Background
NFPA 409, Standard on Aircraft Hangars, has historically (until the 2022 edition) required various fire protection options using firefighting foam systems. The requirements for foam fire protection systems in NFPA 409 (e.g., low expansion, high expansion) are largely based on large-scale fire tests (~900 ft² pool fire tests) conducted by FM Global in the 1970’s, however it has been a challenge to replicate these large-scale pool fire tests today. There have traditionally been no avenues for evaluating alternative fire protection methods for possible inclusion in NFPA 409. While systems such as water mist, compressed air foam, clean agents and other solutions have been proposed, the path to understand their effectiveness in protecting an aircraft hangar is unclear. Therefore, it was necessary to develop an alternative evaluation method that can be used to assess the performance of other technologies on the assumed aircraft hangar fire scenario.

Project Goal & Approach
The overall goal of this research program is to establish an evaluation method that can be used to assess the performance of alternative fire protection systems for aircraft hangar facilities. The objectives include:

- Review and clarify the technical basis of the performance criteria of fire protection systems permitted in NFPA 409
- Conduct a risk assessment of aircraft hangar facilities and evaluate the applicability of alternate fire protection technologies
- Develop a research plan to further investigate the effectiveness of fire protection solutions in aircraft hangars.

Summary Observations
This project involved a literature review of the current fire suppression systems applied in aircraft hangar applications. The code revisions have been reviewed and summarized in this report, which at the time of review were primarily on foam-based fire protection.

Statistics on aircraft hangar incidents, including the prevalence of fuel spills and incidences of foam discharge, in response to fire and accidental discharges were gathered through various sources and surveys. To summarize the data collected as part of this study, it was found that there were very few fuel spills in aircraft hangars (only 25 in the last 5 years per the US Coast Guard), which has historically been viewed as the most likely fire scenario. Additionally, in the last 17 years, there were 44 foam system discharges in response to fire (2.6 per year) and 357 foam system discharges where a fire is NOT present (21 foam discharges per year creating $7 million in damages per year), which are considered to be accidental foam discharges.

In light of these statistics, potential alternative fire protection solutions were evaluated. These include, alternate firefighting foam formulations, such as fluorine free foams, compressed air foams, water sprinklers, water mist, ignitable liquid drainage (ILD) floor assembly, clean agents and wetting and encapsulating agents. As this report was being completed, a new edition of NFPA 409 (2022) was released, which allows for alternate methods of hangar fire protection, including risk based approaches and ILD systems.

A risk-based approach for hangar fire protection was proposed and outlined within this report. A sample risk assessment with discussion on various scenarios and consequences is provided therein.

The gap analysis conducted highlighted future research needs:

- More fire incident data needs to be collected to better understand the cause and inform appropriate fire scenarios
- More data to evaluate the performance of various fire protection solutions
- More research is needed to explore the limitations of the solutions and identify design optimizations.