



# RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

## PROJECT SUMMARY

### Combustible Gas Distribution in Buildings and Detector Location Analysis

20 September 2019

**Background:** Recent experiences with combustible gas releases in residential buildings have led to a proposal for NFPA Standards Development for locating combustible gas detectors and consensus on installation location requirements. NFPA is considering a proposed project on detector location and installation, similar to the Standard NFPA 720, "Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment." To date, technical analysis for justifying combustible gas detector installation location is lacking to support standards development. This study is proposed to address the residential installation criteria for these devices and systems.

**Project Goal:** The overall goal of this project is to clarify the technical basis of location requirements for installation of gas detectors for the detection of combustible gases in residential occupancies.

This effort is intended to provide a framework to address these subject hazards with the intent in the future this approach can be validated and readily adapted for additional similar application (e.g., scope expansion to address hydrogen, gas blends, additional residential scenarios).

**Project Scope:** The scope of this project will be based on the following:

- Potential accidental release points of gases in residential occupancies separately involving each of these three combustible gases: natural gas, methane and propane,
- Transport mechanisms of gases and barriers (including buoyancies of gases),
- Flammability of gases,
- Related occupant needs for notification for emergency responses,
- Discrimination of combustible gas alarms from other hazard notifications, and
- Gas detectors including but not limited to listed devices (e.g., UL 1484 listed devices).

**Project Tasks:** This project will involve the following tasks:

**Task 1. Appointment and administration of project technical panel** (handled by FPRF): A technical panel including the subject matter experts will be appointed to provide input and feedback throughout the project. The administration of the panel will be handled by the FPRF. The role of the Panel will be to provide input to the project, review periodic reports of progress and research results, review and provide feedback on the final project report.

**Task 2. Literature review:**

- **Task 2.1. Regulatory:** Conduct a literature review to study the existing guidance for combustible gas detector location and installation in residential occupancies for gas detectors intended to detect flammable gases such as propane, methane and natural gas. This should also include reviewing currently available manufacturers' installation instructions, state laws (e.g., Idaho, Montana) and existing standards for residential gas detectors (e.g., UL 1484). Provide insights and technical basis on the flammability limits requirements of gas detection in support of residential occupancies, including consideration of other occupancies as appropriate. Summarize the existing model code notification requirements of other hazard alarms (e.g., smoke detection) for the application of combustible gas detection.
- **Task 2.2. Incidents:** Identify, review and summarize any historical and/or recent incidents that report specific issues of gas detector location, and flammable gas distribution in residential occupancies.

- **Task 2.3. Research:** Review any prior studies including but not limited to peer reviewed articles, conference proceedings and research reports on combustible gas detector location analysis and summarize observations and results from these earlier studies on combustible gas dispersion in support of residential occupancies.

**Task 3. Establish CFD modeling plan:** It is anticipated that a minimum of thirty scenarios will be simulated, though more is preferable based on the available project resources.

- **Task 3.1. Source characterizations:** Consider the potential gaseous fuel releases in residential occupancies involving natural gas, methane and propane. Identify and assess the variables associated with these potential gaseous fuel releases in residential occupancies.
- **Task 3.2. Mechanisms:** Summarize the potential accidental release points of gases, transport mechanisms and barriers (including buoyancies of gases), flammability of gases and related occupant needs for notification for emergency responses.
- **Task 3.3. Scenarios:** Develop a limited number of residential occupancy configurations/scenarios for CFD modeling analysis. The scenarios should consider addressing at a minimum one- and two-family homes, multi-family residential buildings of three stories or less, high-rise residential building over three stories, and mix-use residential and commercial buildings for modeling gas releases.
- **Task 3.4. Panel review:** Review and prioritize the scenarios with project technical panel for their feedback, considering the available resources for the project.

**Task 4. Implement CFD modeling:** Conduct CFD modeling of the gaseous fuel releases in limited number of occupancy configurations identified and prioritized in Task 3.

**Task 5. Analysis:** Analyze CFD modeling results to provide inferences on the development of flammable gas concentrations over time. Develop preliminary recommendations of detector coverage in terms of specific parameters such as floor area, common way locations, vertical placement of detectors, and discrimination of combustible gas alarms from other hazard notifications.

**Task 6. Future research:** Identify future research requirements including an experimental test plan at full scale or reduced scale, for validation of CFD modeling using non-flammable test gases. Explain the details of the plan will be implemented, for future additional efforts for experimental validation and scope expansion.

**Task 7. Final Report:**

- **Task 7.1. Draft Report:** Prepare a draft final report including the findings from above tasks and review it with the panel.
- **Task 7.2. Final Report:** Submit a final report after incorporating the necessary revisions based on the panel feedback.

**Reporting and Deliverables:** Four interim updates: first interim update completion of Task 2; second interim update during Task 3; Third interim update after completion of Task 4 & 5; and Fourth interim update during Task 6 are required from the contractor. A draft final report, and final report will be developed for this project. Final report will be disseminated by the Research Foundation through FPRF website.

**Implementation:** This research project is led by the Fire Protection Research Foundation and will be conducted in accordance with the "[Research Foundation Policies for the Conduct of Research Projects](#)". The project will be guided by a Project Technical Panel who will provide input to the project, recommend contractor selection, review periodic reports of progress and research results, and review the final project report.

**Intellectual Property:** The Research Foundation will retain rights to the project deliverables including the final report which will be published on the Foundation website.

**Schedule and Costs:** The total project duration is 7 months from the time of initiation September 2019, with final deliverables expected by April 2020.

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