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*Pictured on the Cover: (top row) Brown, Source: NYC OEM, 2018; Goward, Source: ©iStock.com/Andrey Suslov (second row) Bergeron, Source: Bergeron, 2018; Rahkonen/Green, Source: ©iStock.com/Shakesbeare*

# Disasters – Seeing the Big Picture
### By Catherine L. Feinman

Stakeholders in each discipline are tasked with protecting their industries' assets and resources from potential risks and threats. However, each industry is interdependent on numerous other industries and their preparedness practices. The "whole community" concept encompasses the "all for one and one for all" motto. Together, communities can build strength and resilience. Apart, they may miss the warning signs and opportunities to mitigate disaster.

The most qualified staff and the highest quality equipment, for example, are hugely beneficial in a normal operating environment. However, a single point of failure could negate these benefits, such as: the best computer hardware and software without electricity, the best navigation equipment without a global positioning system (GPS), or the best communication systems without cellular tower signals. Electricity, GPS, and cell towers each represent a potential single point of failure and the need for a whole community approach.

Similarly, when responding to an incident such as a clandestine drug laboratory, people from different disciplines are needed to ensure a safe and effective response. Law enforcement officers secure the scene to keep out those who wish to do harm. Fire and hazardous materials personnel extinguish and/or neutralize various hazards. Emergency medical services focus on injuries and threats to life. Public health professionals address short- and long-term health effects. And so on. Each has a focus, but all must keep the big picture in mind.

Whether considering the evolution of the digital world, advances in technology, changing climate conditions, or the innumerable interdependencies that exist in modern society, emergency preparedness professionals have a lot to consider. It is not possible to plan and prepare for every potential threat, risk, and scenario. However, by always keeping the "big picture" in mind, emergency planners, responders, and resilience professionals will certainly be better positioned to address the single points of failure and to mitigate potentially devastating consequences.

The authors in this edition of the *DomPrep Journal* see the "big picture" in emergency preparedness, response, and resilience.

# Technology Behind the Next Heat Emergency

*By Tashawn Brown*

*According to the National Weather Service, there were <u>107 fatalities across the United States related to heat</u> in 2017, more than the deaths related to tornados, hurricanes, and cold weather combined. Local emergency management agencies must work closely with the National Weather Service – as well as other agencies and organizations – to monitor extreme heat and related threats that can affect local communities.*

Extreme heat is a significant hazard. Exposure to extreme heat over an extended period can lead to heat stroke, heat exhaustion, heat cramps, sunburn, heat rash, even death. Older adults, individuals with chronic health conditions, and people who use certain medications or abuse drugs or alcohol are among those at highest risk for heat-related illness.

### Keeping Residents Cool

Cooling centers can help community members avoid the adverse effects of extreme heat. These centers are air-conditioned spaces such as senior centers, community centers, public libraries, and other public facilities that typically operate during normal business hours. Through partnerships with city agencies and organizations such as the Department for the Aging, Parks Department, Housing Authority, The Salvation Army, and public libraries, these spaces are available to the public during a heat emergency.

Before each summer, emergency management agencies should collaborate with city agencies and organizations to identify potential cooling center facilities throughout their jurisdictions.

> *"Much of our work is in identifying air-conditioned spaces that are already being utilized by community members such as senior centers and libraries," said New York City Emergency Management Advance Warning System Program Manager Christopher Pagnotta. "Residents are more likely to go to facilities that they know and trust. Many of these facilities also have daily programs and activities to engage the public and provide them relief from the heat."*

Signage to cooling center facilities in multiple languages helps the public identify cooling center site locations within their neighborhoods and understand the dangers of extreme heat.

### Technological Solutions for Heat Emergencies

New York City employs several campaigns that could be adapted to the needs of other jurisdictions to inform the public and mitigate the consequences of heat-related injuries and deaths:

- New York City Emergency Management's Beat the Heat campaign encourages residents to know the hazards they may face, have a plan, and stay informed about potential heat-related injuries. This campaign includes print and digital ads featuring personal preparedness tips from older New Yorkers.

- Notify NYC is the city's free, official source for information about emergency events and important city services. Notify NYC alerts include information about National Weather Service and issued heat advisories, which provide safety tips and general information about the hazards associated with the emergency. Residents can also download a mobile application for Notify NYC, or receive emergency notification through Twitter @NotifyNYC.

- The Advance Warning System (AWS) allows New York City Emergency Management to communicate directly with organizations that serve people with disabilities, access, and functional needs before, during, and after an emergency.

- The Cooling Center Finder, which is only activated during a heat emergency, is a public online portal to view available cooling centers in the area. Once The City of New York determines the need for cooling centers, New York City Emergency Management's Geographic Information Systems (GIS) division activates the finder and is responsible for all mapping and data needs. GIS also works with cooling center partners to provide real-time updates.

During extreme heat, New York City Emergency Management officials urge individuals to go to an air-conditioned space during the hottest parts of the day. For those who may not have access to an air-conditioned space, cooling centers throughout the area offer respite, but only if they are accessible and easy to locate.

*"The Cooling Center Finder is a map-based online tool that allows New Yorkers to get up-to-date information on cooling centers in their area," said New York City Emergency Management Geographic Information Systems Director Joshua Friedman. "The online portal can be activated instantaneously and is a great tool in combatting extreme heat for those without air-conditioners."*

With interagency planning and collaboration, cities can minimize the impact of heat-related emergencies within their jurisdictions. Staying in constant contact with cooling center facilities and frequently updating the roster based on changes in availability – for example, if the air-conditioner at a cooling site is out of order – emergency management agencies and others charged with protecting the public can mitigate heat-related threats.

*Tashawn Brown is the press assistant at the New York City Emergency Management Department, where he has responded to various disasters and emergencies. As press assistant, he assists the press secretary and deputy press secretary in day-to-day press operations and serves as one of the agency's spokespersons, helping to develop and distribute information to the news media. He has been at the forefront of expanding the reach of New York City Emergency Management, connecting with relevant academic and trade publications to promote agency content. Prior to joining NYC Emergency Management, he worked as a research analyst at The City of New York, Mayor's Office of Media and Research Analysis. The author can be reached at (718) 422-4888.*


NYC OEM, 2018

# Combating the Single Point of Failure

*By Dana Goward*

*On 25-26 January 2016, many first responder radio systems across North America reported faults. The U.S. government received similar reports from cellular networks and digital broadcast companies around the world. A Federal Aviation Administration (FAA) flight safety system called ADS-B was also out of service for several hours. Some systems failed, some services were degraded, others just alarmed. All required human intervention and caused concern for the better part of a day.*

The culprit of the January 2016 faults was a 13.7 microsecond error in the signals transmitted by about half of the global positioning system (GPS) satellites. The glitch unexpectedly appeared when the Air Force removed its oldest GPS satellite from service. The ensuing problems took around 11 hours to correct.

