


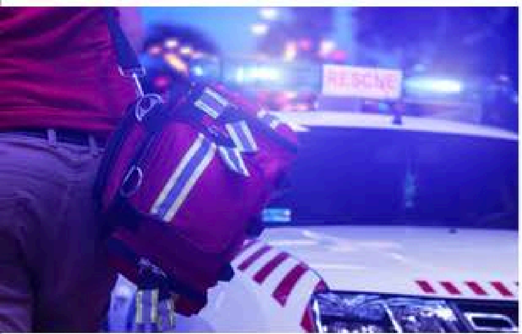
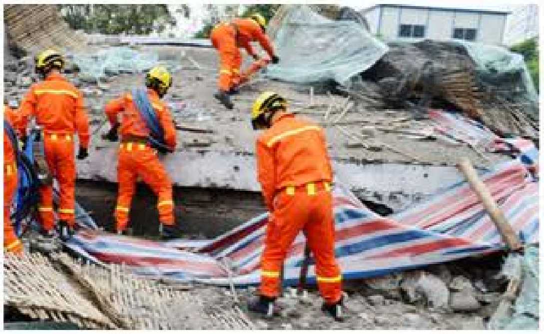
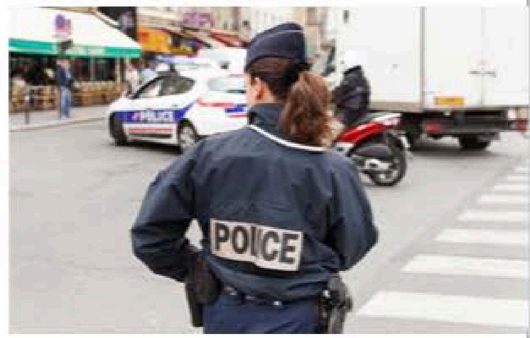

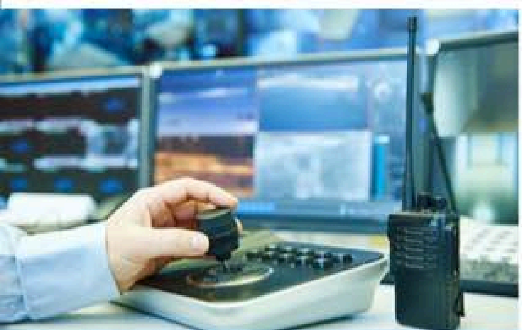
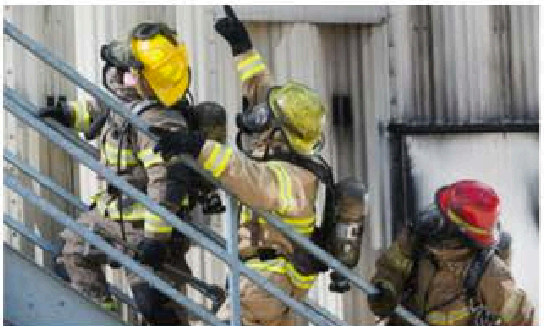


The International Forum to Advance First Responder Innovation

Statement of Objectives (SOO) for Technologies Related to: "The Ability to Rapidly Identify Hazardous Agents and Contaminants"

June 2018

International Forum to Advance
FIRST RESPONDER INNOVATION

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International Forum to Advance
FIRST RESPONDER INNOVATION

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Statement of Objectives (SOO) for Technologies Related to: **The Ability to Rapidly Identify Hazardous Agents and Contaminants**

Background

The International Forum to Advance First Responder Innovation (IFAFRI) is an organization of international government leaders from 13 countries and the European Commission, focused on enhancing and expanding the development of new technology for first responders worldwide.[1] IFAFRI does this by:

1. Working with the global first responder community to define a list of common, high priority capability gaps;
2. Providing a platform for international collaboration on innovative research and development (R&D) initiatives and solutions;
3. Characterizing global first responder markets to inform and guide industry and academia to develop and produce innovative technology solutions at affordable prices; and
4. Providing information about relevant and available first responder technologies to the first responder community.

IFAFRI has reached consensus on four first responder capability gaps. These gaps represent the highest priority gaps common amongst the first responders represented by the IFAFRI member nations. These gaps are:

- The ability to know the location of responders and their proximity to risks and hazards in real time;
- The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real time;
- The ability to rapidly identify hazardous agents and contaminants; and
- The ability to incorporate information from multiple and nontraditional sources (for example, crowdsourcing and social media) into incident command operations.

To arrive at this initial set of *Common Global Capability Gaps*, IFAFRI participants conducted analyses of first responder capability gaps in their countries.

[1] For the purpose of this document, the term "first responder" refers to those individuals who, in the early stages of an incident, are responsible for the protection and preservation of life, property, evidence and the environment, including law enforcement, fire service and emergency medical services.

