

**T H E C A L I F O R N I A**

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# **FIRE SERVICE**

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## Radios: What we really need

### The facts about P-25 Digital and Trunked Radio Systems for the fire service



***"The safest network for firefighters is one that uses analog repeated and analog simplex channels as part of it and not a fully trunked or digital system".***

**Background:** There has been a lot of controversy with Digital and Trunked radio systems and how to use them, or not to use them in the fire service. CSFA developed an ad-hoc committee of fire service communications professionals that gathered a lot of data, and through their experience and consultation with professional communications engineers, have developed the 16 CSFA Digital Radio "Watch Outs". The first six "watch outs" pertain to conventional radio systems. The next ten "watch outs" pertain to trunked radio systems. Some of the "watch outs" are the same for conventional and trunked systems. CSFA provided a presentation to the APCO P-25 User Needs Committee on

August 14, 2009 in Las Vegas just prior to the APCO conference. CSFA has also made requests to make this presentation to the International Wireless Communications Expo attendees and others. We will be presenting at Firehouse World in San Diego as well. The intent of these watch outs and this article is to better educate the fire service community and radio system consultants, designers and politicians of what the fire service needs and the ramifications if these watch outs are not followed.

To help the less "radio literate", a conventional radio system is one channel, one conversation. Picture a bank teller line with one

customer line per teller. For the California readers, CA White 1 is a conventional channel in what is a conventional radio system. A trunked radio system is made up of a group of channels that are computer controlled by a separate "data channel" that steers the base, mobile and portable radios to the correct talk-group. Think of "trunked" as one long line of customers waiting for several tellers with a "controller" teller placing the customers in the next available line.

A talk-group is a virtual channel created by the "computer controller" and a human system administrator. In other words, a trunked radio system maximizes spectrum efficiency and allows more than one virtual channel per real/physical frequency/channel. A 10 channel trunked system theoretically could have 100 talk-groups giving 100 groups of users their own "channel". A 10 channel trunked system can only handle nine simultaneous conversations, with one channel being held back for data.

A 10 channel conventional radio system only has 10 channels, no talk groups and can only handle 10 simultaneous conversations. The main benefit to trunking is spectrum efficiency. The main benefit to a conventional radio system is no computerized controller and no system administrator is needed. Special firmware is also needed to operate on a trunked radio system along with specific radio authorization and additional cost for the trunking firmware.

Conventional for fireground operations is more reliable and keeps the system much simpler. Local Firefighter Association boards or their appointees need to participate in the development of a new radio system to ensure that the 16 CSFA Watch outs are implemented as part of the system design. Once the system is designed, it may be too late or too costly to fix the problems.

## Six CSFA P-25 Digital Conventional Radio Watch Outs

**1.** The DAQ (digital audio quality) standard of 3.4 (at the street-level) does not penetrate deep enough into structures or under ground in unpredictable surroundings to provide effective communications. DAQ 3.4 is what most systems are designed to. Systems designed above DAQ 3.4 makes a new system extremely expensive. Most systems cover 95% above ground in their design. As you know, firefighters go into the 5% above ground where no one else goes and we go well below street level routinely in basements, subterranean garages, confined space rescues, etc.

Adequate analog repeated and simplex/talk around channels are necessary for the firefighter's working environment. Some consultants have recommended "Leaky cable", but it is costly for new construction and it is not practical to install in every building, parking structure and basement that is pre-existing. Many cities have local ordinances requiring leaky cable for new construction. Leaky cable works well until it loses power. If building power is cut, or the UPS to the amplifier is lost, all signal is lost potentially leaving the firefighters stranded without communications to the command post.

**2.** Simultaneous transmitting on digital radios on the same channel may result in radio traffic not being received. Simultaneous transmitting on analog radios have a better chance of successful communication. Some communication at the command post or between firefighters is better than none. When two digital signals collide, no signal is heard because the digital stream is interrupted. If two analog signals collide, interference is heard, signaling the command post and oth-



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ers that there is someone attempting to transmit.

