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Smoke Detector Spacing for High Ceiling Spaces

FINAL REPORT BY:

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October 2017

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Executive Summary

NFPA 72, National Fire Alarm and Signaling Code, sets forth requirements for the application, installation, performance and inspection/testing/maintenance of fire alarm and emergency communications systems as well as their related components. As part of these requirements, NFPA 72 specifies location and spacing criteria for smoke detectors. Unlike the spacing reduction for heat detectors that is required based on ceiling height, NFPA 72 does not address spacing considerations for smoke detectors based on ceiling height. There is inconsistency in design and code enforcement for spacing requirements of smoke detectors when installed in areas with high ceilings, where high ceilings are defined as over 10 feet in height. Clarification is required in NFPA 72 on how to apply smoke detection spacing requirements for these high ceiling applications. To assist in justifying the code change (as applicable), the NFPA 72 technical committee needs additional information on the impact of ceiling height and detector spacing on smoke detection performance.

Detection devices perform an important function by providing warning for building occupants so that they are aware of a fire in time to allow for safe egress; however, a performance metric for a significant fire challenge or an acceptable response time is not clearly defined in NFPA 72. The 30 foot (9.1 meter) nominal spacing currently used for smoke detector spacing is defined by the NFPA 72 handbook as being "...adequate to achieve the life safety objectives implied by the building codes...", however the fire challenge(s) this protects is not explicitly defined. [1]

There is a body of research, including standard fire tests, non-standard fire tests, and computer modelling, which have studied smoke detector performance in high spaces (see Section 2.2); however, the central problem is that it is difficult to achieve consistency in identifying the smoke detector performance. Smoke detectors are tested in accordance to ANSI/UL 268 *Standard for Smoke Detectors for Fire Alarm Systems*, which specifies that sensitivity meet a minimum obscuration level measured using smoke generated from either a smoldering cotton lamp wick or an aerosol generator. [2] The sensitivity standard can compare one device to another, but it cannot provide guidance as to how the spacing in the built environment will affect the smoke detector performance.

Some countries have included maximum ceiling heights with respect to detector types, while others codify general approaches to high ceiling spaces. British Standards and Ireland Regulations include tables for numerous types of detectors. Codes from Australia, France, Germany, and the Netherlands, provide guidance to a certain height and require additional detection to be added at designated heights (see Section 2.1).

The content of this review of the impact of ceiling height and detector spacing on smoke detection performance will follow the proposed project tasks. The literature review gathered related information around the following focus areas.

- NFPA 72 requirements (including review of past editions of NFPA 72 and the technical basis for relevant smoke and heat detector spacing requirements for high ceiling applications) [Section 1]
- Requirements of other non-NFPA fire alarm codes/standards from around the world (i.e. fire alarm codes outside the United States, etc.) and the respective basis for smoke and heat detector spacing requirements for high ceiling applications [Section 2.1]
- Literature review on key research reports and studies [Section 2.2]
- Available literature on related fire dynamics modeling (computer modeling, detector entry modelling, detection modeling) and fire testing and data [Section 3]
- Available fire alarm manufacturer literature for spacing requirements for specific products and the associated justification as well as detector technology.

The outcomes of this review indicates that there is limited context and significant gaps in knowledge that preclude the formulation of scientifically justified prescriptive requirements regarding smoke detectors relative to ceiling height (see Section 4). Additional work is required to ensure that there is an appropriate scientific and engineering basis for future code requirements.

To resolve the gaps found a research plan has been formulated, which provides a path forward to better characterize the smoke detection spacing in high ceiling spaces (see Section 5). One of the imperatives for establishing the smoke detectors in high spaces is establishing the performance metric for smoke detectors along with other stakeholders, which can be applied towards higher ceilings. This would involve identifying either (a.) a generic set of design fires (i.e. range of combustibles, range of fire-growth rates, etc.) through which detector performance can be assessed, or (b.) developing a time by which smoke detectors need to respond to provide a tenable environment for occupants.