Obstructions and ESFR Sprinklers

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Outline

- Introduction
- ESFR Sprinkler Design Concept
- Previous Actual Delivered Density Testing
- Proposed Actual Delivered Density Testing
- Proposed Full-scale Testing
- Questions
Introduction

- Project Goal: Develop a tool which can be used to provide a reliable analysis of the impact of obstructions on ESFR sprinkler performance.
  - Existing data
  - New fire testing/analysis

- Phase I of the project included:
  - Literature review
  - GAP analysis
  - Test plan development

- Phase II of the project includes:
  - Actual Delivered Density testing
  - Full-scale fire testing

- The results of the project will be provided to the NFPA 13 Technical Committee to develop requirements for inclusion in the standard.
ADD > RDD = Fire Suppression

Where:
ADD - Actual Delivered Density (gpm/sq. ft.)
RDD - Required Delivered Density (gpm/sq. ft.)
ESFR Sprinkler Head Obstruction Demo
Bar Joist Obstruction ADD Testing – Mammoser & McCormick, UL

ESFR SPRINKLER
HORIZONTAL OFFSET OF 3"

CEILING

14"

8"

BAR JOIST DEPTH: 22"

2" x 2" DOUBLE ANGLE
Bar Joist Obstruction ADD Testing – Mammoser & McCormick, UL

Esfr Sprinkler
Horizontal Offset of 3'

Ceiling

14"

16"

Bar Joist Depth: 30"

2" x 2" Double Angle
Bar Joist Obstruction ADD Testing – Mammoser & McCormick, UL

- ESFR Sprinkler
  - Horizontal Offset of 3"
- Ceiling
- 14"
- 22"
- Bar Joist Depth: 36"
- 2 1/2" x 2 1/2" Double Angle
Bar Joist and Bridging Member Diagram

FIELD WELDED
<table>
<thead>
<tr>
<th>Bar Joist Depth (In)</th>
<th>Bar Joist Offset (In)</th>
<th>Ceiling to Apparatus Top (Ft)</th>
<th>Fire Size (MW)</th>
<th>Fire Location</th>
<th>Sprinkler Type</th>
<th>Discharge Pressure (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22,30,36</td>
<td>0,3,6</td>
<td>10</td>
<td>1.5</td>
<td>Centered under one sprinkler</td>
<td>ESFR K-14</td>
<td>50, 75</td>
</tr>
</tbody>
</table>
Actual Delivered Density (ADD) Testing

Goal: Determine the ESFR K17 sprinkler to be used in the full scale testing.

- ADD testing of three different manufacturers’ ESFR sprinklers:
  - Tyco
  - Reliable
  - Viking
- Apparatus – UL Third Generation ADD Apparatus
- Fire Size – 2.5 MW fire to simulate the heat release rate of the 30 Ft. Group A plastic commodity in full scale test.
- The first series of tests will be used to establish the sprinkler with the strongest center core ADD. This sprinkler will then be further tested in more scenarios. A total of 22 tests will be completed.
## ADD Testing Parameters

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</thead>
<tbody>
<tr>
<td>22,30,36</td>
<td>0,3,6</td>
<td>10</td>
<td>2.5</td>
<td>Centered under one sprinkler</td>
<td>ESFR K-17</td>
<td>52</td>
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</tbody>
</table>
ESFR Full Scale Testing Overview

- **Test Array**
  - Standard Group A commodity
  - 30 ft. storage, 40 ft. ceiling
  - Double row racks, 6 in. longitudinal and transverse flue space
  - ESFR K17 sprinklers, 52 psi
  - 4 ft. aisles
  - 4 bay target arrays
  - Sprinkler spacing 10 ft. x 10 ft.
  - The ignition point will be under one sprinkler at the intersection of the transverse and longitudinal flues in the pinwheel configuration.
Obstruction – 40 ft. long

Plan View of Test Arrangement – 4 Bay Targets with Single Line Obstruction
17 ft. 4 ft. 6 in. 40 ft. ceiling height

Nominal 4 ft. long, 2 by 2 inch steel angle, centered above ignition

22 inch deep truss, with tip of 2 by 2 angle offset 3 inches from the centerline of the sprinkler

40 ft. ceiling height

10 ft. (typical)

Ignition Location – Four half igniters positioned at base of commodity, centered at the intersection of the longitudinal and central transverse flue space (pinwheel arrangement) (igniters are shown in front of the drawing for clarity)
Ignition Location – Four half igniters positioned at base of commodity, centered at the intersection of the longitudinal and central transverse flue space (pinwheel arrangement).

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L
10 ft. (typ.)
14 inches
Steel Beam
36 inch depth
Joist – Vulcraft
Mark T1

Aon Fire Protection Engineering Corporation
Full Scale Testing – Bridging Member Obstructions

- The most rigorous successful bar joist depth and offset will be used in the initial bridging member test arrangement.
- The bridging member will be located on the bar joist with variable offsets that increase if the test results in a failure.
- The bridging members will have an initial offset from the sprinkler of 0 inches that can be increased to 3, 6, and 9 inches.
The following pass/fail criteria were established:

- A maximum of eight sprinklers activate
- The fire is generally contained to the ignition array
- Ceiling gas temperatures are such that exposed structural steel would not be endangered (peak one minute average temperatures less than 1,000° F)
Conclusion

A test plan has been developed which will allow measurement of the sensitivity of ESFR K17 sprinklers to near field obstructions.

This data should allow the NFPA 13 committee to develop scientifically based requirements for inclusion in the standard.

Data is still needed for various other obstruction situations such as miscellaneous piping, light fixtures, or duct work.
Questions and Answers

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