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International Association of Fire Chiefs Investigate Fireground Noise and Digital Radio Transmissions

In June 2008, the International Association of Fire Chiefs (IAFC) released a report on the use of digital radio technology following results of federal testing that found some current digital systems have unintelligible audio in loud noise environments. The report's conclusions are based on 9 months of laboratory testing conducted by the National Institute of Standards and Technology (NIST) and National Telecommunications and Information Administration (NTIA). The report, *Interim Report and Recommendations: Fireground Noise and Digital Radio Transmissions*, describes the testing protocol, findings, and analysis as well as providing important recommendations for the fire community. It is available at www.iafc.org/digitalproblem . The test results indicate that digital communication needs improvement especially in high-noise environments.

Background: In late 2006 and early 2007, IAFC began to receive reports of firefighters who experienced unintelligible audio communications while using a digital two-way portable radio in close proximity to the low-pressure alarm of their self-contained breathing apparatus (SCBA). Other common fireground noises, such as power tools, diesel engines, and personal alert safety system (PASS) devices, appeared to affect voice intelligibility.

IAFC formed a working group, the Digital Problem Working Group (DPWG), continuing today as the Digital Project Working Group, composed of fire service personnel, other public safety representatives, wireless radio manufacturers, fire equipment manufacturers, and Institute for Telecommunications Sciences (ITS) engineers to research and verify potential problems found in digital radios in the presence of loud background noise.

The DPWG identified the vocoder, which converts voice into a digital signal and back to audio, as the cause of voice audio distortion that some digital radio users have experienced. While many emergency response agencies are using digital radio systems with success, the vocoder may make voice communications unintelligible in the presence of loud background noise, potentially compromising mission-critical operations.

Operational Effect of Unintelligible Communications: When the noise generated from a facepiece's low air alarm mixes with the firefighter's voice into the radio's vocoder, a "MAYDAY" voice message often becomes nothing more than unintelligible noise to the incident commander and everyone else listening. The result is that a desperate call for help is likely to be dismissed as just another fireground noise.

Laboratory Testing Protocol: Testing was initiated to evaluate radio intelligibility that compared two vocoder technologies—the baseline Project 25 (P25) Full Rate vocoder and the P25 Enhanced Full Rate vocoder—against a 25 kHz analog FM pair under nine different noise conditions. In three of the background noise conditions, testers also evaluated 12.5 kHz analog FM to determine whether or not that might be a viable alternative to meet the Federal Communication Commission (FCC's) narrowbanding mandate while still providing a required level of intelligibility to the user. Noise conditions tested ranged from "no mask, at the fire truck pump panel," to "mask, with two PASS alarms" to "mask, rotary saw cutting metal."

The Modified Rhyme Test (MRT) was used to evaluate the intelligibility of digital and analog communication systems. In this type of test, each tester listens to a sentence asking the individual to select a word from a list. The listeners' ability to select the correct word is averaged across a panel of test listeners and produces a percentage of intelligibility score.

Testing Results: Based on the MRT test scores, analog communication was more intelligible in six of nine high-noise environments tested. In two of the nine tests, analog and digital were statistically similar. In one instance, enhanced vocoder was more intelligible than analog.

The results of the NIST/NTIA testing can be found in the report, *Intelligibility of Selected Radio Systems in the Presence of Fireground Noise: Test Plan and Results* at http://www.its.bldrdoc.gov/pub/ntia-rpt/08-453/ . Because there is no current audio intelligibility performance standard for public safety radio communications systems, the findings in the report are based on comparable scores of analog FM and vocoder technologies tested.

Recommendations: The report makes strong recommendations for best practices, addressing policy, technical, and operational issues. Seven recommendations are directed at incident commanders, and six at users in the field, and include the following.

- Comprehensive and continuing training is critical to the successful use of complex communications equipment. Personnel need to be trained to properly use assigned radio equipment with all the components of their protective equipment.

- There is currently no standard for public safety communications intelligibility. That must be addressed along with the development of standards and guidelines for scenario-based user training utilizing their communications equipment that includes integration of communications policies and procedures into agency operations.

- The fire service and all first responders need to be involved in the design and development of requirements for any communication system implementation from the beginning. Radio systems that are designed and constructed without consideration of first responder requirements frequently do not meet the needs of first responders.

Finally, in the absence of a public safety audio intelligibility performance standard by which to measure success or failure, the report asks for "analog voice intelligibility quality or better in digital radios to protect first responders in high-noise environments."