Fire-ground background noise, low radio volume and high noise levels are common causes for accidental simultaneous transmitting. Simultaneous transmitting is unavoidable in our profession. Firefighters are taught to avoid simultaneous transmitting, but it still occurs.

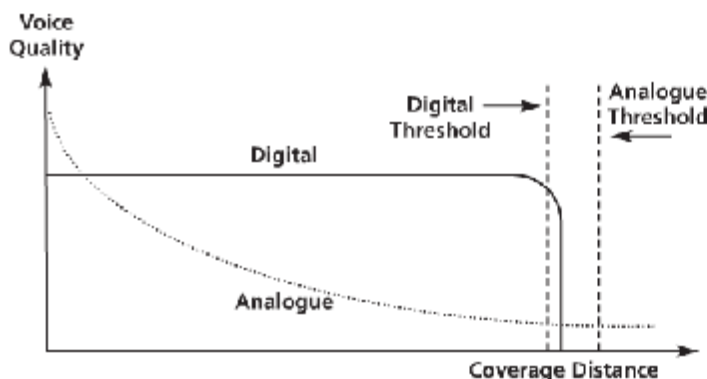
**3.** Background noise such as sirens, fire engine pumps, motorized saws, and PASS devices may cause audio distortion resulting in unintelligible messages.

High background noise is unavoidable in our profession. Some consultants have reported that this is no longer an issue, but it is. APCO along with NTIA continue to identify potential solutions. In lay terms, the microprocessor (vocoder) in the radio cannot always distinguish between the human voice and background noise. The background noise confuses the microprocessor and causes the human voice to be unintelligible. This is still a current, and serious problem. Using an analog channel resolved this issue. Ref. NTIA Technical Report TR-08-453

**4.** Weak and/or intermittent digital signals take longer to decode than analog signals especially when the "picket fencing" phenomenon occurs.

"Picket-fencing" occurs when a radio signal goes in and out of coverage quickly. Imagine looking through a picket fence while being driven down a street. You can make out what is on the other side of the picket fence, but you cannot get all of the detail. The same phenomenon occurs with analog radio. With digital radio, because the vocoder has to detect whether the signal is analog or digital, it takes milliseconds to decode the signal properly, and send it to the speaker. If picket fencing occurs with a digital radio, you will only hear digital gibberish and will not be able to make out anything intelligible. Using an analog channel resolved this issue.

**5.** Digital signals drop off suddenly in fringe areas as opposed to analog signals which have ever increasing levels of static until the signal is lost. Digital signals dropping off suddenly is a real problem for firefighters as it provides no safety buffer to know when they are approaching the end of radio coverage. Firefighters use static as a safety indicator of how far to go into a building or into back country before losing all communications. This is a controversial issue. The chart below shows that the digital threshold is less than analog, thus dropping off sooner than analog and more abruptly



**6.** Firefighters often operate while in horizontal positions in structures, confined spaces and outside. Greater signal loss occurs in these situations than on a radio in a vertical position being operated from the hip or chest pocket of a firefighter. While on a digital network, coverage may be acceptable while standing outside the building, but upon entry, or entry and getting into a horizontal firefighting position, the signal may abruptly be lost or distorted.

Switch to a predetermined conventional analog repeated channel

with simplex capability BEFORE entering an area with these situational issues. Consider using analog simplex first if short range communications is acceptable.

## 10 CSFA P-25 Digital and Trunked Radio Watch Outs

For the sake of the length of this article, Trunked watch outs 1, 2, 3, 4 & 6 are the same as conventional digital. We separated conventional digital watch outs from trunked digital watch outs to ensure firefighters are aware of the difference.

We will address CSFA P-25 Digital and Trunked Radio Watch Outs 5, 7, 8, 9, & 10 in this section of the article.