IFAFRI is publishing this Statement of Objectives (SOO) to provide a technical overview of the global first responder need and direct the research, development, and manufacturing communities who may be interested in pursuing development of a solution. IFAFRI will assist with facilitating interactions between first responders and organizations pursuing development toward this capability gap. This particular SOO is focused on the third capability gap identified above:

"The ability to rapidly identify hazardous agents and contaminants"

This capability is described as such: Upon arriving at an incident scene, responders may have little or no awareness of the hazardous agents or contaminants that may be present. This lack of awareness places responders at increased risk of exposure to a range of threats, including unknown toxins, biological agents or contaminants, during response operations. Even minimum exposure to many of these agents can cause significant health concerns. Responders need the ability to detect hazardous agents remotely and understand pertinent information regarding protective actions or treatments."[2]

General Description of Operational Capability

The focus of this capability gap is on the initial detection and identification of hazardous agents and contaminants on the incident scene and the delivery of pertinent information about those threats to responders and commanders. Responders face a large number of diverse hazards and threats, including chemical and biological agents, radioactive particles, deficient oxygen levels, and explosive compounds.[3] However, they may have little or no awareness of these hazards upon arrival at the scene. This lack of awareness can place responders at significant risk, as even minimum exposure can have significant health impacts.

Responders currently use a combination of personal detectors, vehicle-mounted sensors and other stand-off systems to detect chemical, explosive and radiological hazards on scene. Existing equipment detects a limited number of common compounds or hazardous agents that impact standard daily operations. However, none of this equipment provides awareness of the range of agents on scene. Nor are they able to rapidly identify and characterize these agents. Further, many current detection systems are vehicle-mounted or deployed in a stationary location, providing limited awareness for dismounted responders. Lastly, there is limited ability to detect biological agents in real time.

Responders need specific information about the threats and hazards when they arrive on scene and throughout the duration of their operations. Responders and commanders need to be alerted upon detection of hazards and as concentration levels approach established health safety exposure thresholds. Further, pertinent information, including protective action guidance, must be conveyed so that responders can better protect themselves, victims, and the population.

This third gap is distinct from the second gap, – "the ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real time" – which focuses on the

[2] *Project Responder 4: 2014 National Technology Plan for Emergency Response to Catastrophic Incidents*, p. 23, https://www.dhs.gov/sites/default/files/publications/Project%20Responder%204_1.pdf
[3] Ibid, p. 37.

continuing monitoring and analysis of a wider array of threats, along with the integration and visualization of threat data. Data measurements derived from solutions to address the gap described in this document may be integrated into solutions for the second gap. However, this SOO focuses on the rapid detection, identification and characterization of specific chemical, and biological and radiological hazards.

Existing First Responder Gear

Current capabilities to detect and identify hazardous agents and contaminants on the incident scene include:

- Threat and hazard detection equipment in the following categories:
  - Handheld portable detection equipment;
  - Vehicle-mounted detection equipment;
  - Fixed-site detection equipment;
  - Mobile laboratory systems;
  - Fixed-site analytical laboratory systems;
  - Standoff detection systems;
- Canines (e.g., bomb-sniffing, drug-sniffing); and
- Camera feeds for visual identification.

Operational Environment

The following list provides examples of operational environments that *may* be encountered by first responders on a daily basis. Tools and systems developed to address this capability gap should be, to the extent possible, used during routine operations.

- Single and multi-level buildings;
- Structures of varied construction materials (e.g., steel, concrete, wood frame, masonry, synthetic materials);
- Collapsed or threatened buildings;
- Extremely confined spaces;
- Subterranean and underground facilities;
- Wooded areas with dense vegetation;
- Rugged outdoor terrain;
- Areas with limited or no cellular and/or radio connectivity;
- Events with large crowds or numbers of people present;
- Extreme high and low temperatures and humidity;
- Wet conditions;
- Thermal radiation;
- Direct flame contact or exposure;
- Excessively noisy and smoky conditions in outdoor, indoor and/or subterranean areas;
- Lack of line-of-sight vision between commanders and deployed personnel; and
- Underwater and maritime environments.

Target Objectives

1. Detects hazardous agents and contaminants on the incident scene in real time,
2. Transmits hazard data to responders and commanders, and
3. Provides pertinent information regarding the threat or hazard.

The following section provides responder-identified requirements for potential solutions. Not all requirements may be currently technically feasible. Responders would prefer incremental, continuous advancement of solutions instead of waiting for equipment that meets all of the requirements at the same time. As such, these requirements do not represent a minimum set of requirements that must be met before new tools, devices, platforms or systems can be released.