## GPS Interdependencies

Although that particular problem may not occur again, a wide variety of other things can go wrong with GPS signals and the way they are used. In August 2017, Pennsylvania's York and Dauphin Counties' 911 paging systems were knocked out because of a problem with the GPS receivers embedded in their systems. According to one dispatcher, "Suddenly it was December 14, 1997." Accounts of the core problem differed between the receiver manufacturer and system operator, but it was another stark example of the importance of GPS in first responder networks.

GPS signals have become essential to an incredible variety of services that everyone relies on: navigation, routing, common operational pictures, blue force, and asset tracking to name a few. But more subtly, GPS timing signals enable digital land mobile radios for multiple conversations on a single frequency. They synchronize wireless networks, allowing messages to be decoded and cell towers to talk to each other. GPS-based time stamps allow databases to know which is the most recent bit of information being stored. They also provide location data as a part of identity management and offender monitoring systems. The list is almost endless.

> *Pennsylvania's York and Dauphin Counties' 911 paging systems were knocked out because of a problem with the GPS receivers embedded in their system.*

## Deliberate & Accidental Interferences

Yet, essential GPS signals are very, very faint. As a result they are very easy to disrupt, either intentionally or accidentally. For $50, a concerned citizen can buy a personal GPS jammer to avoid being tracked by their employer or ex-spouse. The distortion field extends from 10 to 500 feet. They could impact a nearby cell tower where they are waiting for a red light, or a landing system at a nearby airport (as has happened twice at Newark International).

For $250, criminals can purchase a device that jams GPS, LoJack, and cellphones. These are particularly useful for stealing high-value cargo and expensive automobiles that may have embedded tracking devices. Thieves simply turn on the jammer, swipe the cargo, and, when they are in a safe location, find and disable the trackers before turning off the jammer.

In Europe, limited sampling has discovered over 50,000 deliberate jamming incidents in the past few years and more than 300 different kinds of jammers. The problem is at least as big in the United States.

Accidental interference is also a major concern. Signals can bounce off buildings and confuse receivers. Nearby electrical equipment can also be a problem. As an example, security contractors at the 2014 Superbowl reported privately that they found an elevator generated enough radio noise when it went up and down to interfere with GPS reception nearby.

### Solutions at the Federal Level

All of these threats, combined with users' deep dependence on the signals are why officials at the Department of Homeland Security have called GPS "a single point of failure for critical infrastructure." Something that should make officials at every level of government lose sleep at night.

So, the question now is how first responders and other domestic preparedness professionals should address this significant threat and vulnerability. The Resilient Navigation and Timing Foundation supports policies and systems that *protect* GPS signals from disruption, *toughen* users and user equipment, and *augment* GPS signals with other sources (particularly the high-power, wireless, terrestrial system the U.S. government has promised to establish).

Normally, these recommendations focus on federal policy makers because GPS vulnerabilities can be most effectively addressed at the national level. However, "Protect, Toughen, and Augment" is good advice for everyone, especially domestic preparedness professionals:

- *Protect* – GPS signals should be protected in the area of operation. These signals are essential to nearly every activity and, if there is interference, professionals would want to know about it and make it stop. Equipment to detect and locate interference is readily available, though it does vary in complexity and ease of use. Without making any recommendations, an internet search for "GPS interference detection" would produce many good hits.

- *Toughen* – Toughening equipment is equally important. GPS receivers throughout an enterprise should be able to detect and resist many types of jamming (denial of service) and spoofing (false, misleading signals). Spoiler alert – these will cost more than a receiver at a discount store, but they are worth the cost in the end. Unfortunately, there are no industry standards for these kind of added security features, so it is helpful to work with a trusted professional in this field.

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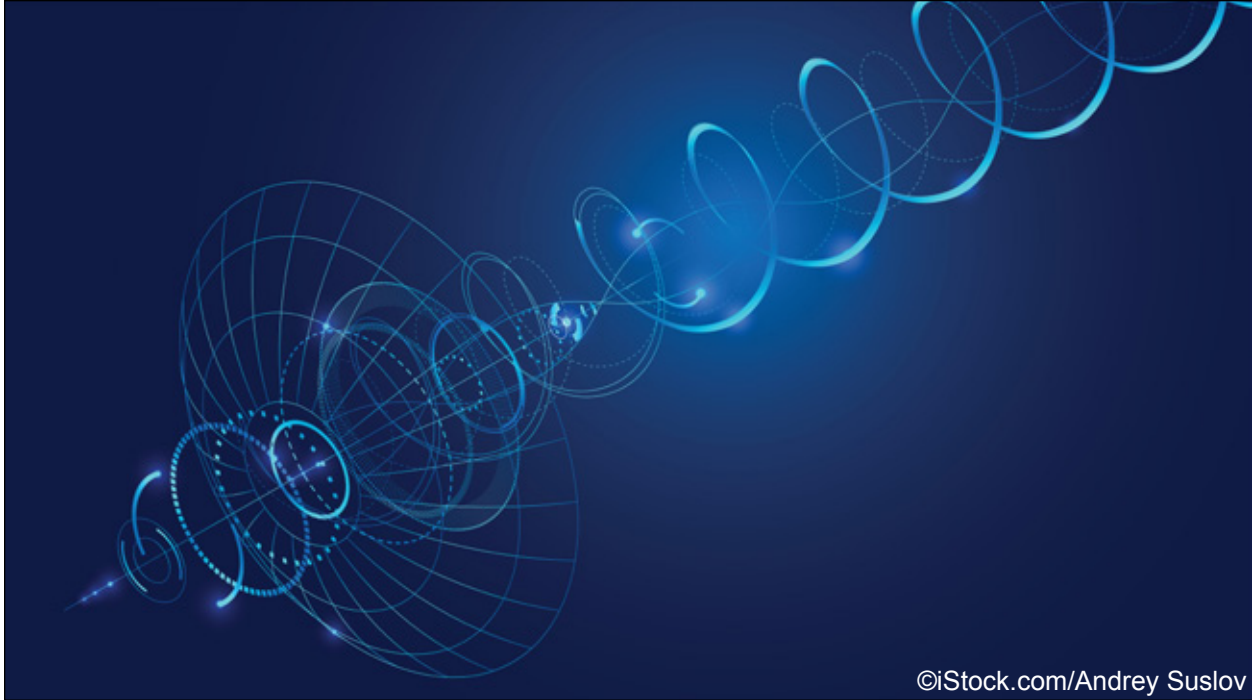
- *Augment* – Both the Bush and Obama administrations promised to augment GPS with high-power eLoran signals so that the combined system would be virtually bullet proof (and it would also work indoors, underground, and under water). The Trump administration is "studying the issue" again.

