

Network Command: *The High-Tech Future of Incident Management*

by Deputy Assistant Chief Joseph W. Pfeifer

Most *WNYF* articles examine lessons learned from past fires. This article, however, looks at new technologies and ways of commanding in the near future. Commanding at fires and disasters requires Incident Commanders (IC) to attain situational awareness, make critical decisions and perform complex organizational tasks to protect life and property. They are asked to act decisively, yet remain adaptable to a changing threat environment. The speed with which they are able to acquire and use information is critical for commanding during a crisis.

Since 9/11, FDNY has invested millions of dollars and thousands of hours of effort into developing a network command (aka network centric command). This initiative is composed of several projects, which form an information-sharing framework that uses voice, video and data for Incident Command and to increase public and Firefighter safety.

The challenge is to design a system that is able to support and adjust readily to the urgent demands of firefighting and emergency medical care from routine to extreme events. Commonly, routine incidents are limited to handie-talkie communications, but as a fire or emergency grows in scale and complexity, there is a greater demand for information. This informational requirement illustrates that today's linear approach to command that is overly dependent on a single voice communication channel no longer is adequate. Tomorrow's system of command must expand to include a network of voice, video and data for maintaining situational awareness and Incident Command. Networks increase the

reach of the IC to access serendipitous information from within and outside the Department that normally would not be available today. The web-like structure of networks connects to different informational sources to enhance command capacity.

Network command is an information-sharing component of the Incident Command System that creates a common operational picture for decision-making, on- and off-scene. This is achieved by leveraging new technologies to connect first responders at an incident and link the Fire Department Operations Center (FDOC) to other emergency operations centers. This level of interoperability allows significant information to be exchanged immediately between and among FDNY and law enforcement, City and State Offices of Emergency Management, mutual-aid partners, Department of Homeland Security and other security partners.

As the Fire Department develops a network command, it must ensure that the system is resilient enough to withstand continual use under extreme conditions. To avoid a single point of failure, the system must have redundant means of transmitting information. The system also must meet a high level of encryption for securing sensitive information. Finally, this new network command system must be simple and intuitive to use under the stress of an expanding incident.

Network command

The definition for network command is an information-sharing framework that uses voice, video and data to connect emergency responders for situational awareness and Incident Command.

Leveraging Technology--Utilize technologies to create a local area network on-scene and to develop a wide area network off-scene to form a robust command network for information-sharing.

Connecting Emergency Responders at the Scene--Swiftly form networks that connect multiple organizations at the scene of an incident for information exchange and collaboration.

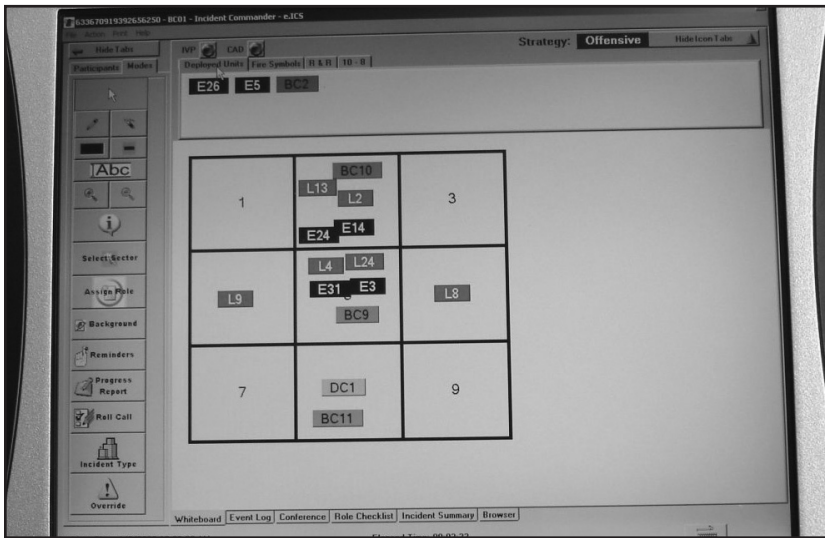
Linking Emergency Operations Centers--Link emergency operations centers together for sharing critical information to form a common operational picture.

