IMPACT OF ELEVATED WALKWAYS ON SPRINKLER PROTECTION: PHASE II

Noah L. Ryder
Brent Turner
Ryan Hutchens

Fire & Risk Alliance, LLC., Rockville, MD, USA

Abstract

English

Keywords: sprinklers, spray patterns, k-factor, elevated walkways

INTRODUCTION

The National Fire Protection Association (NFPA) Fire Protection Research Foundation (FPRF) “Impact of Elevated Walkways in Storage on Sprinkler Protection” Phase II project seeks to address knowledge gaps related to the impact of walkways and mezzanines on sprinkler performance.

The goal of this project is to further the efforts begun in Phase I in which a detailed literature review was performed to document the current sprinkler criteria and the technical substantiation for the currently provided guidance. Based on the gap analysis a research plan was developed to fill the identified gaps in knowledge.

This research was necessary as sprinkler performance may be affected due to the presence of a mezzanine, walkway grating interfering with the spray, delayed activation of the sprinklers as a result of the grate’s influence on the plume, or the impact of pre-wetting of adjacent racks, Figure 1. Ultimately the objective of this effort is to provide guidance to the NFPA 13 technical committee on walkways/sprinkler interface criteria that is well founded in sprinkler performance.

Figure 1 - Various walkway/storage/sprinkler configurations
PROJECT SCOPE AND TASKS

Based on the outcome of the Phase I research, the Phase II research plan included the following proposed Tasks:

- **Task 1**: Survey of existing conditions. FRA will develop a survey and collect information on current warehouse configurations to gain insight into the status quo and to attempt to ascertain how storage protection may be changing;

- **Task 2**: Sprinkler characterization and modeling of spray and walkway/rack interactions to include baseline scenarios for comparison of the spray pattern development and water delivery and will help determine the range of scenarios to be examined experimentally;

- **Task 3**: Cold flow experiments to examine the sprinkler spray characteristics and determination of delivered density to fuel surfaces and storage array faces in a mock storage rack/walkway environment;

- **Task 4**: CFD modeling of anticipated fire test scenarios to examine activation and spray distribution; and

- **Task 5**: Development of a large-scale fire test plan to fill the identified knowledge gaps in order to complete the development of technical guidance.

The research plan is designed to yield as comprehensive a set of guidance as possible recognizing that field variations and design scenarios are always changing. Thus, the intent is to create a plan that provides for simple guidance to address the most commonly encountered scenarios but also provides a framework for addressing scenarios that may fall outside of the norm. Ideally a combination of prescriptive solutions and a framework for a performance-based approach will be derived. In addition, the research plan is designed to maximize the information that is able to be obtained given a finite set or resources.

One of the primary goals of the research plan will be to identify the role that each of the parameters play and to divide them into three categories:

1. **Negligible** – a mezzanine/spray configuration that has negligible impact on sprinkler activation times and water delivery.

2. **Impactful** – a mezzanine/spray configuration that has a clear impact on either sprinkler activation or water delivery (Actual Delivery Density). Example – significant fraction of water is blocked preventing pre-wetting of surfaces.
3. Questionable – a mezzanine/spray configuration that is neither “Negligible” or “Impactful” and the impact of which needs to be determined through an engineering analysis.

Figure 2 provides an overview of the proposed research plan highlighting the interdependencies of each step of the plan after the survey is completed.

![Flowchart of Proposal Research Plan](image)

**INITIAL RESULTS**

Figure 3 below shows the impact of droplets impacting by the grating based on the grate dimensions and sprinkler height. Figure 4 shows the percent of spray that is unobstructed for a given sprinkler/grate configuration.

![Initial grate configurations and sprays](image)
As can be observed for each elevation/azimuthal angle pair the grating impact results in a reduction in the unobstructed water flowing from the sprinkler which can be observed on the spray sphere, Figure 5. This reduced flow can then be used to evaluate the effectiveness of the sprinkler in a given installation or used as an input into a CFD model. The advantage of the simplified tool is that it can evaluate the percent blocked in a short time frame and the reduced sphere allows for modeling of sub-grid scale geometries of walkways/grates.

![Figure 4 - Percent of water unobstructed](image)

![Figure 5 - (a) original spray sphere, (b) reduced flow sphere](image)