### Solutions at the State & Local Levels

State and local authorities are probably not going to want to set up their own eLoran networks (though they might consider talking to their elected federal representatives about GPS as a "single point of failure" and broken promises about augmenting it). However, jurisdictions can plan and prepare for what they would do during a GPS outage, whether local or widespread. Questions to answer include:

- Do all vehicles and personnel have current paper maps?

- How will blue forces communicate when land mobile radios and cellphones are not available or working poorly?

- Do contingency plans and exercises even consider "no-GPS" scenarios?

GPS signals are a critical underpinning of everyday life. Responsible first responders need to ensure GPS use is as good as it can be when it is available, and they are prepared to continue operating when it is not.

*Dana A. Goward is the president of the Resilient Navigation and Timing Foundation, a scientific and educational charity in northern Virginia. He spent several decades as a first responder piloting Coast Guard helicopters, and was serving as the maritime navigation authority for the United States when he retired from federal service.*

# Managing Crisis & Disaster in a Connected Digital World

### By Wayne P. Bergeron

*#SafetyBeforeSelfie – Please make sure to exit the burning building before texting, tweeting, posting, or live streaming about it. Surprisingly, the current security and emergency management (EM) environment that exists both in the public and increasingly in the private sector may necessitate such emergency warning statements as part of EM organizations' risk communication planning.*

In an increasingly interconnected world, vast knowledge that the world has produced is available in an easily accessible and on-demand format from almost anywhere. Combined with the ability to constantly connect with any past friends and acquaintances (or those one desires to know) through social media and online communication platforms, people are living in a time and age that has no real historical parallel. Of course, what is actually done with that capability on a daily basis generally does not reach society's full potential.

## Opportunities & Challenges

The current environment should enable EM capabilities that far exceed anything that has ever been seen before, with a level of achievability and economic affordability that should satisfy most public managers. However, the truth is much more nuanced. Therefore, the very capabilities, technologies, and breakthroughs that provide these advantages also potentially create or expose a set of challenges, vulnerabilities, and liabilities that most have likely not seen or not fully considered.

This interplay of opportunities and challenges creates a unique security environment and ecosystem that demands a level of understanding and a comprehensive security and EM approach that, in many cases, is only in its infancy in most organizations for routine operations and conditions, and is likely nonexistent for crisis/disaster and response situations. This reality needs to change quickly given the potential enormity of the consequences.

## Social Media in Crisis & Disaster

For better or worse, social media and the digitally connected world have in many ways changed the nature of how humans interact and communicate. These changes also have a profound effect on what are currently considered the necessary elements of good living and reasonable quality of life. In many developed countries, internet access and broadband connectivity are being increasingly prioritized and regulated as a form of public utility akin to water and electricity versus a luxury commodity. Highlighting this was this 2016 U.S. judicial majority opinion:

> Over the past two decades, this content [internet] has transformed nearly every aspect of our lives, from profound actions like choosing a leader, building a career, and falling in love to more quotidian ones like hailing a cab and watching a movie.

Beyond the domain of individuals, many forward-thinking companies and organizations are also beginning to realize the value of social media technology. These technologies and approaches are becoming a critical part and, in some cases, an existential part of business models and organizational structures. Although many of these approaches are being "hard-wired" into organizational structures and cultures, the security considerations and potential threat and vulnerability impacts are, in many cases, lagging behind. This then creates significant hazard exposure for many EM organizations, with the true nature and extent of risk being largely unknown.

Although individual platforms depicted in Figure 1 may change or increase/decrease in use and popularity, the fundamentals of social media use are largely universal. As such, organizations, agencies, and businesses must consider these fundamentals in their crisis and disaster planning as well as daily operations – in terms of providing core services and functions, as well as security for the organization and its employees. For crisis and disaster situations, social media provides a robust set of communication tools – with some inherently unique capabilities – that have mostly been unavailable outside the realm of the largest and most capable EM organizations.

Beyond two-way communication capabilities – when combined with aggregation, analytical tools, and data mining – social media can become a valuable source of intelligence information and situational awareness without the need to deploy sensors or reporting assets. In response to disasters, a simple capability such as geolocation (with some limitations and caveats) can assist in search and rescue operations, and geolocated photos provide real-time damage assessment capability that can far exceed traditional methods.

Beyond immediate response and recovery operations, social media platforms provide capability for just-in-time training for protective action procedures as well as video coverage of events. All of these capabilities, when properly integrated, greatly enhance an organization's crisis and disaster response capability.

### Social Media Management Strategy
When integrating these capabilities, though, the challenge for many agencies and organizations is developing a suitable social media strategy that fits particular organizational needs. Although platforms and technologies may be new, novel, or different, a social media strategy is still a media management strategy that must adhere to the basic tenets of the organization's outcomes and objectives. Key components for social media in crisis and disaster include:

- *Degraded connectivity and communications capability in crisis and disaster situations must be assumed and planned for.* Graphic-rich formats, embedded video, etc. that work well during normal operations generally become an impediment to effective communication during periods of degraded and limited communication capability. Having a pre-configured plan to switch to alternate lower bandwidth, less graphical, and text-based formats should be considered and planned for.

- *A social media and internet communications strategy is more than just a website or social media page.* The strategy must be comprehensive and encompass the breadth and range of platforms that constituents and customers are likely to use on a daily basis and likely to default to in crisis and disaster.

- *EM agency and organizational social media operations must be monitored, updated, and moderated to be effective.* Discovering months-old information on a platform when searching for relevant organizational information during a crisis or disaster impedes response.

- *Organizations need to communicate on multiple platforms.* To reach disparate audiences, organizations must utilize multiple messages and multiple formats appropriate to both situation and desired outcome.

- *In terms of management and implementation, even in small organizations, social media should not be considered merely an additional duty given to the newest or youngest employee.* The social media management strategy should garner as much attention as other core operations functions.

- *Social media messaging in crisis and disaster must be relevant and consistent.* This includes messaging across platforms and media types and synching organizational objectives and desired outcomes.

### The Good, the Bad & the Ugly (of Social Media)

For individuals, the self-oriented world can lead to comments and online attention contributing to perceptions of importance, status, fame, etc. For organizations and many high-profile individuals, more clicks, comments, "likes," "pokes," and shares do not necessarily equal overall effectiveness in the social media world. An organization is as likely to have viral content related to lapses, mistakes, indiscretions, and bad behavior of the organization, its employees, and associates as it is for outstanding performance activity.

Additionally, unlike face-to-face interaction, the impersonal and sometimes anonymous nature of online communications and interactions can lead to bad behavior and encourage the emotionalization and escalation of events that might otherwise be easily handled if conducted in person. In some cases, "people" online may not be who they say they are and, in some cases, may not be people at all – for example, "botnets," automated responses, and "clickbait" server farms.

