
- AWARD WINNING PAPERS -

Law Enforcement Responders (LER): Are They Protected in a Chemical, Toxic Industrial, Biological, Radiological And/or Nuclear (CTBRN) Weapon of Mass Destruction (WMD) Terrorism Incident? t

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Abstract

One aspect of the Age of Terrorism or Super Terrorism involves the constant threat of deliberate or accidental use of some form of a Weapon of Mass Destruction (WMD) to inflict mass casualties and hysteria. Without sounding the doomsday alarm or over simplifying the appropriate response to a WMD incident, a chemical or biological warfare agent released on an international municipality by clandestine or overt means would place civilian first responders in immediate harms way. Respiratory equipment in use now is the first line of defense for responders reacting to a toxic chemical or biological WMD. Law Enforcement Responders (LER), on average, have a higher 911 emergency response call rate and do not have any form of respiratory protection available if they detect unknown toxins on the 911 scene. At the minimum, LER require a protective posture consisting of an individual respirator, a butyl hood/shroud on the respirator and butyl gloves to compliment their standard issue of wet weather gear. The protective posture is called CFEP, Civilian Field Expedient Protection. It provides liquid and vapor escape and egress protection for a LER under WMD chemical or biological terrorism incident conditions. CFEP should be standard issue to all law enforcement officers.

Credible Threat

Since 1995, international civilians have been in the Age of Terrorism - gone are the ages of Agricultural, Industrial and Information. Gone are the Y2K jitters, two simultaneous theater war conflicts and cold war mentalities- here in the present day, the Age of Terrorism has truly come of age. Governments are baffled by the actions of independent terrorist groups or individuals bent on hidden religious or zealot agendas. Additional precautionary defense measures appear to be on the to do list of governments. From equipping civilian first responders, to transforming entire military forces, to designing and testing air defense umbrellas in support of homeland defense, to developing extensive counter - cyber techniques, the Age of Terrorism, and one of its principle tools "Weapons of Mass Destruction," known as WMD, is prevalent in media and emergency management in the United States. Per Mr. Yonah Alexander, Director, Terrorism Studies Program, George Washington University, Washington, DC terrorism is a permanent fixture of international life.

A week after the USS Cole attack, the viral strain known as is *Bola suddenly* was identified by the United States (US) Center for Disease Control (CDC) as killing 73 people in the Ugandan town of Gulu. In the 13

year Ugandan rebel struggle, a viral sideshow again raises its specter; Bola biological agents may have been used as a rebel weapon. High explosives on a raft cause a strategic asset of the United States to limp home. The US Congress questions the former US Central Command (Centcom) leader on naval port of call security measures. The Centcom commander explains the logistical reasons why the USS Cole was in Yemen and blatantly predicts an attack against US forces in the "future" with WMD. These actions just lend credence to the adage "WMD: not if, but when?" So whether it is high explosives, Ricin, Bola, the Malaysian Nipa virus, or a Toxic Industrial Chemical or Material (TIC or TIM), Weapons of Mass Destruction are a credible threat and tool for creating mass casualties and/or hysteria. The short-term mission of the US Counter Terrorism and Domestic Preparedness Program should be to ensure a mass casualty scenario and hysteria does not materialize prior to, during or after the 2002 Winter Games in the United States.

A short-term analysis of the US national and international Chemical/Biological Warfare (CW/BW) WMD threat shows indicators that a threat does exist. Whether the US Domestic Preparedness Program is adequately supported, lacking concerted leadership, over inflated, over funded, underestimated or misunderstood, the international threat is there spanning the potential range of high explosive detonations, biological toxins, Toxic Industrial Materials (TIM), biological pathogens, radiological isotopes, chemical warfare agents and nuclear low or high yield detonations. The Federal Bureau of Investigation (FBI) of the United States is the lead crisis management agency in the criminal investigation of actual US WMD cases. The FBI ranks biological toxins as the number one threat followed by TIME as the second. In the time frame of 1980 to 1995, the terrorist incidents on FBI record show 249 actual cases, 48 prevented cases and 43 suspected. A steady increase in cases is evident from 1997 to 2000. In 1997, the FBI recognized 74 WMD cases, that is 6.2 per month. In 1998, 181 WMD cases were catalogued, 15.1 per month. In 1999, 210 cases were WMD, 17.5 per month. In the spans of three years, the cases have tripled. As of the end of August 2000, 155 cases were identified, 19.3/month. Of the 155 in the year 2000, 82 were biological and the rest chemical agent cases. Of the total cases in 1999, only 12 were actual releases, the rest were bogus threats (160 biological, 19 chemical, 11 radiological/ nuclear and 20 WMD combination/other per Special Agent Steve Wheeler, US FBI, Longboat Key, FL, 10/13/00). To date all biological "Anthrax" threats in the US have been hoaxes.

The deliberate release of a sarin nerve agent mixture in the confined space subways of Japan focused the international responder community on the possibility of such an event in their own geographical area. In reference to the FBI statistics, the US has had minor low key CW/BW events over the past 10-15 years (excluding High Explosives (HE)). The salmonella salad bar infection in Oregon, the dysentery donuts in Dallas, the H2S release as a bank robbing cover in Dallas and the Minneapolis, MN, lethal blood agent canisters uncovered during an animal genetics demonstration, are all deliberate actions by terrorist individuals in support of non aligned goals. But, to date, no mass casualty incidents involving a lethal CW or BW have been identified. The FBI current assessment is that there is No credible Intelligence that a US Domestic Group is acquiring, developing or planning the use of Nuclear, Biological or Chemical (NBC) weapons on US soil as of October, 2000le. According to Agent Wheeler, interest in WMD/CW/BW will continue to increase and the threat from hoaxes, blackmail and "Mass Disruption" will remain high. Recently, since the introduction of TIME into the threat scenario for the United States, a new concept called "Weapons of Opportunity (WO)" is evolving and it involves the use of Toxic Industrial Materials as a ready made compound for terrorism available in many industrial parks across the US.