Leveraging technology

FDNY's vision of using voice, video and data for commanding has led to innovative technologies, which are in the forefront of firefighting and homeland security. An Incident Commander without all three elements for command is similar to a pilot flying blind. The Department is strongly committed not to let that happen and is moving aggressively with the concept of net-



Network Command will provide the Incident Commander with an information-sharing framework that uses 42-inch LCD screens to display maps with building information and apparatus location; ECBs with unit deployment; and video from the CTU and helicopters.



FDNY RFID Demo (Version 1.0)

ASSIGNMENT	FIREFIGHTER NAME
OFF	DALESSANDRO, NICHOLAS
CHAF	CESTARO JR, ROBERT
NOZ	BARBOUR, DONALD
NONE	BACHYNSKY, THOMAS
NONE	COSGROVE, SEAN
NONE	DESJARDIN, MATTHEW

By using radio frequency identification, the electronic riding list provides the names of all Firefighters and their assignments for that particular tour of duty.

designated button on the radio, a signal would be recorded and an algorithm written into the ECB would show those Firefighters who did *not* signal. This would make roll calls more efficient.

Video

When terrorists attacked the World Trade Center, the Incident Commander from the FDNY lacked video images that many saw on television. Since then, Operations, the Center for Terrorism and Disaster Preparedness, the Imaging Technology Unit and the Bureau of Communications, assisted by BTDS, have undertaken innovative efforts to provide real-time video and still images from the scene to the Incident Command Post and FDOC.

Helicopter video is an essential tool for Incident Command. Agreements are in place with NYPD, WPIX-11 and WCBS to receive live video from their respective helicopters to FDOC. The 9/11 Commission (2004) established that *FDNY Chiefs would have benefited greatly had they been able to communicate with personnel in a helicopter*. In the wake of these attacks, FDNY and NYPD have agreed to place a Battalion Chief in an NYPD helicopter at all third alarms, second alarms in high-rise buildings and unusual incidents. This type of cooperation between organizations enhances network connections for command.

Command Tactical Unit (CTU) is a retrofitted ambulance equipped with wireless cameras, thermal and infrared imaging, a satellite dish and a 30-foot antenna that greatly broadens the vantage point of the Incident Commander. The mission of CTU is to increase situational awareness by providing images that cannot be seen from the Command Post. CTU operates as the eyes and ears of FDOC by responding to multiple-alarm fires, structural collapses, hazardous material incidents and other major emergencies. Its interoperability features provide command tactical video to mutual-aid partners, law enforcement and City, State and National Operations Centers.

Soon, members will be able to view live feed video from Staff Chiefs' vehicles while responding to major incidents. CTU also has the ability to connect to helicopter video, news media feeds and the NY/NJ Joint Situational Awareness System. Information from other City agencies is available on NYCWiN and other imaging systems. Efforts are underway to connect to United States Coast Guard cameras in the harbor and NYPD cameras throughout the City. (For more details, see the accompanying sidebar, "Command Tactical Unit," by Supervising Fire Marshal Ralph Bernard, on page 16.)

At the conclusion of multiple-alarm fires, the Incident Commander can request a copy of the video for training purposes. This was done at a second-alarm fire in Queens that involved an exterior flashover of a polystyrene foam façade. The video assisted Battalion Chief Bradley Walls in writing an article on this subject. (See "Exterior Flashover," on page 2 of this issue.) Video imaging also will assist the Safety Command and the Fire

Electronic Command Boards (ECBs) illustrate unit deployment at incidents. With automatic back-up, data can be recovered immediately in case of a mechanical failure.

work command.

Voice

Successful Incident Command often is dependent on a constant flow of voice communication on tactical, command and dispatch channels during an incident. During the past seven years, the Fire Department has designed its Field Communication System to be flexible, reliable and scalable. The communication system allows for interoperability within and across agencies. At both routine and extreme events, several different types of communication equipment are needed for incident management. Members should know when and how to use each of these communication tools. Chief Officers and their Division and Battalion Firefighters, in particular, should use dynamic scenario training to be proficient in operating the different types of equipment and managing multiple frequencies in an emergency.