**5.** Transition from exterior to interior tactical operations and remaining on a trunked system does not provide for direct communications when the control channel signal is lost. This is a critical watch

## Changing to a pre-determined channel before entering the structure is the best choice most of the time.

out. This means that communications may be fine on the trunked network outside the structure. Upon entry, if your radio loses the control channel (remember the "controller teller" we used as an example earlier) your radio will stop operating and may beep at you, or just indicate "out of range". At this point, you can't talk to anyone. Now you need to change to a "direct" channel. As we all know, changing channels is darkness, or in an IDLH environment, is not the ideal situation. Changing to a pre-determined channel before entering the structure is the best choice most of the time. Some trunked systems can change you to a direct channel upon losing the control channel on a trunked system, however, now you are separated from everyone else on the incident. Another scenario that is not acceptable.

**7.** In deployed wildland shelters while being overrun by fire, firefighters who lose the control channel lose all possibility of communications. This case is the same as watch out #5, except it occurs when you are in a deployed shelter, and corrects itself upon leaving the shelter. Obviously if you have to deploy a shelter, radio communications may not be your first concern, but if everyone's radio starts honking that you are out of range and some direct communications is needed for an immediate water drop, your message to the aircraft, or to your crew-mates 10' from you will never be heard.

## The SOLUTION for CSFA P-25 Digital and Trunked Radio Watch Outs 1 through 7 is:

Switch to a predetermined conventional analog repeated channel with simplex capability BEFORE entering an area with these situational issues.

**8.** An "emergency trigger" or "Mayday" talkgroup repeater uplink frequency (the channel your portable radio transmit to the repeater on) is unable to be monitored at the command post. This has become a problem when a firefighter is in radio coverage, but may fall through the roof, or fall through the floor and suddenly finds themselves "out of range". Without a radio at the command post that will receive the "uplink" frequency, when the firefighter presses the emergency button, and the radio attempts to send a signal to the

repeater and because the radio is out of range of the repeater, the radio's call for help will not make it through the network to the dispatch center or command post.

**SOLUTION:** Emergency trigger channels should be conventional analog so the repeater up-link frequency can be monitored at the command post in the event the portable radio cannot reach a repeater site. This will require two radios to be monitored at the command post, but it gives the fallen firefighter the best chance to get help.

9. Loss of the control channel on a trunking system eliminates the use of the trunked "emergency trigger" or "Mayday" talkgroup. If the firefighter loses the control channel on a trunked network, they lose all chance of being heard when calling for help.

**SOLUTION:** Emergency trigger channels should be conventional analog so the repeater up-link frequency can be monitored at the command post in the event the portable radio cannot reach a repeater site.

10. The goals of spectrum efficiency, trunking technology and cost savings is taking priority over firefighter safety.

Firefighters are in a zero-fail profession. Firefighting communications is mission critical and has no tolerance for the "efficiency" of trunking. Trunking is unsafe and inappropriate for some tactical fire operations.

**CSFA P-25 DIGITAL WORKING GROUP SUMMARY**

The CSFA P-25 working group understands the positive attributes of the P-25 Standard for wide-area dispatch, command and some above ground tactical operations. This technology however does not always work for the Fire Service in all cases. The safest network for firefighters is one that uses analog repeated and analog simplex channels as part of it and not a fully trunked system. Most in-building communications to the local command post will be enhanced by using local repeaters, or direct/simplex operation to communicate with the command post.

The CSFA P-25 working group respectfully recommended to the APCO P-25 standards committee that the six CSFA P-25 Digital Conventional Radio Watch Outs and 10 CSFA P-25 Digital and Trunked Radio Watch Outs be adopted and promulgated in addition to the IAFC's P-25 Digital Best Practices. This recommendation is working it's way through the APCO process.

The full power point presented to the APCO user needs group is posted on the CSFA website members section at [www.csfa.net](http://www.csfa.net)

Questions about this article can be directed to [kmida@csfa.net](mailto:kmida@csfa.net).



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