Who responds to these WMD Terrorism psychological hoaxes, threats and/or real world situations? Local, state and federal responders in the public safety specialty areas of fire fighting, law enforcement, emergency medical service, hazardous materials, bomb disposal and public health are all on the cutting edge of international domestic preparedness against WMD terrorism. In the US, Law Enforcement Responders (LER), on average, have a 3 % higher response rate over other responders. A police person is more likely to be first on the scene than any other responder is. The Top Official Exercise (TOPOFF) conducted this past spring in the US proved this in the Portsmouth, NH mustard simulant attack. A LER and vehicle were persistently contaminated upon responding to the 911 directed scene. Some after action

results of TOPOFF identify recommended improvements in local 911 center operations. 911 emergency centers, the initial lynchpin of first responder communications, receive pertinent incoming calls, prioritize the calls and direct local response. How do 911 centers assess reports? Do they know the telltale signs of Weapons of Mass Destruction (WMD), in particular, Chemical Warfare (CW) and Biological Warfare (BW)? Do they know how to ask the right questions that allow differentiation between a grass fire description and a mass casualty gun fire situation? United States 911 center training programs are making training inroads on risk assessment training, situation differentiation and casualty exposure contamination symptoms recognition. These training programs should also encompass respiratory and skin protection requirements for moments when the 911 entire HIVAC air system is turned off and the center is sheltering in place from a down wind or adjacent contaminated incident.

Indicators

The year 2000 has had all forms of domestic preparedness indicators in the United States. On 1/12/00, the National Domestic Preparedness Office (NDPO) of the FBI reissued WMD threat sample guidelines on four potential scenarios: the anonymous caller, a potential WMD device located, an anthrax letter opened with material present and an anthrax letter opened with no material present. On 1/18/00, a US Department of Defense aerial kill vehicle missed a US ICBM in a Pacific Ocean test. The US National Missile Defense Program (NDMP) is well underway. The NDMP has the potential of preventing NBC capable threat missiles from simultaneously contaminating 5 different US population centers. On 2/5/00, an example of how the media portrays WMD terrorism was broadcasted by US Cable News Network (CNN). After attending a conference in California, CNN quoted conference speakers as stating or supporting a concept that a US Bio-Terrorism threat exists for the next 5-10 years. Anthrax, Plague and Smallpox were identified as the main threats. In 1999, an endemic virus to Africa, the West Nile Virus appears in New York City and on 6/22/00 the Centers for Disease Control in Atlanta, GA, establish a web site that tracks potential West Nile Virus cases in 18 eastern US states.

What does the US first responder community think of these indicators? On 8/26/00, Dallas, TX, the International Association of Fire Chiefs (IAFC) Terrorism Committee concludes that the fire service still has the same challenges today as it had back in 1995, despite valid attempts by governmental funding programs. Responders in the US are planning on how to sustain themselves and mitigate an incident for 6-12-24 hours until federal aid arrives. In support of providing US responders with an equipment approval protocol several key US government agencies and one US private non-profit association signed a Memorandum of Understanding (MOU), published on 5/15/00 by US OSHA, intending to collaborate on the establishment of reliability/test standards and selection guidelines to be used to protect emergency responders against CW/BW/TIME. The agencies in this novel government approach are the Department of Justice's Office of Law Enforcement Standards (OLES), the Department of Commerce National Institute of Standards and Technologies (NIST), the National Fire Protection Association (NFPA), the Department of Health and Human Services, Center for Disease Control and Prevention National Institute for Occupational Safety and Health (NIOSH) and the Department of Labor's Occupational Safety and Health Administration (OSHA). The US Department of Defense is not a signatory agency to the MOU. The generation of a NBC equipment approval protocol by this agency joint venture will be a standard bearer for respirator manufacturers and complimentary equipment manufacturers.

Hopefully the protocol generated from this MOU will standardize the current military specified NBC equipment against the US NIOSH approval protocols for select protective equipment and more than likely create a whole new class of Personal Protective Equipment (PPE).

Police Threat Scenarios

What are the police threats from chemical or biological military or terrorist grade incidents? Eleven potential scenarios could exist. Scenarios ranging from anthrax threats, anthrax look-a-likes, anthrax

actual exposures, unknown biological contamination, industrial plant or tanker release with secondary explosive device, routine 911 response but multiple indicators of potential CW/BW agents at scene, unknown CW/BW vapor hazard with secondary explosion, Immediately Dangerous to Life Health (IDLH) confined space harboring criminal activity, contagious or contaminated suspects, bystanders or victims, or cold zone security detail turned into a toxic downwind hazard site containment detail with a simple shift of weather systems. All scenarios that will have multiple indicators ranging from visual to olfactory. Per the Emergency Response to Terrorism Job Aid, Edition 1.0, May 2000, firefighters are recommended to assess security by contacting law enforcement for coordination and possible escort into the scene. The rush in-save, the life and handcuff the perpetrator mentality is a dual edged sword under WMD CW/BW situations. LER can-do motivation must be tempered by stand off risk assessment or the LER faces the risk of becoming a true "blue canary" of a highly lethal domestic terrorism crime.

Chemical, Toxic Industrial Materials, Biological, Radiological and/or Nuclear (CTBRN) agents are broad spectrum in their effect. Broad spectrum in that no one preparedness plan will have all the pre planned cookie cutter answers. Broad spectrum, in that these agents are elusive, usually nondescript, falsely routine ("Hazmat with an Attitude"/Hazardous Materials (HAZMAT)) and outright mass casualty producing. For example the US Secretary of Defense, Mr. Cohen, in his speeches uses a 5 pound sized "sugar" bag of anthrax, under suitable weather conditions and dispersal methods, to create 70,000 casualties in a crowded metropolis. This is not "HAZMAT with an Attitude" it is "HAZMAT with Lethality." A concept of certification that bears merit in establishing true HAZMAT Technician certification programs in the current Civil Support Teams (RAID) across the US. The Terrorism Tools of CTBRN cover eight categories. Categories requiring respiratory protection as a first line of defense followed very closely by skin protection. Nerve, blister, blood, choking, biological, riot control, radiological particulate and unknown agent scenarios require respiratory protection that encompasses fully encapsulated suits with encapsulated suits with SCBA to a simple full face respirator with a P100 carbon sorbent canister. These are the terrorist tools in CW/BW because they are relatively cheap, easy to formulate, hard to detect and lethal or non-lethal depending on the route of employment and readiness of the terrorist™s target. Respiratory protection options against these terrorism tools require integration with a protective suit and glove technologies. Fire fighter turn out gear, effective for standard fire fighting, provides limited skin protection (30 seconds to 30 minutes max) against persistent and non persistent CW/BW agents. Without a carbon or tyvek layer in turn out gear, firemen must adapt their exposure times based on the mission of escape, casualty recovery or mitigation. Depending on whether brand new turn out gear is tapped at wrists, waist, ankles etc. - varying time frames of protection have been scientifically published for use of new turn out gear on the fringe of hot zones (US Army Soldier and Biological Chemical Command (SBCCOM) study published in August, 1999). The study is proving to be invaluable for use as a decision tool for responders and responder Incident Command (IC) procedures under Chemical Warfare and TIC conditions.