Communication equipment

- Portable Systems--handie-talkies and Post Radio, cellular, satellite and sound-powered phones
- Mobile Systems--borough dispatcher VHF radio, 800MHz radio, vehicle cross-band repeater and a UHF radio for situational awareness, interoperability and redundancy
- Auxiliary Radio Communication Systems--subway repeaters, in-building repeaters and coaxial cables

The FieldComm Unit (FCU) has several additional capabilities available through a frequency-patching piece of equipment called ACU-1000. This equipment can join together several frequencies that normally cannot communicate. For example, a mutual-aid unit from New Jersey would be able to communicate with FDNY handie-talkies. At the scene of an incident, radio frequencies of all agencies that have members in the danger zone also can be programmed into the ACU-1000. In case of an emergency, one message from the IC can be broadcast to all emergency responders at once. Additionally, FCU transmits handie-talkie communication to the FDOC through Voice-over Internet Protocol. In the near future, the Department will switch the mobile dispatch frequency from VHF to UHF (400MHz bands). This will provide separate dispatch channels for the Bronx and Staten Island. Additionally, it will allow for more reliable transmission from handheld radios at the Command Post to the dispatcher.

The hope is that these layers of communication and redundancy will make the fireground safer and lead to additional innovation for fire service communications. One idea that is being considered for the future is use of a radio frequency for a reverse roll call to signal that a Firefighter is not in need of assistance. (A Firefighter still may need assistance even if he/she did not signal.) By depressing a

Command Tactical Unit

by Supervising Fire Marshal Ralph Bernard

The Incident Commander (IC) at a fire scene will communicate with the operating units via their portable radios to collect information regarding the location, amount and spread of fire. This information is collected from the Officers and Firefighters operating in and around the incident. Remember, the Officer in Command of the incident usually is situated remotely from the fire floor. This could be in the street, in front of the fire building, in the lobby of a high-rise building or not even on-scene as he/she still is responding to the Box.

The operating members are the eyes and ears of the IC. Some of the IC's operational decisions are based on the information received from these members. The IC counts on them to be articulate and describe the situation accurately. While FDNY's current radio communications system is effective, describing an item found or the extent of damage to a building can be difficult. This is the area where a single photo for the IC could make all the difference; a picture is worth a thousand words.

The Command Tactical Unit (CTU) is bridging the information gap for the FDNY when it comes to making operational decisions at a fire, hazmat incident or other emergency. The CTU aids the IC and the operating units' exchange of information. An information conduit is established whereby information and visuals can be exchanged between members. A simple picture of a hazard transmitted to the IC from an operating unit could reduce the time it takes to identify the problem, decide what to do and implement a strategy. The ability to provide the IC with real-time images is just one of the many capabilities of CTU.

Staffed 24/7 with an Officer and one Firefighter, the CTU is the Fire Department's Operations Center (FDOC) on the road, providing a network of accessible knowledge, photos, live video, floor plans and known hazards of the incident to the operating field units and the IC and field operational

information back to the FDOC. This type of interactive command and live exchange of information is better known as a network-centric command and control operation.

According to John J. Daly and Dr. Andreas Tolk (experts in military and combat modeling), *Network Centric Command and Control operations postulate that the more information we can collect, create, and share about the adversary, the operational environment, our capabilities, readiness, and logistics, the more we can focus our capabilities to produce desired effects with less risk of unintended consequences and more efficient expenditure of national resources.*

FDNY's network-centric command and control matrix is based on three separate matrices working together in unity. The first two are provided by CTU and the third by FDNY Officers and Firefighters. A description of each matrix follows.

Hardware Matrix--Is all the equipment deployed and used at an incident that enables computers at the scene to communicate with each other, access the FDNY network and stream video? The deployable units that make this possible are called Tactical Access Points (TAP). The TAP allows computers at the scene to access the network via a standard computer communication in the 2.4GHZ spectrum band, IEEE 802.11. The exchange of information occurs through a secure portable mesh networking system via a secure RF network.

Data Matrix--Provides the IC with continued access to information needed to formulate operational strategies. This information can include local area maps, building floor plans, storage hazards, support agency contacts and a direct link to FDOC and all of its resources.

Dialogue Matrix--The information and visuals collected are analyzed and members collaborate on actions and resources needed. With a better understanding of the incident--situational



The CTU is a refitted ambulance that provides vital information to the IC by using cameras, a network system and satellite dish.

Marshals at fires involving serious injuries and fatalities.