The strengths of social media engagement for organizations can also be the greatest potential weaknesses and vulnerabilities. Although a robust social media strategy and active engagement allows organizations to "speak" directly to constituents, customers, and stakeholders, in crisis and disaster, many organizations find that, as the level of engagement and number of followers explodes exponentially, their capability to effectively and efficiently manage those interactions become incredibly difficult. In such situations, the increased social media presence becomes a double-edged sword and can be particularly difficult for small and lean staffed organizations to handle.



The Platforms: Snapchat, Skype, Pinterest, Instagram, facebook, GroupMe, YouTube, tinder, twitter, WhatsApp, LinkedIn, kik Messenger

An additional challenge in the social media world is the increasing propensity for self-selection and filtering of content, particularly in daily and pre-crisis environments. This can also be exacerbated by the algorithmic nature of many social media network operating systems and policies, which tend to steer members toward similar sites such as those that they have already shown a propensity to favor. However, this is not as big of a consideration in the immediate aftermath of a crisis and disaster situation as users tend to search for relevant content that reaches their perspective needs and is not the case with all social media platforms. This can also be mitigated with multi-platform engagement.

Somewhat related to the self-filtering phenomenon is that the nature of social media interaction – with its inherent "trusted relationship" status between social media "friends" and connections – in many cases, cultivates the perfect environment for creating, propagating, and circulating conspiracy theories. As a result, there are entire organizations, media outlets, and businesses that have been created just to debunk these theories – for example, Snopes, FactCheck.org, and PolitiFact.

### Social Media "Truths"

In social media and online interaction, the nature of the truth can change daily. However, organizations should consider some guiding principals when operating in the social media realm, especially during times of crisis and disaster. The first factor to consider is that, unlike traditional media sources and outlets such as radio, television, print, etc., social media is largely a "pull" medium. Thus, followers and users must specifically seek specific platforms, channels, and sites.

The idea of passive exposure to social media content is highly unlikely for most EM organizations. One caveat to this in crisis and disaster, however, is the increasing tendency of traditional media outlets (especially broadcast and online) to use social media postings from government, EM organizations, agencies, and even private individuals as primary sources in emerging crisis and disaster situations. This tendency provides a unique opportunity for an organization to position itself as an early authoritative source to fill the critical information void in the first minutes and hours after disaster and crisis. An additional advantage is that the organization can largely communicate directly with the public in an unfiltered manner. However, this capability could have unintended consequences, with the need to later counteract some of the unfiltered communications.

As mentioned previously, followers will increase rapidly both during the run-up to a pending crisis or disaster as well as in its immediate aftermath, which can seriously strain organizational resources dedicated to social media engagement activities. Of course, almost as quickly as followers are onboarded to social media sites and platforms during crisis and disaster, they often begin separating themselves soon afterward. Innovative organizations may be able to cultivate these followers as part of its social media base.

Finally, given the unregulated nature of social media and the online communication environment, EM organizations should anticipate being unable to fully control (or control at all) the information environment surrounding a crisis and disaster situation. Multiple players will have differing agendas, motives, and desired outcomes for engagement – and not all of them in the affected organization's best interest. Criminals and scammers also occupy the social media space and may compete directly with legitimate organizations and entities.

### Implications/Outlook for the Future

For social media in crisis and disaster, the only real constant is constant change. Users and followers likewise are constantly changing their likes, habits, and consumption patterns, which means organizations must tailor their communications to multiple audiences, multiple mediums, and multiple messages. While doing this, it is imperative that organizational information is planned for in an in-depth and comprehensive manner, with social media platforms complementing rather than replacing traditional media.

Another reality that goes beyond social media but is greatly enabled by it is the ubiquity of sensors and devices. Many people possess both a camera and the capability to instantly upload or broadcast images, videos, and audio. In many high-profile incidents, this ability has proven critical in defining and countering the narrative of EM agencies and organizations. As such, officials must assume that every interaction of its agents and employees will be captured, shared, and broadcasted in crisis and disaster situations, particularly when they are controversial or show the organization in a bad light. EM organizational social media strategy, policy, operations, and management simply cannot be an additional duty or part-time job, but rather planned for well before a crisis or disaster occurs and carefully managed once it does.

### Some Final Thoughts

The EM world is always changing and evolving, but social media and emerging technologies tend to move faster and further than organizations can anticipate their impact and react to them. EM organizations must determine whether embracing these new systems and technologies would benefit their missions, goals, and objectives, and enhance organizational safety, security, and effectiveness of response, especially considering that many of these new additions come with significant staffing and manpower impacts, maintenance costs, and other possible unforeseen mandates, liabilities, and lifecycle costs.

In addition, a new technology or capability could increase expectations of the organization's capability, which would be challenging especially in the early stages of adoption since many systems and technologies come with a significant learning curve and a gap between initial expectations and operational capability. Care must be taken to ensure that there is no lapse in organizational effectiveness in such circumstances.

Ultimately, some of the biggest opportunities when it comes to leveraging social media and emerging technology are likewise some of the biggest potential challenges and threats going forward within the EM realm, and even more so when crisis or disaster strikes. Ignoring or discounting potential challenges and threats could lead to critical vulnerabilities and points of failure, not only in terms of an immediate situation but even more so in the mid to long term. Now is the time to address them.

*Dr. Wayne P. Bergeron, lieutenant colonel (ret.), retired from the United States Army in 2011 after a 23-year career within the Military Police Corps and Special Operations Forces. He currently serves as an assistant professor teaching both criminal justice and security and emergency management at the University of North Alabama in Florence, Alabama. His education includes undergraduate degrees in criminal justice and political science, a master's degree in international relations from Troy University, and a Doctor of Science in emergency management from Jacksonville State University.*

# Planning Needed – Climate Change Impact on Animals

*By Johanna Rahkonen & Richard (Dick) Green*

*Animal populations will be uniquely impacted by the increasing, changing, and compounding disasters attributed to the rapidly advancing effects of climate change. Companion animals will face displacement, livestock will suffer from physiological stressors, and wildlife may face localized extinctions. Animals from all sectors may experience increased instances of negative health outcomes such as infectious diseases. Emergency and disaster planners must take steps to proactively assess the impact of climate changes on animals within their communities as they work to improve their climate resilience.*
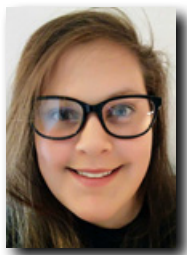
I n December 2017, millions of people from around the world viewed a viral video depicting a starving polar bear struggling on atrophied legs to make its way across the Canadian arctic, rummaging through refuse in search of something to eat. Critics were quick to point out that climate change could not definitively be blamed for the dying bear's condition, but others noted that the risk of starvation from melting sea-ice, driven by climatic warming, has a long history of being regarded as a threat to polar bear populations and other arctic species. Polar bears living in the southern Beaufort Sea in Canada, between 2001 and 2010, are thought to have undergone a population decline of at least 25% and possibly as much as 50%.