Chemical Agents

Military grade chemical warfare agents have essentially 5 classes. The classes are Nerve, Blister, Choking, Blood and Riot Control. The classes or "agents" rely on the primary methods of inhalation and skin adsorption to create their effects. Persistency of the agent contributes to the length of time that breathing and skin protection is required. Non-persistent (NP) agents like AC, C, GB and GA create immediate/rapid vapor hazards but for limited duration times of 5-10-30 minutes. Whereas, Persistent (P) agents like V'S, HD, G.D.(semi persistent), GO and HN-3 create vapor and liquid hazards that will persist for hours to days dependent on weathering and dispersal patterns. NP agents are used on unprepared personnel to force them into protective posture, kill the untrained personnel and allow the NP agent attacker to occupy the target area that is free of contamination - an ideal terrorism tool for a person who wants to deliver a toxic compound and not be concerned about residual contamination.

Persistent agents take the toxicity perspective to the long duration liquid hazard level. Their use is primarily to contaminate terrain, equipment, buildings and avenues of approach. Off gassing is present

but not pervasive since the liquid will settle in low ground/terrain and present a low vapor pressure but significant liquid hazard for days at a time. Decontamination of a persistent agent is logistically intensive. NP agents usually do not require extensive decontamination. Terrorist use of a Persistent agent might be done as a combination attack, first triggered by a Non-Persistent and followed by a persistent agent in a secondary explosion designed to contaminate responders on site. A secondary persistent agent explosion or dispersal would contaminate responders, fully test their respiratory equipment and overall PPE and cause command and control reassessment. A terrorist would need to remotely detonate a persistent agent dispersal device if not willing to be self-contaminated. The Tokyo Subway attack of March, 1995, was a Non-Persistent dilute GB/Sarin Nerve Agent (35%) and remaining compounds were organic compounds consisting of Hexane (16%) and N,N - Diethylaniline (DEA) (37%). Pure GB would have caused a higher casualty rate. Due to the non- - persistency of the GB mixture, the organic compound concentrations were at various decreasing levels from the origin points of the subway train, the train platform and to the subway escalators.

As a noted learning point a risk assessment based on accurate detection would have allowed multiple types of respiratory devices to be used by responders and quite possibly could have prevented the greatest single responder death incident from a Chemical Warfare agent in current history. The NIOSH-DOD-OSHA Sponsored Chem/Bio Respiratory Protection Workshop Report, February 2000, pages 39 & 40, outlines the possible respirators for counter-terrorism use by any civilian responder. All of these respirator configurations support various levels of protection against a terrorist use of a various containers to include a 55-gallon drum or a 1-quart bottle of CW/BW. What are the perceived real facts about Chemical Warfare agents, military or terrorist grade? Are they easy to make? Yes and No. Any Polyvinyl Chloride (PVC) industrial manufacturer generates a hazardous material called phosgene-a historical military choking agent, as a routine industrial byproduct. Phosgene was used in WW1. Are Chemical Warfare agents stable in production and storage? Yes and No. Is delivery on target hard? No. Are precursors restricted by US laws? Yes. Are decontamination procedures standardized? Yes. Is weather a decontaminating agent? Yes. Will responders spend long times in protective clothing to support decontamination of persistent agent (CW/BW) operations? Yes for P agents and No for NP agents. Are chemical agents (CW or TIM) easier to detect and identify than Biological agents? Yes. Can Live Agent Testing/Training (LAT) provide equipment performance parameters and confidence for responders? Yes. Is LAT part of a to be published equipment approval protocol for First Responder use? It should be. Chemical warfare agent effects, military or terrorist grade can be stopped, provided responders have the right equipment, training and preparedness.

NATO won the Cold War because of NATO's readiness and preparedness against a weakening communist nation. The "Terrorism War" will be won the same way. Battling military grade or terrorist grade chemical warfare agents like GB/Sarin is just one aspect of this New World Order War. Chemical agents in the form of Toxic Industrial Chemicals or Materials (TIC/TIMs) pose another challenge to responder due to their bulk storage in industrial parks, visibility under the US EPA RMP, rapid transport by DOT placard trucks, railcars and air packages and their general pervasiveness in society. Respiratory protection canisters that protect against CW/BW, TIME and CS/CN are just now becoming available to the responder. They are rated by the US National Institute for Occupational Safety and Health (NIOSH) for select TIME based on the amount of carbon sorbent in the canister, military specified for CW and particulate tested against CS/CN/Biological simulant particulate. Assigned Protection Factors (APF) of the respirators play an important part in determining suitable protection against CW/BW, TIME and CS/CN.

Biological Agents

Biological agents such as Anthrax, Ebola, Botulism, Ricin, VEE, Smallpox and Plague represent the 4 types of Biological Potential Terrorism/Warfare (BW) Tools. The 4 recognized types of Biological Warfare agents are bacteria, viruses, toxins and rickettsia. Aerosolized anthrax, the bacteria spores that Mr. Ken Alibekov weaponized in the tonnage for the former Soviet Union, use the respiratory tract or open cuts as primary means of entry into the human body. A simple High Efficiency Particulate Filter (HEPA) or P100

cartridge will provide 99.97% effective protection against the 6-7 micron size of Anthrax rods. Water and soap provide effective surface decontamination, provided no open wounds are infected. A properly worn and fit tested full-face respirator will provide adequate protection against aerosolized anthrax contamination. A Powered Air Purifying Respirator (PAPR) with rated canisters will generate slight over pressurization to the wearer and enhance wear times under long duration decontamination or detection requirements. Loose fitting hoods with PAPRs provide enhanced comfort to the wearer, no tight fitting head harness effects and require a steady power supply to maintain the over-pressurized seal.

Biological agents target specific organs, have set incubation times and use various routes of entry. The real perceived facts about biological agents are the reason why BW is the number one threat on the FBI threat analysis. Biological agents have seed stock that is easy to obtain, make and culture. Small to large quantities can be made at all levels of production ranging from basement petri culture dish to 5,000-gallon fermentation reactors. Delivery is as simple as an aerosol can in an indoor HVAC air conditioning system or as complicated as a bulk aerial spray attack over a metropolis. Most BW agents need stabilization to remain virulent, however, the preferred form of anthrax is disseminated as a harden spore and until it is hydrated, the spore is very persistent when left untouched. Most BW agents are inexpensive and some like Ebola virus or Ricin toxin have no cure. Simple hospital room hygiene prevents the contact or spread of most BW agents. The trick in the ambient atmosphere is to use the correct respiratory protection and conduct contamination avoidance. Detection is fairly difficult due to the incubation period of the agents and lack of accurate means of attack.