Data

Fire Department Operations Center is the hub of network centric command. Already, the FDOC is equipped to receive and push information in all three domains. It monitors fire and EMS communications, reviews video images and searches data bases for vital information. It acts as a conduit and filter for information flow from diverse parts of the emergency response system to the scene of an incident and to the Command Staff and senior management. Critical information is transmitted over phone lines, wireless technology, fiber optics and satellite. Incident Commanders also can request information from FDOC. This high-tech Emergency Operations Center reports directly to the Chief of Communications and is staffed 24/7 by uniformed personnel.

Electronic Command Boards are touch-screen computers with specially designed software to illustrate unit deployment at fires, emergencies and pre-planned events. Information displayed on one computer at an incident also is available to other ECBs at the scene through a wireless local area network and to FDOC through New York City's Wireless Network (NYCWIn). The data automatically are backed up and immediately recoverable in case of mechanical failure. In the future, the ECB will replace the old magnetic command boards that are carried by FieldComm units and Divisions.

The revolutionary idea for command is that the ECBs not only provide a large display for major fires, but also are small personal

electronic command boards for use at routine and extreme events. These small ECBs will be assigned to all Battalions and Divisions, EMS Divisions and Command Chiefs. On receipt of the alarm, the Battalion Chief will receive the Box assignment displayed on the ECB in the car. On arrival at the scene, the small, 10-inch handheld tablet computer is removed from the car and units are deployed by the touch of a finger to a graphical display of the building. Immediate accountability of units avoids the problems of playing catch-up when an incident expands rapidly.

While responding and at the scene, the Deputy Chief's handheld device automatically is populated with the deployed units from the Battalion. There is also seamless transition from the handheld device to the larger ECB for multiple alarms. Other features FDNY hopes to add include pop-up screens with members' names, assignments and units whenever the emergency alert button is activated; roll call check lists; hazardous material exposure monitoring; a link to operational check lists and Incident Action Plans; and progress report and search reminders. A pilot program is planned for this fall in Manhattan.

Critical Response Information Management System (CRIMS) is a secure web-based data management tool, developed by Fire Prevention with Operations to assist Fire Chiefs in evaluating critical infrastructure for situational awareness and risk assessment. CRIMS is an FDNY web portal that links data together on building construction, storage of hazardous material, in-building communication systems, digital blueprints of floor areas,



Interior of the CTU.

awareness--the IC can choose the best course of action, producing the intended effects with less risk of unintended consequences.

CTU's technical capabilities

CTU can connect wirelessly to the internet via broadband and the new City network. This connection allows access to CTU's videos and establishes a conduit that allows the free exchange of real-time operational video and data among Staff Chiefs, the FDOC and other FDNY members on the Department's network.

The information provided and/or available over the network includes multiple-alarm operational packages, maps, floor plans, building hazards, any critical information and the exchange of stills and videos between field units via CTU and FDOC.

CTU's specialized equipment

Wireless Independent Network System (WINS)--This portable system is used to establish a wireless computer mesh network throughout the operation. This network is deployed by CTU members and is used to give the Incident Commander and Command Officers access to live operational video from cameras placed at the exposures, in addition to direct communications with FDOC via a standard computer with Wifi.

Tactical Access Points (TAP)--These units are deployed around the incident to establish the wireless computer mesh network. Each TAP is equipped with a pan, tilt and zoom IP camera that provides the IC with a visual of the incident. A four-radio mesh node installed in the

case is used to establish a communication link among CTU, other TAPs and portable computers at the incident.

Ink-jet printer--The unit is equipped with an 11- by 17-inch color printer, which allows FDNY members to print the photos and documents needed by the IC.

Digital still camera--FDNY currently uses a Nikon D-3, which has the ability to photograph in very low light. This camera is used to photograph remote areas of concern. These photographs can be transmitted via the network wirelessly so the IC can see them within seconds. This camera also is used to photograph accidents and other safety investigations and concerns.

Digital video recorder (DVR)--The CTU currently can record 16 separate video sources via its DVR. These videos can be accessed remotely via the wireless network. While these images are used for command and control decisions, they can be very helpful when critiquing an operation, too.

DV video camera--This digital video camera is used to record operations at an incident and to document a safety investigation.

Satellite dish--Provided by the Port Authority, this dish allows FDNY to connect to the internet via satellite.

Wireless camera system--This system is used by the broadcast industry and is capable of receiving wireless video transmission from news helicopters.