The Beaufort Sea is also the location of the longest recorded polar bear swim. Less ice means more water, and in 2008 a female polar bear swam for nine days straight, traveling across 426 miles of water, losing 22% of her body weight and her cub along the way. Certainly this does not mean that all polar bears will meet this same fate. What it does mean is that the time for action for some of these bears has already passed. When Paul Nicklen posted the viral video of the starving polar bear, he wrote, "This is what starvation looks like. The muscles atrophy. No energy. It's a slow, painful death."

With climate change already affecting animals of all types and classifications, steps must now be taken to appropriately identify new threats and risks. The rapidly evolving nature of climate change requires the need for preparation activities to address the damaging impact felt by animal populations as disasters and emerging threats develop and intensify.

### Impact of Extreme Weather & Temperatures on Animals

Climate change has been identified as an emerging risk to global communities. According to the World Economic Forum's *The Global Risks Report 2018*, extreme weather events, natural disasters, and failure of climate change mitigation and adaptation have been identified as three of the top five global risks in terms of both likelihood and impact. According to The Intergovernmental Panel on Climate Change (IPCC) an increase of greenhouse gases in the atmosphere will likely boost temperatures over most land surfaces, though the exact change will vary regionally. NASA has estimated that the planet's average surface temperature has already risen about 1.1°C since the late 19th century. Extreme temperatures will also occur more frequently.

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Rising temperatures will lead to melting ice and subsequent increased instances of flooding, particularly along the coast. By 2050, the expected rise of 4-8 inches (10-20 cm) could more than double the flooding frequency in places such as the tropics. Long-term sea level rise may have been underestimated, as it is now believed warming may be twice what prior models have suggested. Because warmer air can hold more water, increases in global temperatures can result in increased intensity of storms, including tropical cyclones with higher wind speeds and more intense mid-latitude storms.

From 1949 through 2016, tropical-cyclone translation speed has decreased globally by about 10%, leading to increased rainfall totals. As more rain travels more slowly over a given area, higher rainfall totals should be anticipated. The damaging consequences of these sorts of developments have already been seen. In 2017, Hurricane Harvey stalled after making landfall in Texas, remaining partially over the waters of the Gulf of Mexico for four days and resulting in unprecedented rainfall rather than moving inland and dispersing.

A review of the Federal Emergency Management Agency's (FEMA) database of disaster declarations revealed that 73% of the presidential disaster declarations from 2008 to 2017 were flood-related events. During this same period, eight of the ten states with the most flood-related presidential disaster declarations were inland, with Arkansas having the greatest frequency. Nevertheless, the potential for coastal flooding remains significant. All of the top 10 states most at risk for devastating floods over the next 100 years are along the U.S. coastline.

Climate change has also been projected to increase very large fire (VLF) potential in historically fire-prone regions in the United States. This will have greater impact in the intermountain west and northern California due to an increase in frequency of conditions conducive to VLFs and an extension of the seasonal window. In December 2017, California's Thomas wildfire became the largest known in state history, burning roughly 281,893 acres. In the past 10 years, California has experienced 9 of the 20 largest fires on state record.

*Impact on companion animals.* Few studies have been done on the direct impact of climate change on companion animals. However, due to their close relationship with human populations, many of the effects of climate change felt by humans will be felt by the companion animals who cohabit and live among human populations. The 2017 Internal Displacement Monitoring Center's Global Report on Internal Displacement found that, in 2016, there were 24.6 million new displacements from disasters. China had the highest number of displacements with over 7.4 million, the United States was 5th with over 1.1 million, and small island states (like Puerto Rico) were found to "suffer disproportionately" after making

considerations for population size. As people are displaced from their home communities, they may lose financial stability, food and/or water security, and the capacity to take care of themselves and their animals. Structures need to be implemented within and between governmental and state entities in order to accommodate displaced humans and their pets. An increased population of abandoned pets should also be anticipated.

*Impact on livestock.* The global human population is expected to increase from 7.6 to 9.8 billion in 2050, an increase of 29%. As such, demand for agricultural products are projected to increase over 40%. Research indicates that grazing systems may be directly impacted by extreme weather events and temperature changes, such as droughts, floods, productivity losses, and water availability. Further, grazing systems may be indirectly affected through issues related to fodder quantity and quality, disease epidemics, and host-pathogen interactions. In general, warmer conditions make disease transmission more likely between hosts. Non-grazing livestock production systems may be directly impacted by water availability and extreme weather events, and indirectly impacted by increased resource pricing, disease epidemics, and increased cost of animal housing due to changing needs such as cooling systems. As rising demand encourages production growth and intensification, a greater number of animals are subsequently at risk.

> *With climate change already affecting animals of all types and classifications, steps must now be taken to appropriately identify new threats and risks.*

*Impact on wildlife.* The effects of climate change on wildlife species has been broadly and increasingly researched in recent years. Even with an average global warming of only about 1°C, scientists have recognized climate change impact across every ecosystem on Earth. Out of 94 processes primarily involved with ecosystem functioning across terrestrial, marine, and freshwater ecosystems, 82% were found to have been impacted by climate change. Negative impacts from climate change have also been measured for individual species, as many are threatened and may face extinction due to climate change effects. Biodiversity is also threatened, with hundreds of species already experiencing climate-related local extinctions, including 47% of one study looking at 976 species. Though incidence was similar across climatic zones and habitats, extinctions were significantly higher in tropical species (55%) compared to temperate species (39%), animals (50%) compared to plants (39%), and freshwater habitats (74%) relative to terrestrial (46%) and marine habitats (51%). As climate change places new and intensifying stressors on wildlife, a departure from noninterventionist wildlife management approaches may be needed to mitigate these and other impacts.

### Planning & Response to Increased Threats

In many regions across the United States, emergency management has already addressed the importance of including animals in their preparedness and response activities. However, without accounting for rapid developments of these changes, appropriate mitigation, preparation, and subsequent response may lag behind need. Agencies, organizations, and individuals must be prepared to rapidly respond to "snowballing" events that affect a

multiplicity of animals groups. For example, a wildfire that required wildlife rescue may lead to a mudslide requiring companion animal rescue. Climate change science and preparation will help targeted planning objectives in the emergency management field better plan and subsequently respond and recover from anthropogenic-induced climatic events that affect humans and animals alike.

Despite increased legislative and subsequent agency attention to animal issues in disasters, risk-driven preparation linking animals and climate change impact remains stagnated. As of 2018, FEMA has removed all reference to climate from its 2018-2022 Strategic Plan, detracting from the severity and focus, which increasing climatic shifts will demand from the emergency management and response fields. The word "climate" does not appear at all in the document, and emerging threats are primarily attributed to terrorism and cybersecurity. It ignores one of the driving factors in change when it comes to the evolving nature of disasters presently and in the future.