Detection technology for BW ranges from under \$1,000.00 for "Smart Tickets" to \$68,000 Idaho Boxes to multi-million dollar mobile tactical detection DOD platforms. Detection technologies are rapidly improving through the advent of the recent genetic code cracking and enhanced nano-technology. Detection is current very real challenge for the responder because many BW agents have delayed effects and incubation symptoms mirror common cold or flu symptoms. It is when mass numbers of civilians flood the public health systems that a definite indicator light "pops" on at local public health offices and the US CDC. Despite the advantages of delayed effects for BW terrorism, new vaccines and detection technologies are being made, funded and stockpiled. Biological agents can be defeated, whether it is a responder in a EPA Level A encapsulated suit, a level B suit, level C Mission Oriented Protective Posture (MOPP 4), level D full face piece with CW/BW canister or vaccination programs. Their use as a terrorism tool is only as good as the terrorist's knowledge of the BW agent. High explosives are easier to obtain. The economic collapse of the Soviet Union did not help in stemming the transfer of biological weapons grade technology to the "wanna-be" super power governments or rogue terrorist organizations willing to pay the money.

Nuclear/Radiological

The last part of CTBRN threats, Nuclear and Radiological Isotopes, revolves around radiological contaminated particulate and pure radiation. Radiological isotopes and particulate can be dispersed like BW aerosols and generate chronic or acute radiological poisoning without real time indicator evidence. Radiological particulate are stopped by HEPA/P100 filters and contained in the micron size screen of the filters. These particulate turn a CW/BW air purifying filtering canister into a HAZWOPER disposable container. Harper's magazine published an article (The Radioactive Boy Scout, Harper's Magazine, Ken Silverstein, 1995) about how a boy scout became radioactive after pursuing a merit badge for scouting and other interests. The boy did not wear complete respiratory protection. Radiological particulate can be stopped by full face respiratory protection using supplied air, SCBA or a combination organic vapor/acid gas P100/HEPA cartridge or canister. A properly fitted and worn respirator will stop nuclear detonation fallout particulate with P100/HEPA air filters.

TOPOFF

The ability of United States responders to manage, mitigate and overcome the effects of a deliberate Nuclear, Biological and/or Chemical (NBC)(CTBRN) attack relies on training. True interagency training and evaluation at the local, state and federal levels requires dedicated assets at various training readiness levels. The US Department of Justice implemented an example of this training this year. The training involved state government Top Officials (TOPOFF), their Emergency Operations Centers (EOC) and first/follow on responders at all levels. The first Top Official Exercise (Top Off) NBC training exercise occurred this past spring in three different geographical locations in the US. Three cities were contaminated with simulant NBC agents, Washington, DC, Portsmouth, NH and Denver, CO. Washington, DC responders dealt with radiological isotope contamination and exposure. Portsmouth, NH, reacted to a chemical incident involving persistent mustard agent. Denver, CO, responders defended against a biological weapons attack. All three locations were contaminated simultaneously or near simultaneously. Denver was one of the first US cities to be trained by the Department of Defense under the Nunn-Lugar-Dominici Authorization Act and was tasked with the most difficult terrorism scenario. Portsmouth, NH was not Nunn-Lugar-Dominici trained city and was deliberately chosen because of that reason to assess the effects of a persistent CW agent on a unprepared city. Washington, DC, being the high profile terrorist target that it is, handled the radiological contamination scenario. The exercise was so realistic that local and national media jumped on the bandwagon and televised portions of the exercise. The National Broadcasting Company (NBC) Today Show broadcasted a 4-minute TV clip during one of its prime morning slots. The clip showed respiratory equipment of all forms being used by local, state and federal responders. Responders were aiding contaminated civilians and other responders with emergency first aid and triage. Mass casualties were created and controlled in each situation. The reactivity, ignitability, corrosivity and toxicity of Chemical, Biological and Radiological (CBR) agents contaminated and exposed any person or item in the hot zone and any responder that conducted initial and follow on entry. TOPOFF allowed government and local officials to test their command and control under all phases of a WMD CW/BW Incident. TOPOFF and events like it, contribute immensely to the payoff analysis of where and why so much governmental money is Spent on Us Domestic Preparedness.

Phases of a WMD Incident

The confusion generated at the bombing of the Murrah Federal Building in Oklahoma City was managed by the Incident Command Standard Operating Procedures of the local Fire Department and state agencies. Add persistent chemical warfare contamination on top of that high explosive domestic terrorist event and the phases of a WMD Incident become greatly needed. The Department of Justice (DOJ) formally established the phases. DOJ trains law enforcement responders in their Louisiana State University (LSU) Academy of Counter-Terrorist Education program on WMD incidents. A National Emergency Response Training Center supported by Texas A & M University is another leading trainer in first response to WMD terrorist events. In order to have a structured response to a WMD/CW/BW terrorism incident a defined sequence of events must occur. The 5 Phases of a WMD Incident, per to LSU and the US DOJ are Prevention/Deterrence, Notification, Response, Recovery and Restoration. Manufacturers, responders and stakeholders do the first phase everyday. The 10 th International Conference of the ISRP is a prime example of the first phase of a WMD Incident- Prevention/Deterrence. Through allocation of resources, we prevent and deter WMD terrorism on a daily, if not hourly, basis. Our consistent vigilance toward doing what is right, preserving freedom of choice and supporting counter-terrorism programs is the foundation of prevention. The second phase is Notification. The first call maybe in person to person, electronically or written. Notification centers (911 etc-) must be integrated in all WMD training exercises from the bottom up to ensure notification is run by the numbers smoothly. The third phase, Response, has six categories. Response categories are Isolate, Identify, Notify, Protect/Mitigate, Document and Transition. Respiratory equipment and its inherent training requirements share a triangle of protection that includes suits, gloves/booties and detection. A triangle of protection that hinges on the human factor of proper training and focus. The fourth phase, Recovery and the fifth phase, Restoration, allow the incident cycle to stabilize and generate site recovery. Protection and mitigation are focused on self and collective protection.

