K-25.2 ESFR sprinkler that does not demonstrate compliance with the new fire test criteria by the effective date will no longer be authorized to have the UL mark applied to it after September 2, 2014. As previously indicated, it is important to understand that all sprinklers manufactured on or before the effective date will remain listed by UL and can be installed in accordance with NFPA 13.

Summary

For now, the K-14 ESFR should be used in accordance with the appropriate installation standards. As far as NFPA 13 is concerned, the use of K-16.8, K-22.4 and K-25.2 ESFR sprinklers is acceptable for ceiling only protection with buildings having 40 ft ceilings. **But again, any change would only apply to new systems going forward.**

Regardless of the changes to UL 1767 and NFPA 13, the FM Approval has not been altered. Approved sprinklers must be installed in accordance with the FM Data Sheets. The FM Data Sheets vary from the NFPA standards. In order to use the FM data sheets in a jurisdiction legally enforcing NFPA 13, you would also need the AHJ to agree that the FM standards are acceptable "alternative arrangements" to the NFPA standards. Sections 1.5 and 1.6 of NFPA 13 allow this approach, but the AHJ needs to agree.

Retroactively forcing an existing building owner to replace their K-14 ESFR sprinklers with some other ESFR sprinkler should be discouraged. This was never the intent of the NFPA committee.

It should be noted that the above is the NFSA staff's opinion as members of the NFPA Technical Committee on Sprinkler System Discharge Criteria. It has not been processed as a formal interpretation in accordance with the NFPA Regulations Governing Committee Projects and should therefore not be considered, nor relied upon, as the official position of the NFPA or its Committees.

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