The increasing and evolving risk of climate change requires a shift in perspective from those responding to animal-related emergencies in the face of disasters. As Adaptation Manager Missy Stults pointed out in a 2010 article, "for emergency planners and response personnel, it becomes really important to start planning for a changing paradigm. We can't plan based on historical situations anymore because history is literally being changed." Relying on reactionary assessment and response planning strategies could potentially lead to substantial harm and loss of life. Emergency planners need to:

- Identify hazards and threats that are facing communities;
- Recognize how those threats may be affected by changes in climate; and
- Understand how these changes may impact animals.

It is not too late to start planning for climate change impacts on animals, but immediate steps are needed to mitigate these effects.

*Johanna Rahkonen (pictured above) is currently completing her master's in Animals and Public Policy at Tufts Cummings School of Veterinary Medicine, where she has studied state and federal policy, animal welfare, animal law, and other issues involving the intersection between animals and society. She is presently interning with the American Society for the Prevention of Cruelty to Animals (ASPCA), where she has been able to explore her interest in animal emergency and disaster response. Before entering her current program, she obtained her master's in English Composition and Literature from the Indiana University of Pennsylvania and worked for several years in bank operations.*

*Richard (Dick) Green is the senior director of disaster response for the American Society for the Prevention of Cruelty to Animals (ASPCA). Before the ASPCA, he was the emergency relief manager for disasters at the International Fund for Animal Welfare (IFAW). He has responded to international and national disasters, and his teams have rescued thousands of animals from floods, tornadoes, fires, and hurricanes. Recent international responses include typhoons in Taiwan, Philippines, and Australia, volcano eruptions in Philippines and Iceland, and earthquakes in China, Haiti, and Japan. He has trained hundreds of responders in disaster prevention and response and has developed training curricula and texts for Slackwater Rescue, Water Rescue for Companion Animals, and Rope Rescue for Companion Animals. He is the past chair of the National Animal Rescue and Sheltering Coalition, is on the Board of Directors for the National Alliance of State Animal and Agricultural Emergency Programs, co-chairs the Animal Search and Rescue Best Practice Working Group, and is a member of the Evacuation and Transportation Best Practice Working Group. His doctorate is in education with an emphasis in kinesiology and biomechanics. He was an educator for 27 years, the last 10 at Gonzaga University in the Department of Exercise Science.*

# CASE STUDY: Analysis of Unknown Samples in a Methamphetamine Lab

### By Sponsored Case Study

*A clandestine drug lab is a health and safety nightmare for first responders. The chemicals are almost never labelled. The initial on-site team is normally followed by several hazardous materials technicians. These experts need to make sure the crime scene is safe and dangerous items are properly handled before evidence technicians can fully process the scene.*

### Dual Use of ChemPro100i and 100 Indicator

This case study describes the analysis of unknown samples obtained from two separate technologies – ChemPro100i Ion Mobility Spectrometer and 100 Indicator Raman Spectrometer. The benefits from dual use technology will be presented using a case study of challenges encountered in an illegal Methamphetamine lab.

The goal of this testing was to determine if there would be any practical benefits for the Environics Oy ChemPro100i handheld chemical detector and Serstech 100 Indicator being combined to detect and identify chemical components usually associated with clandestine laboratories. Results of the test indicate that almost all of the chemicals encountered and tested can be detected with Environics Oy ChemPro100i and identified by the Serstech 100 Indicator. The measured levels of gases were concentrated, but also small in total. In an actual situation, the vapors would be in the open and thus likely more diluted. However, the volume of vapors encountered would be much higher.
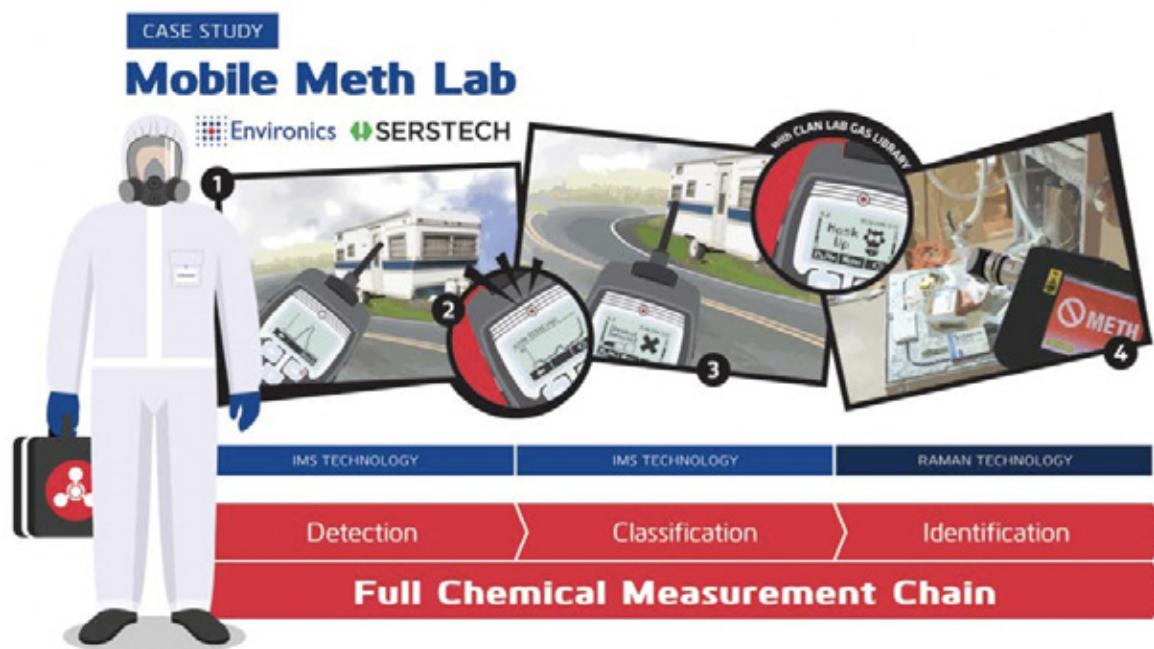
The first step would be to have the ChemPro100i locate the source of the chemical vapors, for example a specific room in a house or a vehicle. After identifying the target location and source, the 100 Indicator would be used to identify the liquids or solids found. This helps to determine and validate the kinds of operations being done at the site. Preliminary testing with these two detectors has shown the process to be viable. Methylamine vapor would likely be the easiest to detect by ChemPro100i from a long distance of the common chemicals usually found in a clandestine lab. This is due to high vapor pressure combined with chemical properties that trigger many of the sensors inside a ChemPro100i unit.
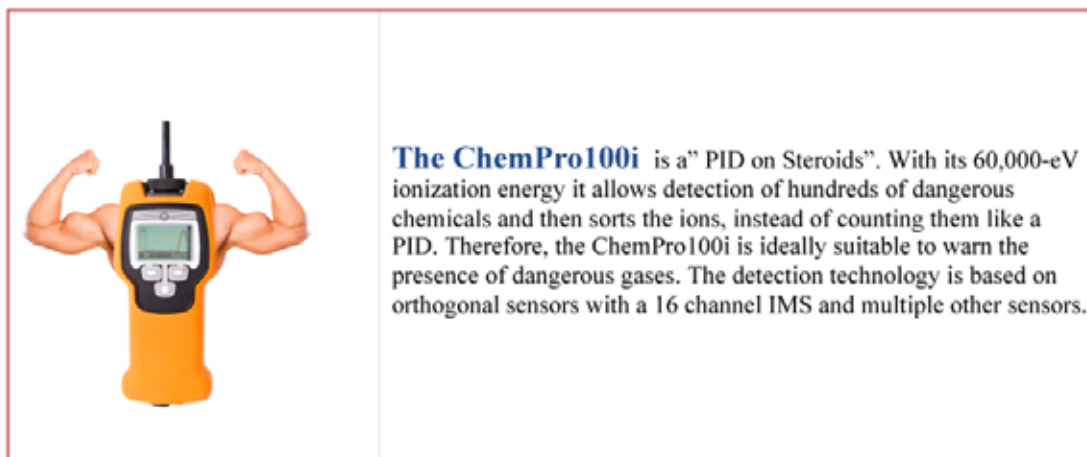
### Introduction to Ion Mobility Spectrometry and the ChemPro100i