The terms of Time, Distance and Shielding define self-protection. Time of initial contact to time of notification for evacuation or shelter in place allows exposure avoidance and rapid containment response. The time since the incident and the exposure duration time for each responder are the essence of safety in the hot zone. Studies on the Firefighter Protective Ensemble (FFPE) with SCBA published by US Army SBCCOM, Aug99, show that standard turnout gear with SCBA provides 30 minutes of rescue time for known live victims and when that same gear is taped up at specific points on the fire fighter a 3 minute reconnaissance to search for living victims is doable in an unknown nerve agent environment. That 3-minute time frame changes to a 2-minute recon if Blister agent (HD) is suspected. So the triangle of protection relies on time distance and shielding in so many ways. Distance from the explosion, spill, aerosol spray or liquid saturation allows control measures such as hot, warm and cold zones and what Personal Protective Equipment (PPE) should be used. Shielding from suits, structures, and other physical barriers plays a critical role in mitigation, exposure avoidance and barrier compromises.

The term TRACEM originates from the need for responders to identify appropriate protective measures before, during and after a Chemical, TIME, Biological, Radiological and/or Nuclear (CTBRN) agent incident. TRACEM per the DOJ is a classification system for "harm" from weapon effects. The term TRACEM provides an easy way to remember how to protect yourself under various conditions. T in TRACEM stands for Thermal. If SRS-5 bomb suits and turn out gear provide rated protection against explosions, fires and incendiaries then they provide the protection barriers against the T of TRACEM. Cold/freezing effects also fall under thermal due to its similar de-habilitating human effects. The R in TRACEM stands for Radiological. Alpha, Beta, Gamma and Neutron radiation are stopped by protective equipment that shields and filters harmful radiation rays and particulate. The A in TRACEM is for Asphyxiation. As Oxygen is displaced by heavier compounds or used up by combustion, self-contained breathing apparatus must be used prior to entry into such atmospheres. The C is for Chemical compounds that may be military, terrorist or industrial grade. Toxic or incapacitating materials require full range of breathing zone and skin protection. The E in TRACEM is for Etiologic and it involves providing protection against disease causing pathogens, virus, toxins and rickettsia. The last initial is M for Mechanical. Projectiles, sharp objects or faulty equipment can cause protective systems to fail, expose responders or terminate specific response measures. Once the elements of TRACEM are applied to a particular situation, PPE measures are developed, emplaced, and responders react in appropriate PPE suited for the job. TRACEM supports Law Enforcement Responder (LER) roles in a WMD/CW/BW incident by providing standardized protective measure guidance under harmful conditions.

LER Roles in a WMD Incident

Law Enforcement Responder (LER) roles are so diverse under crisis management of a WMD incident that without proper respiratory protection these roles can be detrimental to the survival of a LER. Roles that place the primary form of protection- self-protection at the top to the LER role list in a WMD/CW/BW response. The roles determine the types of PPE required for various missions. Roles of LER in WMD CTBRN contamination incident vary depending on how well integrated police are with fellow municipal first responders. One would think that a good flow of communications exists between the primary first responders of a community so that each knows the actions of the other and a concerted one voice is represented for all first responders. Most fire responders, when questioned about their inter-agency coordination levels and actions, reply that they will judge the level of response protection of an incident by the local symptoms indicated in policemen, civilians and other personnel already on the scene. A semi-popular concept known as the "blue canary syndrome" where the blue uniforms of downed LER is what tells a firefighter to use extreme caution. As a means of preventing the blue canary syndrome LER roles are specific in many training courses offered by DOJ, DOD, the Federal Emergency Management Agency (FEMA) and the FBI. A sequential summary of the roles is as follows:

Review of LER Roles in a WMD/CW/BW Incident

1. Self Protection - Avoid contamination, approach slowly from upwind/use PPE.

2. Protect the Team - Use Two Man Concept and Buddy Team analysis of PPE.
3. Secure the Scene - Avoid contamination by using safe sided hazard zones established by quantifiable limited detection measures.
4. Identify Hazards - Fire Department and Hazmat personnel are better suited, but the factor of time is critical here. LER first on the scene must identify hazards (vapor, liquid, odors, victim symptoms etc-) to reduce immediate risks. This is where Government Issue M8 paper, M9 tape and M256 Kits are used.
5. Assess the Situation - Identification taken to the next level. Look at all the 5 WTMs. Contain the site and victims/contaminated personnel and prevent agent spread by use of updated hazard zones.
6. Notify and Obtain Assistance - Mobilize additional manpower for and site security and request state and federal assistance through channels. Average time a LER must be prepared to operate without federal assistance can range from 30 minutes to 6 hours to 12 hours to 24 hours depending on the proximity of federal assets to the incident.
7. Site Entry Decision - The urge to rush in should be over by now, casualties and victims are evident and depending on the PPE readiness of on site LER, select LER maybe tasked to enter hot zone for rescue operations if situation warrants. Confidence in on hand equipment and LER ability to properly use the equipment is crucial in preventing entry LER from becoming contaminated, exposed or victims of the problem.
8. Conduct Response - In the LER role of evidence gathering, the safety of people and responders take priority. Actual response by specific LER under contaminated NBC conditions while interdicting, presenting a warrant or charging a barricaded hostage situation must be tailored to the situation. All forms of respiratory protection, from SCBA to negative pressure, have roles to play in preserving the LER force.
9. Incident Command or Unified Command - A LER may be the Incident Commander. Criminal scene with an ongoing crisis requires a LER as the IC. Crisis changes to consequence management and LER transition IC duties to fire personnel and allow FEMA/Fire responders to recover the site and preserve well being. LERs in former IC crisis role now goes back to routine alert posture for possible counter strike or reaction to a non-lethal situation.

Respiratory Personal Protective Equipment (RPPE)

Success for the Law Enforcement Responder (LER) in the previous nine roles hinges on several factors. Factors such as accurate communications, timely command and control, weapons technology appropriate for the situation, Respiratory Personal Protective Equipment (RPPE), suit/glove and boot PPE, interagency measures, rules of engagement and a host of other intrinsic and external factors that guarantee success under any scenario/incident conditions. Of all those factors the one that is a lynchpin is the factor of RPPE. If you cannot see 20/20 due to low nerve agent exposure miotic effects, as a responder you will not be able to accurately engage a target, negotiate the obstacle or command the response effectively. If you cannot breathe due to toxic vapors exposure, a LER will exhibit mild or severe symptoms of toxic agent poisoning and be ineffective. Respiratory Personal Protective Equipment (RPPE) provides that lynchpin of protection. Are Law Enforcement Responders protected in a Chemical, Toxic Industrial, Biological, Radiological or Nuclear contamination terrorism incident? If they use specialized RPPE devices- Yes, they would have respiratory protection. If they use current equipment configurations equivalent to US EPA Level D- the answer is No. Of all the law enforcement departments observed and spoken with, 80% of them have no respirators issued to the line officer. The same officer

that has a higher 911 response time, on average, than other first responders has no respiratory protection to don when presented with multiple indicators of a WMD/CW/BW incident. Of the 20% that do have select respirators issued to line and/or Swat, the RPPE consists of one-time use disposable hoods or waist belt carriers with military spec gas masks and canisters. After researching the law enforcement market, the following 10 different respirator protective postures were found to be the most common in the US. They are as follows:

1. Tight Fitting Full Facepiece "Gas Mask" with rated NBC Mil Spec Canister.
 - When RPPE is issued to the force this posture is the most popular.
 - Most of these masks have no protective shrouds/hoods with them.
 - Canister can be mounted at the chin or the left or right side of cheek.
2. Disposable Evacuate Canister Device.
 - Nondescript, one time use device that provides limited protection
 - Emergency Escape Smoke Hood that allows wearer to breath filtered air for up to 20 minutes
3. ½ Mask or ¼ Mask with Industrial Rated Cartridges
 - Used for scene post investigation
 - Offers no protection to the eyes
 - Popular device used by the Bureau of Alcohol, Tobacco and Firearms (APF)
 - Disposable Particulate Respirators are half masks which have no cartridges and are very pliable in nature.
4. Self Contained Breathing Apparatus (SCBA)
 - 30, 45 and 60 minute compressed air cylinders in back frames or vests.
 - 60 minute cylinder is most common amongst Swat
 - Some cities/counties have Swat with SCBA's instead of "gas masks" or both.
5. Combination Loose Fitting/Single Neck Band Hood with Built In Rated Canister.
 - Gray Impermeable hood with chin canister
 - "Gas mask" is an example.
 - Small and compact
 - Offers benefits of tight fitting without the need for pre-use fit testing
 - 15 minutes of protection for escape
 - 5 year shelf life.
6. Powered Air Purifying Respirator (PAPR) with Tight Fitting Fullface Respirator and Rated NBC Canisters, with or without butyl shroud/hood
 - Mounted on waist belt or built into a vest.
 - Just now being recognized for use by tactical Swat.
 - Provides longer wear time due to lower wearer stress.
7. PAPR with Loose Fitting Hood/Cape/Shroud and Rated NBC Canisters
 - Provides respiratory protection without the use of a tight fitting head harness
 - Lose of powered air over pressurization can compromise seal performance

8. Escape Self Contained Breathing Apparatus (SCBA)
 - 5 or 10 minute emergency escape breathing respirators
 - Utilizes a tight fitting Facepiece.
 - Not designed for rescue operations due to short air supply
9. Victim Rescue Units (VRU)
 - An escape SCBA
 - Used in Marine Rescue for Downed Aircraft
 - Adaptable to Ground/Land Use
10. Rain Gear, top and bottom, Rain gloves, Duty boots, and No Respirator
 - Poncho or rain suit are routine issue items to line police officer
 - No respirator as standard issue
 - 80% of LERs have this protective posture on hand 100% of the time

These 10 postures reflect a cross spectrum of LER individual protection used in the field. With Law Enforcement Responders responding to 911 calls at a somewhat higher rate than other emergency responders, it makes good sense that individual respiratory devices should be in every squad car at municipality level and higher. Respiratory protection that is not standardized, uses multiple manufacturer sources, has communications compatibility challenges and requires routine training of use should convince a police decision maker to change a less than lethal equipment item into a lethal support item. This mind set change should enhance the readiness serviceability of the LER RPPE program. As sure as the LER is not prepared or takes the WMD/CW/BW as a non-threat, the WMD Chemical agent incident will occur and "blue canaries" will not just be something to kid about at Hazmat training or seen in pet stores. Law enforcement blue uniform officers will be casualties on the scene if not protected. Law enforcement intelligence estimates require WMD/CW/BW threat indicators integrated into local standard operating procedures. The ability for a police person to avoid being contaminated is as simple as maintaining a training edge on weapon proficiency, physical fitness or hand to hand combat. "Gas Mask" training should compliment routine law enforcement tasks and provide compact, inexpensive equipment to the Law Responder. Civilian Field Expedient Protection (CFEP) is the short term answer to providing LER with immediate breathing zone and skin protection against CTBRN agents.

Civilian Field Expedient Protection (CFEP)

Ask a Special Weapons and Tactics Team (SWAT) officer or line police officer to get ready for a WMD Terrorism response and various uniform configurations will result. Now take those same officers and train them at the DOJ Center for Domestic Preparedness (CDP), Anniston, AL and those officers will respond in appropriate protective postures. The untrained police officer will respond to a potential WMD call with exposed skin and maybe some form of respirator on. After CDP training, they will know to have fullface respirator protection, minimal or full skin protection and the ability to use TRACEM-P (TRACEM-Psychological) and B-NICE (Biological, Nuclear, Incendiary, Chemical and Explosive agents/materials) concepts to preserve themselves and the force.

CFEP is a plus up to the recognized US EPA level D protective posture. It is an "in between" level D and level C protective posture that is used to protect the wearer's respiratory, visual and upper head exposed skin areas coupled with butyl gloves for the hands. Take Level D normal work uniform, add a respirator with butyl shroud on the respirator and butyl/neoprene gloves and the end user is wearing Civilian Field Expedient Protection (CFEP). CFEP provides immediate respiratory protection, immediate visual protection; limited skin protection and the ability to conduct escape operations under Non-Immediately Dangerous to Life or Health (Non-IDLH) conditions. United States Environmental Protection Agency (EPA) levels A - D protective postures provide routine protective uniform guidance to all emergency responders. Couple the EPA guidance with the US National Fire Protection Association (NFPA) 1991 compliance levels, the NFPA, to be published, 1994 CW/BW Counter Terrorism regulation and the US

Occupational Safety and Health Administration (OSHA) protective guidance and it is clear to see that the Level C protective posture is slated to be a very common protective posture for responders supporting a suspected WMD/CW/BW incident. Level C hazardous materials protective posture is attained by using a rated respirator system, a full body impermeable suit with or without hood, impermeable gloves and disposable impermeable booties. Given proper reaction time a LER can upgrade his CFEP to level C with the addition of impermeable suit and butyl booties.