Detection and Identification Requirements

Potential solutions should detect and identify hazardous agents and threats in real time. Potential solutions should:

- Detect hazardous chemicals (i.e., chemical warfare agents, toxic industrial chemicals, toxic industrial materials, volatile organic compounds, hazardous gases);
- Detect biological agents (i.e., biological warfare agents, blood-borne pathogens, contagious pathogens);
- Detect ionizing radiation (i.e., alpha, beta, gamma, neutron particles and rays);
    - Measure ionizing radiation using counts per second and System Internationale sievert units;
- Detect explosive compounds and precursors;
- Detect levels of atmospheric gases (e.g., oxygen, carbon monoxide);
    - Measure atmospheric oxygen in percentage of total air;
- Detect airborne particulate matter;
- Identify the specific agent or isotope;
- Measure quantity, volume and concentration of hazards;
- Provide pertinent information, including modes of exposure and protective action information (e.g., appropriate Personal Protective Equipment, standoff distances, immediate treatments, decontamination requirements);
    - Calculate the blast radius from liquid or compressed gas tanks and other hazardous materials;
    - Calculate the proximity to the Lower Explosive Limit based on the concentration of flammable gas at a specific location;
    - Calculate time remaining until responder reaches exposure limits or other agency-configurable limit;
- Detect, analyze and provide feedback in real time;
- Detect agent in all states;
- Measure hazardous agents and contaminants continuously;
- Allow no false negatives; and
- Allow no false positives.

Location Requirements

Potential solutions should geolocate agents and contaminants within a set perimeter around response personnel on an incident-specific map. Potential solutions should:

- Detect hazardous agents and threats within a set perimeter around personnel;
  - Indicate the distance of detected agents and contaminants (from the responder);
  - Indicate the position of detected agents and contaminants (in relation to the responder);
- Use geographic information system (GIS) coordinates to mark the location of identified agents and contaminants;[4]
- Allow agency to configure perimeter location and distances; and
- Identify and transmit the proximity of hazardous agents and threats to on-scene responders when integrated with responder geolocation systems.

Alarm Feature Requirements

Potential solutions should generate an alert when agents and contaminants are detected, based on agency-configured thresholds or parameters. Potential solutions should:

- Generate an alert before responder reaches exposure limits defined by international equivalent or other agency-configurable limit;
  - Alert the responder and commander when specific chemical hazards or groups are detected;
  - Alert the responder and commander when specific pathogens or groups are detected;
  - Alert the responder and commander when the count of radiological particles is approaching isotope-specific counts per second;
  - Alert the responder and commander when on-scene exposure to ionizing radiation approaches critical safety levels;
  - Alert the responder and commander when oxygen percentage in the immediate environment is approaching critical safety levels;
- Integrate aural, visual and haptic alerts;
- Provide functionality or work with legacy systems that automatically alarm when there is no responder movement for a specified duration (Personnel Alerting Safety Systems [PASS] or similar);
- Provide option for tactical mode/covert alerts;
- Require a positive action to acknowledge receipt of the alert;
- Be discriminable and recognizable in environments that are excessively noisy and/or have reduced visibility;
- Generate an alert to notify a user when connection to the communications network is lost; and
- Emit a low power source warning signal.

Transmission Requirements

[4] Geographic information system is a computer system for capturing, storing, checking and displaying data related to positions on Earth's surface, https://www.nationalgeographic.org/encyclopedia/geographic-information-system-gis/

Potential solutions should transmit threat and hazard data to authorized personnel (e.g., emergency managers, commanders, responders). Potential solutions should:

- Encrypt responder geolocation data prior to transmission;[5]
- Transmit the proximity of hazardous agents and contaminants to authorized personnel when integrated with responder geolocation systems;
- Transmit data to intended destination;
- Transmit location of detected agents and contaminants using GIS coordinates;
- Transmit threat and hazard data in real time;
- Function in a communications-degraded environment:
    - Securely cache data intended for recipients when connection to a communication network cannot be made;
    - Securely transmit cached data to recipients when connection to a communications network is restored without affecting live data streaming;
- Be able to operate multiple components in a networked configuration; and
- Store incident-related threat and hazard data for post-incident analysis.

Form Requirements

Potential solutions should be designed to minimize equipment burdens for the responder, while maintaining interoperability of components. Potential solutions should:

- Utilize an internationally-recognized common hub or interface, allowing interchangeable component configuration;
- Be operable by users wearing personal protective equipment;
- Be designed to fit regardless of gender;
- Be portable and transportable by a single responder;
- Be integrated into existing equipment, integrated into a heads-up display or incorporate hands-free capabilities;
- Be minimum weight; and
- Be minimum size.

