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### Cloud Ceiling Obstruction Criteria

Dealing with cloud ceilings have been a frequent question we come across here at the NFSA. Up until the 2016 edition of NFPA 13, there has been no specific criteria on how to address Cloud ceiling installations. Now there is a definition of cloud ceiling provided in section 3.3.5.1 as well as installation criteria in section 8.15.24 which allows for sprinklers to only be installed under the cloud ceiling. However, questions involving cloud ceilings have not slowed down. One reason may be that this is new language and people are still learning it. The other reason is likely that this criteria has quite a limited scope in application and would not address many of the cloud ceiling scenarios that one may come across. This issue of TechNotes is going to discuss the scope and criteria of the new 2016 language and discuss options to address those cloud ceiling challenges that are not addressed by this new language.

#### NFPA 13-2016 Cloud Ceiling Requirements

The concept behind these new requirements is that based on the arrangement and height of a cloud ceiling, it is possible to adequately protect an area by only installing sprinklers below the cloud ceiling system. A Fire Protection Research Foundation funded project which studied different orientations of cloud ceilings was the basis for this new criteria. Outlined below is a step-by-step guide to understanding and utilizing this criteria. Note that when the word "panel" is used, it is for a single "cloud" panel in the cloud ceiling system.

#### **Step 1) Does your "cloud ceiling" meet the definition of NFPA 13's "Cloud Ceiling"?**

The cloud ceiling changes starts with the inclusion of the definition in section 3.3.5.1:

**"3.3.5.1 Cloud Ceiling.** Any ceiling system installed in the same plane with horizontal openings to the structure above on all sides. This does not include sloped ceilings as defined in 3.3.5.4."

Right off the bat this definition excludes sloped ceilings, eliminating this criteria to be used for any inclined, curved or wavy cloud ceilings that may be used for aesthetics purposes.



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Additionally, this definition requires the structure to open above on "all sides" (however this was discussed during the 2019 revision cycle for NFPA 13 and may be changed to "two or more sides" in the next edition). Already based on this definition we have significantly limited the number of scenarios the later criteria will apply to.

The requirements in sections 8.15.24.2 and 8.15.24. states that the cloud ceiling criteria shall only apply where the cloud ceiling height is limited to 20 feet and that the cloud ceiling be of smooth ceiling construction.

In summary, the criteria would then only apply to flat, horizontal, smooth cloud ceiling panels that are limited to 20 feet in height.

**Step 2) Are the openings in your cloud ceiling system less than 20% open to the area above?**

Section 8.15.24.1 for the cloud ceiling criteria states that you must meet the requirements of 8.15.1.2.1.2. However, it should be noted here that the reference to section 8.15.1.2.1.2 is incorrect and the correct reference should be the subsequent section, 8.15.1.2.1.3. While these two sections are similar, the difference between these sections is that the former (incorrect reference) is limited to openings to be no greater than 8 inches in width where the length exceeds 4 feet. This was not the intent of the section, as for a cloud ceiling arrangement all openings could be greater than 4 feet long and would also limit you to 8 inch gaps between panels, as we will see later on is not the case.

Therefore, for this step all you need to do is calculate that the openings between the cloud ceiling do not constitute more than 20% of the ceiling of the construction feature or plane used to determine the boundaries. In a 1,000 square foot room, you would need to have 800 square feet of cloud ceiling panels in the same plane.

Although this is not explicitly noted, this would eliminate any cloud ceiling systems where panels are vertically spaced in respect to one another. To use this criteria, the panels must be in a single, horizontal plane.

**Step 3) Are your panels appropriate sizes? Do you have an acceptable gap between panels and between panels and walls based on the height of your cloud ceiling system?**

Step 3 requires answers to two questions in order to navigate Table 8.15.24.1. This is because the table provides the maximum coverage area for sprinklers installed only below the cloud ceiling based on two criteria: the size of the panels; and the ratio between the gaps between panels or between panels and walls and the height of the cloud ceiling.

To determine the size of your panels, the smallest dimension of the panel is the number you look at to determine which range of coverage areas your sprinkler can use. The table has three rows broken down into "2 feet to 2.5 feet", "2.5 feet to 4 feet", or "greater than 4 feet". Note that panels smaller than 2 feet cannot use the criteria.