The CTU is constantly evolving, receiving improvements to its technical abilities and equipment. While its underlining technology may change, its main objective will not; to ensure Firefighter and public safety by providing the IC and Officers with the information and images needed to run a safe operation.

About the Author...

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range hood diagrams, fire protection plans, pre-incident and target hazard plans, critical information dispatch system (CIDS), maps and other critical concerns about the building. Utilization of wireless technology and ECB laptops will allow Fire Chiefs to access CRIMS while en route or at the scene of an incident.

This is more than just a data base of words. Fire Prevention and the Geographical Information System Unit are working closely with Operations to develop a user-friendly interface for Incident Command. With a click of an icon on the ECB, the program will open up to the incident location in the form of a map or aerial photograph and depict the NFPA 704 diamond on surrounding buildings with hazardous material. The map also will illustrate apparatus location received through Automated Vehicle Location (AVL). By touching a footprint of a building, an expanded CIDS information box will be displayed. If the IC needs more information, the complete data base is pulled up, which is divided into tabs for easy access. CRIMS will be piloted with the Staff Chief and Division laptop initiative this summer and the ECB program this fall.

Electronic Riding Lists are being developed by the Naval Research Labs in cooperation with Operations and BTDS by using

radio frequency identification (RFID). A small RFID chip (about the size of a car key remote) is sown into the buckler gear and a sensor is installed on the apparatus to identify the Firefighter riding the rig. The Officer sees the names of the Firefighters and riding positions automatically displayed in the front cab. In case of a missing Firefighter, collapse or hazardous material incident, the Incident Commander will have immediate access to the riding list at the electronic command board.

For a biological incident, the Bureau of Health Services would be able to access a data base to ascertain the members working at the time of possible exposure. Further research is being conducted to see if this technology can assist in accounting for Firefighters when there is an emergency evacuation of a building. A prototype of the electronic riding list currently is being tested in Queens.

3-D Firefighter Tracking is a futuristic dream for the fire service. Members from the Center of Terrorism and Disaster Preparedness have traveled to Washington, DC, on several occasions to petition the Department of Homeland Security and the Department of Defense for funding to support research and development for 3-D, in-building Firefighter tracking. 3-D tracking provides the Incident Commander with a graphical display of each Firefighter's location (latitude, longitude and elevation) in and outside a building. The ability to accurately track and locate personnel at an incident is critical to the operations and safety of emergency responders. A Firefighter who is in distress or trapped needs to be located as quickly as possible, often in severe conditions with limited visibility. Immediately identifying the location of the distressed Firefighter, as well as the rescuer closest to the Firefighter, may be the difference between life and death. While there is promising research starting, a fully deployable 3-D tracking system for urban firefighting is several years away.

Connecting emergency responders at the scene

As units arrive at the scene of an incident, they hastily form networks for sharing information and coordinating tactics (Denning, 2006). At a building fire, ladder companies search for the fire and inform the engine company of its location. The engine company Officer announces to all units when members are making their attack to extinguish the fire. The roof Firefighter states when the roof is open. And the Battalion Chief, acting as the central node in this network, coordinates operations of all units.

This hastily formed network is necessary for situational awareness and Incident Command. Without it, units would operate in information silos, with units not knowing what the other units are doing. Lack of information networks is extremely dangerous on the fireground.

In the future, the hastily formed network at the scene of a fire or emergency will use many of the technologies mentioned above.

Members are urged to review the following references:

- Hastily Formed Networks, Denning (2006)
- National Incident Management System, DHS (2008)
- FDNY Strategic Plans (2004, 2007 and 2009)
- FDNY Terrorism Strategy (2007)
- The 9/11 Commission Report (2004)
- "Six-Alarm Summer Sizzler Reinforces Lessons Learned," by Deputy Assistant Chief Joseph W. Pfeifer, in the 4th/2008 issue of *WNYF*.

Chief Officers or their Division and Battalion Firefighters, while monitoring the command and tactical handie-talkie channels, will carry personal electronic command boards that interact with the large, 42-inch ECB from FieldComm at the Command Post. Adjacent to FieldComm's ECB is another 42-inch screen from the Division with CRIMS information depicted on a map with building information and apparatus location.