The ChemPro100i is a handheld gas and vapor detector for detection and classification of Toxic Industrial Chemicals (TICs) and Chemical Warfare Agents (CWAs). It is used daily in "routine" HazMat, and for the, less common, CWA incident. The unique trend display shows the chemical concentration with a rolling line graph and audible "Geiger counter" style beep in real time. It allows a fast and easy way to read and hear contamination and a way to quickly localize the chemical. When significant concentrations of chemicals are found and classified, this information is shown on the "trend" display.
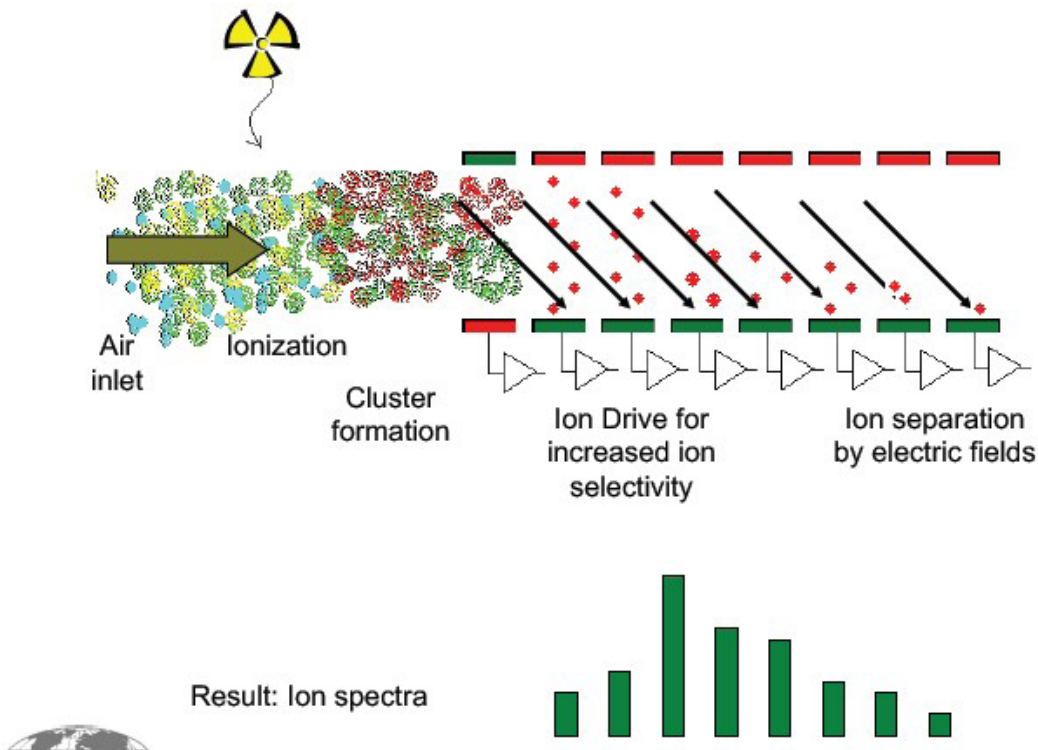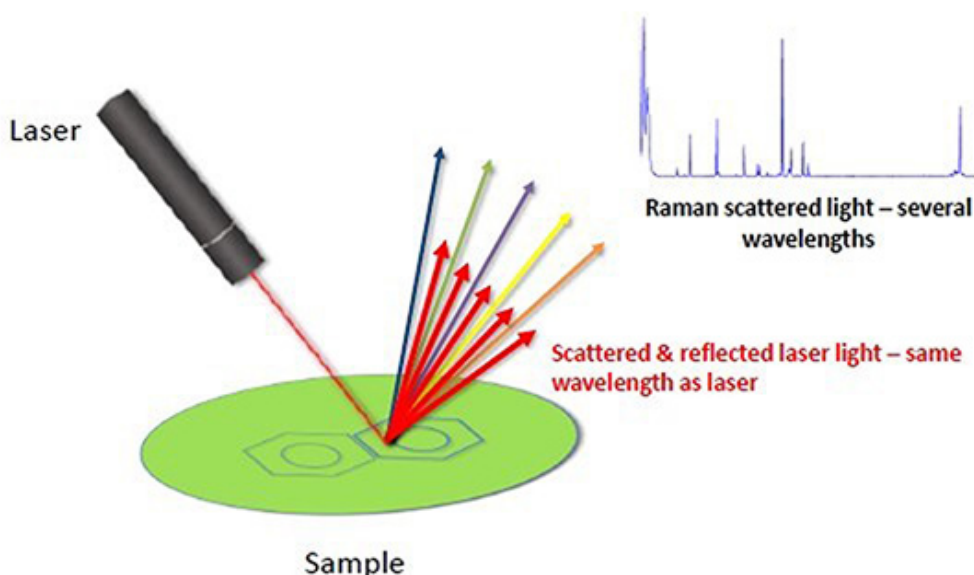


The ChemPro100i is based on open-loop Ion Mobility Spectrometry (IMS). In IMS, the sample is always a vapor. The device has a built-in pump for sample air, which is ionized and the resulting ion clusters are introduced into a series of electric fields. The ions travel different distances depending on their ion mobility and molecular size and are eventually captured by a set of electrodes and electric fields. An electrical current is produced into each

field and each gas creates a signal pattern that is unique. The ChemPro100i has 11 different selectable gas libraries preloaded into the memory that are compared to the signal pattern obtained. The user can manually scroll between libraries. The measurement is performed in real time – typically, results come in seconds. The detector classifies different gases into groups. With some chemicals, more specific identification is possible.