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Determining the ratio between the gaps and the ceiling height is where there is some confusion at first. The first thing to do is to determine the greatest gap distance between cloud panel to cloud panel or between a cloud panel and a wall (if you have some panels that are 4 inches apart and some panels that are 8 inches apart, you would use 8 inches for this ratio). Next you look at the height of your cloud ceiling system in feet. For this example, let's assume the cloud ceiling is 12 feet above finished floor. You then look at the ratio of inches of gap over feet of ceiling height, 8 inches divided by 12 feet or 0.75. Based on this ratio of 0.75 you would then utilize the second column of Table 8.15.24.1 to determine your maximum coverage area per sprinkler.

The size of your panels is used to determine which row of the table you use, and the gap to ceiling height ratio determines which column to use. Assuming we had a cloud ceiling panel greater than 4 feet in dimension with our previous example of a .75 ratio, we would then be limited to a coverage area of 150 square feet per sprinkler below our cloud ceiling system.

### **Summary of Steps**

In conclusion, the criteria in 8.15.24.1 can only be used for cloud ceiling systems where:

- 1) Clouds are horizontal, smooth, flat in a single plane
- 2) The cloud ceiling height is limited to 20 feet maximum
- 3) The area above the cloud ceiling is noncombustible
- 4) The cloud panels are no smaller than 2 feet in a single dimension
- 5) The gap between the panels/wall is no greater than 1 inch for every 1 foot of ceiling height.

If you meet those requirements, then you can install only QR sprinklers (Up to 16 feet maximum between extended sprinklers) under the cloud ceiling system based on the coverage area provided in Table 8.15.24.1. While this is still quite limited in scope, this is a starting place for dealing with these architectural features. It should be noted that while the criteria in NFPA 13 is limited to 20 foot ceiling heights, this is based on the testing done by the Fire Protection Research Foundation which limited their fire tests to 20 foot heights. It was noted that this criteria could be expanded to greater heights based on a simple scaling law(1), but the committee only accepted what was actually tested to. As this is a first step, there is interest to raise money and create additional research foundation projects to expand this scope and application of this criteria.

### **Tackling other Cloud Ceiling Arrangements**

While there was no specific criteria prior to the 2016 edition of NFPA 13 to address cloud ceiling systems, there were a few ways to deal with cloud ceilings depending on the arrangement of the panels.

First, if the cloud ceiling is close enough to the upper ceiling deck to allow sprinklers to be installed below the clouds while still being within the maximum deflector distance, you would

then only need to install sprinklers below the clouds. For example, if the clouds were 10 inches below the upper ceiling deck above, you could install standard spray sprinklers below the deck while still being within their 12 inch maximum distance from the ceiling deck.

Second, if the cloud ceilings are greater than 18 inches below the upper ceiling deck the only obstruction criteria that would need to meet would be for "wide obstructions" which require additional sprinklers to be installed below any obstructions that are greater than 4 feet wide. This is because wide obstructions prevent discharge from reaching the hazard below. Therefore, if the obstructions were less than 4 feet wide, you would not necessarily be required to install sprinklers below these obstructions per the letter of the standard. However, if these clouds were under 4 feet wide, but spaced closely together, consideration should be given to treating them as a single obstruction which would then require sprinklers below.

The last scenario would be if the cloud ceilings were installed at a distance greater than the maximum deflector distance allowed from the upper ceiling deck (12 inch maximum for standard spray sprinklers) for the sprinkler type, but also less than 18 inches below the sprinkler deflector. In this scenario, you would simply treat each panel like a separate obstruction and apply the appropriate obstruction criteria appropriately (beam rule, 3 times rule, or 4 times rule). This is the most challenging to handle and may likely require sprinklers to be installed both above and below the cloud ceiling, however there are too many variations of arrangements to address adequately address this in a single example.

(1) Floyd, Strege and Benfer, (2014) NFPA Fire Protection Research Foundation: Sprinkler Protection for Cloud Ceilings - Phase 2: Small Area Clouds Retrieved from National Fire Protection Research Foundation website:  
<http://www.nfpa.org/news-and-research/fire-statistics-and-reports/research-reports/suppression/sprinkler-protection-for-cloud-ceilings>

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