Continuing outward at the Command Post is a third display with video from CTU and helicopters. The Incident Commander needs only a few seconds to comprehend this vast amount of information because it is displayed graphically. Pictorial illustrations of information are more rapidly understood than spreadsheets of the same information. At the Command Post, multiple frequencies, including interoperable channels, are employed to coordinate strategy and tactics. And a Command Post Radio is standing by if needed. The IC assigns a Planning Chief, who is assisted by the FCU, the Division Firefighter and CTU, to manage this quickly formed network of voice, video and data information.

If the incident involves a multi-agency response, it is equally important to rapidly form networks among agencies for information-sharing. Extreme events, such as terrorism, natural disasters or major emergencies, are multi-jurisdictional and overwhelm one organization's capacity to manage the incident alone. Adapting to these events compels Incident Commanders to rapidly move from a vertical command and control model to a horizontal system to connect and collaborate with each other.

The function of network command is to connect emergency responders for information-sharing. Agencies that understand the importance of interdependence for emergency response are more apt to form information-sharing networks for situational awareness and critical decision-making.

Linking emergency operations centers

With the establishment of Homeland Security grants, many organizations either have expanded or created new Emergency Operation Centers (EOC). Linking these operations centers as part of a network command is an emerging concept for terrorism and disaster preparedness. This extended network of EOCs provides a unique service during an incident by connecting to information on two levels. First, they provide the Incident Command Post with information that often is difficult to attain directly at the scene. Second, they supply situation reports to City, State and Federal agencies.

This concept became evident when the private small plane of Yankees' pitcher Cory Lidle accidentally crashed into a high-rise building on the Upper Eastside of Manhattan on October 11, 2006. Emergency responders needed critical information in order to respond appropriately. They needed to know if this plane crash had any nexus to terrorism as one in a series of attacks or an isolated accident. Concerns for Firefighter safety required gathering specific information about the plane's special parachute system that deploys by use of an explosive charge. Homeland Security officials in Washington, DC, required situational awareness about the incident and the extent of the fire in order to brief the Situation Room in the White House. Networks were quickly formed at the scene to exchange information and FDOC was asked to connect to the OEM, NYPD, Port Authority of NY/NJ, FAA, FBI and the plane manufacturer.

FDOC acts as a critical node by its centrality to Fire Department Operations. At working fires, FDOC members search data bases and video feeds, looking for information they could supply to Command. During third alarms or unusual incidents of major significance, FDOC provides the Office of Emergency Management (OEM) with incident updates and instructions from Incident Commanders on those actions the public is to take or avoid.

Additionally, FDOC posts situation and progress reports on the Homeland Security Information Network web site. This is a secure web site used to ensure that decision-makers across the country have situational awareness on major events happening in New York City. At the emergency landing of U.S. Airways Flight 1549 in the Hudson River on January 15, 2009, FDOC posted several reports about the incident on the Homeland Security Information Network. Even classified information can be exchanged inside the FDOC by uniformed members who have clearances. In case of a major disaster, the Chief of Department could use FDOC as an area command to manage simultaneous incidents. Network Command allows the Fire Department to flow and receive information to a wide group of officials concurrently, leading to better situational awareness and incident management

Incident management in a network world

Possessing information has been a traditional sign of power, which has led to information silos. In a network world, however, power is attained not by hoarding information, but by distributing accurate information to many organizations as quickly as possible. This paradigm shift is vital during fires and disasters, where emergency responders depend on a network command to connect to information systems and other organizations to assist in incident management. The aim of this article is to reveal new technologies for incident management and illustrate the likelihood of sharing vital information at critical times, during complex incidents, becomes greater when groups that ordinarily act independently are connected through networks.

The Fire Department has engaged uniformed and civilian members from the Bureaus of Operations, Technology Development and Systems, Fire Prevention, Communications, Support Service and Legal Affairs, the Imaging Technology Unit, the GIS Unit and the Center for Terrorism and Disaster Preparedness to leverage new technology to develop a network command system. This collaborative, multi-year effort has created innovative voice, video and data solutions, not just for FDNY, but for all emergency responders.

I hesitate to mention the names of these incredible people, who continue to work on these projects, for fear of inadvertently omitting someone. It is my privilege to work with people totally dedicated to Firefighter safety. As we move forward with high-tech initiatives for network command, we ask for honest feedback from the field to ensure that the system's interface works well with Firefighters and will enhance Incident Command. These are tools to assist with decision-making. However, they will never replace the knowledge and experience of our members.



About the Author...

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