CFEP is an inexpensive, compact, simple and practical means for every law enforcement officer to have minimal protection in the Age of Terrorism. CFEP is designed as a splash protection and vapor barrier to toxic substances on exposed skin. It provides escape/egress protection to the first on - the - scene responder. A practical concept that will provide minimum protection to enhance level D and support levels C and B if necessary. CFEP is also usable as a protective posture where there is no liquid hazard, just a vapor hazard. Examples would be the warm zone/cold zone transition line, decontamination vapor contamination control line or site escort duty of gross decontaminated personnel. CFEP can be adapted from 9 of the 10 RPPE postures by adding impermeable gloves and/or a butyl shroud to the respirator. CFEP can also support protecting prisoners in transit from point A to point B while protecting corrections officers from oral fluid contamination and bites. CFEP supports riot control situations as well where there is a high ambient concentration of riot control agent (CS) that will irritate moist skin surfaces. Toxic industrial liquids, vapors and particulate are stopped by the butyl coated nylon shroud making the CFEP usable in limited toxic industrial settings as well as protecting against TIME that might be used in terrorism. CFEP, the immediate answer to reusable respiratory and skin protection for law enforcement, could be the inexpensive posture that every policeman in the United States could benefit from.

Regulatory Agencies

Civilian Field Expedient Protection (CFEP) supports the law enforcement priorities of life safety, incident stabilization and local property/environmental concerns by providing a quick and easy suitable escape device capable of providing protection to all law enforcement officers at an economical price. In the manufacturing of select respirator devices whether it is SCBA, APR or a respirator for CFEP, regulatory approval standards must be in place. These standards allow the commercialization of a product to support commercial demand. WMD Terrorism has created a commercial demand for regulatory approved protective and detection equipment. Standards that are generated in support of this demand will allow the acceptable casualty liability theory to change to a no casualty liability concept for military specified equipment used in the commercial market to combat domestic terrorism. So what regulatory agency approval does a police chief rely on to ensure the purchase of a reliable piece of equipment? What agency establishes Live Agent Testing (LAT) of chemical warfare and biological warfare agents against equipment intended for the domestic preparedness market? Eight different agencies, some government regulatory and others non-profit associations, offer guidelines or use parameters for respiratory personal protective equipment selection. Of the eight agencies, DOD, DOE, NIOSH/MSHA, OSHA, NFPA, NIJ/DOJ, EPA and the new Federal Inter-Agency Board (IAB) of the DOJ and DOD, the only agency that currently approves respirators for commercial use is NIOSH/MSHA. With the US FBI being the mentor governmental agency for local law enforcement in the US, the National Institute of Justice (NIJ) of the Department of Justice (DOJ) might be seen as a potential approval authority for select law enforcement equipment. As Mr. John Dower and Mr. Rich Metzler of NIOSH pursue the ultimate goal of generating specific regulatory standards for commercial respiratory PPE in the use against military or terrorist grade WMD/CW/BW agents, the current police executive is in a quandary about what approvals, if any, are needed when using military specified protective gas masks against terrorist grade CW/BW terrorism.

The US Department of Defense (DOD) has used military specifications for respirators to protect service personnel for over 80 years and just recently NASA is working on cutting edge level A suit system technology for first responders. DOD has a requirement of protecting the largest proficient military incorporational compromise mission success by transferring all of its technology to commercial manufacturers for domestic preparedness. DOD is focused on the battlefield of the year 2030 and

terrorism is just one of the areas of concern. In addition to this National Security constraint/perspective another challenge exists with the uncontrolled use of outdated DOD items found in civilian police stations across the US. The aged M17A1 bi-ocular pre-M40 facepiece, with its "ram tough" cheek pouch filters, is still being used, not by DOD personnel, but by national police departments who got it for free, buy it from military installation Defense Re-utilization Material Offices (DRMO) auctions or might buy it out of the box at commercial Army surplus stores. Chapter 153, Title 10, United States Code, amendment 2576b and section 1707, permit surplus military equipment to be given to commercial fire and emergency medical service agencies. The equipment that has no NIOSH approval yet. The danger here is the use of these products without logistical support on expendable parts of the respirators, expired filters and maintenance posi-check of the mask performance. Expired filters will stop riot control particulate but not lethal Organo-phosphorous nerve agents. The Police Chief that does not conduct a thorough logistical inventory serviceability check of on-hand equipment risks subjecting LER to unnecessary exposure/contamination. Police chiefs must rely on a limited range of NIOSH approved respiratory products for NBC defense. As new NIOSH joint agency protocols are established military specified equipment will gain NIOSH approval provided it meets complete approval standards for commercial use.

You Bought the Respirators, Now Integrate Them

With the advent of US Department of Justice Domestic Preparedness grant programs for 120/157/176 eligible US jurisdictions/cities and 50 states, municipality public safety and state emergency management personnel are establishing risk assessments of their cities/counties and ordering/buying new respirators and other PPE. Manufacturers are making respirators and respirator systems at peak manufacturing capabilities. Manufacturers continue to have banner years in respirator system sales. Law enforcement responders should not let new respirators go by the maintenance wayside. Without a viable maintenance program at the operator level, respirators will not meet manufacturer performance standards. Respirators will fail due to lack of operator maintenance and cause possible fatal results if used under toxic conditions. Just as an individual weapon is maintained and cleaned daily, respirators, in regular use, require operator and technical maintenance checks. Integration of a new respirator product to the police force requires SOP adjustment, operator, unit and squad/department training, interagency training, IC event integration, local emergency management integration, communications procedures while masked, change out criteria for the canisters and what level of issue is the mask used (entire force, select members, Swat only, is it carried on the waist, in the trunk, in the station? etc.). What training stockages of NBC canisters are needed? One set of canisters for training and two sets of canisters for contingency response should be allocated per officer mask. Should you have extra respirators for called up reserves, perpetrators, civilians or other responders in mutual aid? If the emergency management plan calls for mutual aid from adjacent responders they should come properly outfitted. The worse thing that could happen is to buy respirators with DOJ grant funding, never use them, get audited by DOJ and have the mask fail in a tactical engagement. The proper use of respirators supports lethal tactical operations.