**The ChemPro100i** is a" PID on Steroids". With its 60,000-eV ionization energy it allows detection of hundreds of dangerous chemicals and then sorts the ions, instead of counting them like a PID. Therefore, the ChemPro100i is ideally suitable to warn the presence of dangerous gases. The detection technology is based on orthogonal sensors with a 16 channel IMS and multiple other sensors.

### *Introduction to Raman Spectroscopy and the 100 Indicator*

Serstech 100 Indicator is an easy-to-use, handheld, Raman spectrometer that enables on-the-spot chemical identification and data sharing. In Raman spectroscopy, sample molecules start to vibrate due to laser illumination. The vibration generates a specific light pattern (spectrum) that can be seen as the chemical fingerprint of the sample. The fingerprint is analyzed by the Serstech 100 Indicator and then compared to spectra of known chemicals in the embedded database. When a spectrum match is found, it is displayed with a confidence level indication.

Laser

Raman scattered light – several wavelengths

Scattered & reflected laser light – same wavelength as laser

Sample

Raman spectroscopy is suitable for measuring inorganic and organic compounds in liquid or solid form. It does not detect gases or vapors. The sample can be analyzed directly through the wall of the sample container provided the container is clear. The 100 Indicator is capable of analyzing:

- Drugs
- Explosives
- Narcotics



### Case Study – Illegal Methamphetamine laboratory

A typical illegal methamphetamine laboratory may contain various chemical vapor and liquid substances in different purities and phases of the manufacturing process. Analyzing these on site quickly and reliably is a challenge.

A clandestine drug lab is a health and safety nightmare for the first responder. The various chemicals are almost never labelled. The initial on-site team is normally followed by several hazardous materials technicians. These experts need to make sure the crime scene is safe and that dangerous items are properly handled before evidence technicians can fully process the scene.

The most common chemicals found in an amphetamine lab, in addition to controlled substances are:

- Formamide
- Formic acid

- Sulfuric acid
- Hydrochloric acid
- Sodium hydroxide
- Methylamine
- Various solvents

A set of substances was tested with both ChemPro100i and 100 Indicator. ChemPro100i tests were headspace tests (sniff tests) straight from the bottle whereas 100 Indicator was used to measure either directly through the container or using the sample vials. The samples tested were: BMK (butyl methyl ketone), which is used as a raw material in both amphetamine and methamphetamine, and amphetamine bases of three different purity levels (54% base / 74% sulfide salt, 61% base / 84% sulfide salt and 70% base / 96% sulfide salt).

### *Dual use principles and system benefits*

Adding Raman Spectroscopy to IMS in the field immediately delivers the advantage of analyzing also Narcotics and Explosives in addition to the current capability of IMS for Chemical vapors. Furthermore – the sample matrix now consists of volatile gases to liquids, powders and solids.

In a Methamphetamine laboratory, the ChemPro100i can be used to quickly screen the several containers and vials on site. The Responder may then select specific ones for further analysis by the 100 Indicator.

Both technologies have their advantages and disadvantages in detection and identification. IMS is suitable for gas detection and Raman for solids and liquids. Bringing the information from these two together helps a responder to reach an educated conclusion regarding sample content. Each technology has its limitations. Raman technology might have challenges in:

- Mixtures with very low concentration of target samples
- Layered samples
- Dark colored samples – possibility to an explosion in case of high solvent content on a dark sample
- Samples containing polar compounds (such as water, Hydrogen Fluoride, Ammonia, Hydrogen Chloride)

On the other hand – IMS can have problems with:

- Mixtures
- Very low volatility compounds (many narcotics for example – detection requires sample collection and heating; headspace analysis is rarely enough)
- High water content
- Extremely high concentrations – typically on a headspace analysis (can be solved by clever sampling technique)
- Substances that give only small amount of vapor signal such as Benzene.

A scenario where these limitations may happen: Dark colored substance with a high concentration of solvent (Methanol) Raman might have difficulties in identifying the sample. Therefore, it is always recommended to first perform a sniff test with the ChemPro100i- in case of a solvent the ChemPro100i will alarm "TIC Organic" with the TIC Classifier library. Trend display will give indication of the volatility. In this scenario, careful proceeding with the Raman is recommended perhaps by reducing the sample volume to a minimum.

### Results

The 100 Indicator can measure and identify a wide range of chemicals and chemical mixtures. Of the measured substances, hydrochloride acid and water solution of sodium hydroxide were unable to be measured with Raman spectroscopy due to little or no signal. Additionally, methylamine gave a clear indicationofmethanol. Sodiumhydroxidegranulesgavealowindicationofsodiumnitrate.Ontheother hand, of the 10 chemicals measured, 7 were identified correctly - even in mixtures.

The ability of ChemPro100i to detect vapors in air requires the compound in question to be such that it evaporates readily in ambient conditions, i.e. is volatile. Alcohols and solvents are easy to detect with the ChemPro100i 100i due to high vapor pressure. In addition to the chemical being in a vaporized form, the chemical properties of the compound determine which, if any, of the additional ChemPro100i sensors react to the compound.

### About Us & ChemPro100i

ChemPro100i is a product of Environics Finland, fielded in more than 50 countries and widely used among Hazmat teams and First Responders in the US and Canada. Environics has been present in the US since 1988 and now is represented by Gases101 LLC, Round Rock Texas. 100 Indicator is a product of Serstech Sweden. The Indicator 100 is designed to be used by police, border patrol, hazmat teams and military forces. 100 Indicator is also represented by Gases101 LLC, Round Rock, Texas.


Master Distributor in the US
Gases 101 LLC
sales@gases101.com
1107 Wonder Dr, Round Rock
TX 78681
+1 512 436 8923


Environics Oy
Timo Jaakkola
timo.jaakkola@environicsusa.com
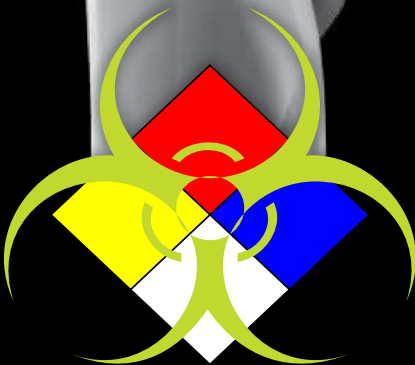Sammonkatu 12
50100 Mikkeli – Finland
US Cell +1 443 703 8008