Power Source Requirements

Potential solutions should use a non-proprietary power source that provides sufficient power for an operational period. Potential solutions should:

- Operate for a minimum of 24 operational hours and 48 stand-by hours;
- Be able to replenish power supply using non-proprietary technology;
- Utilize an easy-to-replenish power source;
- Power source should be replaceable with gloved hands and wearing protective clothing in a manner that reduces the potential for erroneous installation without interruption to operations, to extend operational life;
- Be intrinsically safe; and
    - Be compatible with renewable or sustainable energy sources.

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[5] Responders recognize that it may not be possible to encrypt solutions that rely on analog technologies.

Maintenance Requirements

Potential solutions should be easy to operate, calibrate and maintain throughout the service life. Potential solutions should:

- Allow for auto-calibration;
- Self-initialize, self-calibrate and execute self-diagnostics in less than one minute;
- Be modular to allow for upgrade and replacement of components;
- Maintain backwards compatibility after upgrade;
- Be rated for a service life of no less than 5 years;
- Be designed to reduce the time to repair;
- Be designed to minimize skills needed for maintenance (e.g., calibration, cleaning);
- Perform automated periodic virus detection and cybersecurity screening of software components;
- Allow for remote maintenance;
- Allow for remote upgrades;
- Provide live notification of a fault; and
- Maintain a fault log.

Compatibility Requirements

Potential solutions should integrate with current data sets, model outputs, and emergency response software systems and applications to detect and identify threat and hazard information. Potential solutions should:

- Comply with exchange standards for data transmission (e.g., National Information Exchange Model);
- Bi-directionally integrate with:
    - Sensor data from other hazard detection systems;
        - Continuously integrate captured data with GIS-configured location of sensor or platform;
    - Existing electronic situational awareness tools;
    - Existing electronic incident command systems;
    - Existing modeling systems (e.g., hazard models, contaminant migration models, explosive power/air blast models);
    - Responder geolocation systems;
    - Responder physiological monitoring systems;
    - Other incident-specific data sources (e.g., traffic cameras, weather projections);
    - Existing digital maps, blueprints and floorplans; and
    - Transportation monitoring systems (e.g., Rail Chemical Transportation System) to provide advanced notification when hazardous materials are entering a jurisdiction.

Robustness Requirements

Potential solutions should operate within multiple environments (e.g., smoke, humidity, temperature extremes, and precipitation). Potential solutions should:

- Operate at temperature ranges typical of international climate (e.g., -30 degrees C to 50 degrees C);[6,7]
- Operate at temperature ranges typical of response activities (e.g., -100 degrees C to 500 degrees C);[8,9]
- Be ruggedized;
- Function after immersion in water;[10]
- Function at humidity of 100 percent;
- Function properly after exposure for five minutes at a maximum thermal radiation threshold of 500 degrees C;
- Resist air pollutants, dust, smoke, ash and sand;[11]
- Match the laundry life of garment or textile if components are integrated into garments or textiles;
- Have recyclable components;
- Be easy to decontaminate;[12]
- Be non-degradable due to wear or hazard;
- Not cause injury to the user if damaged;
- Be designed to prevent entanglement or entrapment;
- Comply with existing federal and/or international standards and guidelines; and
- Function underwater.

Cost Requirements

Potential solutions should be designed to minimize price of system, consumables and maintenance. Potential solutions should:

- Be priced to affordably outfit the entire workforce; and
- Be designed with inexpensive, replaceable parts.

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[6] Average minimum temperature in Sweden was used to provide a minimum figure for international climate, https://www.weatheronline.co.uk/reports/climate/Sweden.htm

[7] Historic summer temperature in Phoenix, Arizona was used to provide a maximum figure for international climate, http://www.12news.com/article/weather/heat/hottest-day-ever-122-and-other-cool-phoenix-is-really-hot-facts/448964915

[8] *NIST Technical Note 1474: Thermal Environment for Electronic Equipment Used by First Responders*, p. 7 http://ws680.nist.gov/publication/get_pdf.cfm?pub_id=101375

[9] First responder participants of the SOO Validation Meeting (January 23-25, 2018 in Stockholm, Sweden) stated that operations may involve temperatures of -100 degrees C to 500 degrees C.

[10] Refer to IP68 of IEC 60529: Degrees of Protection Provided by Enclosures, https://webstore.iec.ch/publication/2452

[11] Refer to IP68 of IEC 60529: Degrees of Protection Provided by Enclosures, https://webstore.iec.ch/publication/2452

[12] Refer to NFPA 1841: Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting, https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1851

Additional Considerations

As in other research and development endeavors, additional considerations should be evaluated by organizations wishing to pursue innovation toward this gap:

- Detailed test and evaluation strategy for the viability of system(s);
- Transition strategy to guide the prototype(s) into commercialization;
- Specification to guide the development of viable commercial system(s);
- Standards, guidelines, other legal requirements; and
- Stakeholder oversight/interaction, to ensure that the developed system meets the requirements identified by the first responder community.