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Live Agent Testing/Training (LAT)

Law enforcement training academies, fire training academies and emergency medical courses use realistic training methods to prepare and train responders for real world specific public safety situations. Live Agent Testing and Training (LAT) for all first and follow on responders and their equipment to Weapons of Mass Destruction Chemical Warfare/Biological Warfare (WMD/CW/BW) agents is a recommended mandatory requirement for any responder and responder equipment identified for that environment. LAT instills confidence in respiratory equipment, the first line of defense, detection measures, personal abilities and teamwork. The limits of equipment and personnel are determined by live chemical warfare agent controlled contamination exercises in EPA approved facilities. The National Domestic Preparedness Training Consortium operates several facilities in the US but only one, the CDP, is for actual training of first responders in chemical warfare defense. The DOD currently does LAT of equipment (both commercial and military) until NIOSH protocol is established. Just as the NFPA is the

"official" recognition of fire safety, the US Army is the official DOD agency for LAT of National Domestic Preparedness Equipment. The co-chaired DOD/DOJ Inter-Agency Board for Equipment Standardization and Operability (IAB) generates a Standardized Equipment Listing (SEL) for responder municipalities to voluntarily use when selecting equipment purchases funded by the US Department of Justice. LAT of the items on the SEL is a vital component for rating the equipment for use in a WMD/CW/BW incident just as a NIOSH bench test is used for approval of commercial negative pressure cartridges. LAT plays a lynchpin role in separating the quality domestic preparedness PPE from the inferior standard domestic preparedness PPE. LAT results that meet specific standards set by military specifications or the "to be published NIOSH joint protocols" must fully support the complete spectrum of end users. The responder community and civilians have individual respirator needs very much like the days of the US Civil Defense program when responders worked with emergency managers to protect civilians by using underground nuclear defense shelters. Civilian Field Expedient Protection (CFEP) can provide egress protection to law enforcement, medical services, fire, hazmat, federal responders, utility workers, hospital off site staff, airport/arena security workers, emergency operations centers and remote 911 operations centers. Live Agent Testing of CFEP should involve exposure of the items to liquid mustard, lewisite, sarin, and select Toxic Industrial Materials for permeability rates and breakthrough service data..

A successful Civilian Field Expedient Protection system should provide a minimum of 30 minutes of complete protection from any specific tested military or terrorist grade concentration. Upon completion of a successful live agent testing, a CFEP system should allow a LER to perform a tactical mission under Non-IDLH conditions with minimal harm. Considerably less harm than facing a 5.56mm round or a 9mm round being fired at a Law Enforcement Responder from a fleeing terrorist in a confined highway tunnel system.

Conclusion

With the addition of Live Agent Tested (LAT) individual protective full face respirators, shrouds and NBC canisters, Law Enforcement Responders (LER) can survive WMD/CW/BW (CTBRN) incidents that are non-persistent toxic chemical warfare agents, pathogenic biological particulate and/or radiological particulate. This is the first step in overcoming a Chemical or Biological agent terrorism attack. Law Enforcement Responders can be protected in non persistent Chemical, Toxic Industrial, Biological, Radiological and/or Nuclear (CTBRN) Weapons of Mass Destruction (WMD) terrorism incidents provided they use some form of Live Agent Tested (LAT) Civilian Field Expedient Protection at the minimum. Areas that need further development consist of protecting the responder from semi - persistent and persistent chemical and industrial persistent chemical toxic liquid agents and biological virus exposure. Administrative control measures that need improved are the establishment of NBC canister change out criteria, if used in multiple attacks, and the need to increase compatibility between different municipal/county/state and federal inter agency responders. An analysis of the biological attack response portion of the TOPOFF three day exercise (May 20-23, 2000) proved that the interagency leadership must be decisive, that public health agencies need additional personnel in times of crisis and that command and control lines of crisis and consequence management will become blurred at many times (in other words, who is in charge?) resulting in civil unrest, overloaded hospitals and significant cross contamination of the general public from contagious exposed civilians. Law Enforcement Responders (LER) play an important role in WMD mass casualty incidents. US Swat teams from Houston, TX, Phoenix, AZ, Jefferson City, MO, Springfield, IL and Buffalo, NY have or are developing internal equipment needs based on credible threat assessments. They are designing WMD response plans in support of detecting, mitigating and containing the effects of a true CTBRN terrorism incident. Of all commercial law officers, Special Weapons and Tactics (SWAT) Teams are the most aggressive in planning and training for surviving in a contaminated mission posture. Conversely, the routine patrol officer that does vehicular traffic, DOT inspections or routine public safety in the local municipality or state is in dire need of escape/egress respiratory and skin protection from caustic vapors and liquids designed for immediate lethality or incapacitation.

There are no "industrial safe sided Time Weighted Averages (TWA) or Biological Exposure Indices (BE) concepts" in the art of chemical or biological warfare, the terrorist knows that. With Permissive Exposure Limits (PEL) for GB, the most common of nerve agents, in the 0.00002 Parts Per Million (PPE) range, one pin head drop of pure GB will put the unprotected responder into mild or severe nerve agent poisoning shock in seconds to minutes. Training with on hand equipment is the immediate answer coupled with improved rated equipment that provides initial Civilian Field Expedient Protection (CFEP) to all deployed and static law enforcement personnel. These factors will ensure that a patrol officer, a SWAT team member or a command post tactician or leader has the minimum respiratory and exposed skin protection required to survive being contaminated by toxic lethal Chemical, Industrial, Biological and/or Radiological agents in multiple environmental and tactical situations.

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The Evolution of a Filter Family †

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Abstract

This paper describes the evolution of a filter-family from the early 90's into the new Millennium. Evolution instead of development was chosen, because the process to create a filter-family is like an evolution where the most fitted will survive. In this paper basic information about the filters is presented - the dimensions of the filters and their properties for gas and particle filtration. Also comparisons to older filters and filters of other producers are made and the results are discussed. In house test results as well as results from independent test laboratories are presented.

Introduction

In the beginning of the 90's, in Kemira Safety, we realized that our filters were old and old-fashioned. They were big and bulky, had gas capacities far over the minimum requirements of the new EN standards and had relatively high breathing resistance. However the filters were selling better than ever before, a steady growth of 2-3% per year. So it was not an easy decision, to go for a new filter generation. In the laboratory we started in 1991 to look at suitable filtration media, different types of activated carbon and fibreglass media, canister-materials and production technologies, to see what kind of goal we could set up for our new filter series. In 1992, Kemira Safety was awarded the contract for developing and producing a new NBC-filter for the Finnish military. By combining resources we now had the splendid opportunity to also develop a new filter for the industrial market. In this paper I will discuss the reasons for making the choices we did, with respect to filter dimensions, materials and technologies. The performances of the different end products are compared with older versions and products from other producers. Finally I will show that in a changing world, that development work will never end and the product developer will never come to the "final product!" The headline "evolution" (instead of development) is used because the process is more like an evolution. Because of standards requirements, customer needs, available materials, production technologies and market competition the products are "evolving" and only the most fitted will survive.

Product Family

The first approach was to make one canister for both military use and industrial use. EN standards minimum-requirement and the Finnish army performance specification did not fit together. From the laboratory work we did 1991 we had a pretty good knowledge of what would be achievable and what would not. It was evident that the carbon amount of the military filter had to be reduced to such a small amount, to meet the airflow resistance (30 l/min = 140 Pa and 95 l/min = 500 Pa) with the specified carbon type, that the filter size would not meet EN141 (1) class 2. The army specification specified