

Evaluation and Enhancement of Fire Fighter PASS Effectiveness

PROJECT SUMMARY

29 August 2011

Background: When firefighters are overcome by the heat or smoke of a fire and become disoriented or trapped in a structure, it is crucial that there is a reliable means to alert other fire ground personnel to their need for assistance. Personal Alert Safety System (PASS) devices are designed to alert aid using audible signal technology. Normal operation is for the PASS devices to activate a 95-decibel multiple-frequency alarm signal if the lack of motion exceeds a specific time period.

However, despite its widespread use throughout the fire service and on-going enhancements in recent years, certain problems still exist with audible PASS technology. Foremost among these problems is that nationally recognized standards currently allow a range of performance for the PASS alarm signal, and this has resulted in multiple different PASS alarms being used in the field.

This project seeks to establish a scientific basis for a single PASS alarm signal for use throughout the U.S fire service, and additionally address possible technological enhancements such as receiver enhancements and addressable non-audible frequencies.

Research Goal and Objectives: The goal of this project is to improve the safety of distressed firefighters engaged in structural firefighting operations and to aid in rescue activities, by establishing a credible and scientific basis for determining the optimum PASS signal performance characteristics and to evaluate technological enhancements for this technology. The specific objectives for meeting this goal are to:

- a) Provide science-based guidance to PASS device manufacturers, firefighters, researchers, and standards developing organizations for the optimization of PASS alarm sounds;
- b) Investigate the feasibility of technological enhancements to PASS devices that can be implemented within five years; and
- c) Produce a methodology by which to optimize audible alarms that can be applied to a wide range of research areas.

Affected NFPA Documents: This project is directly applicable to the requirements addressed by NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*. This project is also applicable to NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*,

Project Tasks: This project is a collaborative effort involving researchers from the University of Texas Austin (UTA) and the National Institute of Standards and Technology (NIST), administered under the direction of the Fire Protection Research Foundation (FPRF) in coordination with fire service partners. The project involves the following tasks:

- **1.** <u>Task 1: Advisory Panel.</u> Establish and administer an advisory panel that will provide guidance throughout project to the project research team. (months 1 36)
- 2. <u>Task 2 Literature Review</u>. Collect and analyze background information (months 2 5) applicable to this study, including:
 - **a.** Existing and available PASS signals;
 - **b.** Fire ground background noise;
 - c. firefighter hearing test data;
 - **d.** Incidents involving PASS and Rapid Intervention Team (RIT) use;
 - **e.** Most prevalent structural configurations in which FF injuries/deaths occur, using these scenarios to motivate model simulations;
 - **f.** Alternative technologies to enable improved PASS effectiveness (e.g. receiver technology, addressable frequencies, etc); and
 - **g.** Other critical factors required to evaluate PASS signals.
- **3.** <u>Task 3: Portfolio of fire ground Noise</u>. Establish a digital portfolio that is representative of fire ground noise for PASS signal evaluation (months 6 12). This will include the following:
 - a. Establish field measurement protocol and required measurement equipment;
 - **b.** Review data collection plan for Advisory Panel guidance;
 - c. Collect calibrated baseline fire ground noises (UTA);
 - **d.** Collect additional supplemental sounds with fire service partners;
 - **e.** Analyze all captured sounds, create a digital portfolio of fire ground noises in workable electronic formats, and address the reproducibility of the acoustical signature of firefighting operations; and
 - **f.** Generate worst-case sound compilations and review fire ground noise portfolio and compilations with Panel and fire service partners.
- **4.** <u>Task 4: Analysis of Existing PASS Alarm Sounds.</u> Provide a detailed analysis of existing PASS alarm sounds (months 13 15) with consideration for the following:
 - **a.** Establish existing resonant frequencies; and
 - **b.** Collect data and analyze aging characteristics.
- 5. <u>Task 5: Modeling and Validation of Sound Transmission</u>. Develop models of sound transmission and validate these models (months 2 30), with consideration for the following:
 - **a.** Analyze building types and available burn buildings for model simulations;
 - **b.** Construct basic sonar equation analog for fire ground representation;
 - **c.** Model sound transmission in structures identified in literature review as being most commonly associated with LODI/LODD;
 - d. Validate model parameters using experiments and computations;
 - **e.** Use modeling tools to determine how several representative sounds (typical of fire fighting operations) mix and are sensed at different locations in the structure;

- **f.** Characterize acoustic transmission through PPE headgear, and develop model and calibrate with experiments; and
- **g.** Conduct limited full scale experiments to calibrate models and more extensive experiments to be used for validation cases.
- 6. <u>Task 6: Evaluation of firefighter Response to PASS Signal.</u> Evaluate existing and available PASS signals against fire ground noise and other factors (months 16 34), and recommend optimum PASS signal(s) based on existing and available technology based on the following:
 - **a.** Analysis of existing literature and data;
 - **b.** Review PASS signal evaluation plan with Advisory Panel for guidance;
 - **c.** Combine background noise, firefighter hearing response, existing PASS alarm sounds, and model results;
 - d. Classify and overlay PASS sounds and develop modeled optimized PASS alarm sound(s);
 - **e.** Evaluate optimum PASS sound versus existing PASS sounds, using a representative sample of firefighters using a non-fire environment (using fire fighter hearing tests and turnout gear/breathing apparatus tests); and
 - **f.** Evaluate optimum PASS sounds with training scenarios using fire service partners (Implement field audibility tests at four participating fire department training facilities engaged in representative fire ground conditions).
- 7. <u>Task 7: Establish Recommendations for Readily Implemented Alternative Technologies.</u> Develop recommendations for alternative technologies (months 30 34) that can be readily implemented, based on the following:
 - a. Investigate feasibility of acoustic directive receivers (one-way);
 - **b.** Provide feasibility assessment of detectability enhancement technology; and
 - c. Review feasibility of addressable non-audible frequencies.
- Task 8: Reporting and Dissemination. Finalize documentation with review from project Panel and generate project report (months 34 36). Widely circulate and disseminate project deliverables. Report at AFG Annual Update meetings.

Project deliverables will be a detailed report on the literature search, digital portfolio of fire ground noise, analysis of existing PASS alarm sounds, models of sound transmissions applicable to PASS, evaluation of fire fighter response to PASS signals, and recommendations for practical and readily implemented alternative technologies.

Implementation: The research program will be conducted under the auspices of the Fire Protection Research Foundation and will be guided by a Project Technical Panel. The final report will be issued by July, 2014.