3M Transcript for the following interview: 94 David Crouch - CBRN Respiratory Protection Part 1

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(R) Welcome to the 3M Science of Safety podcast presented by 3M Australia and New Zealand Personal Safety Division. This is a podcast that is curious about the science and systems of all things work, health and safety, that keep workers safe and protect their health. I am Mark Reggers, an occupational hygienist, who likes to ask the questions Why, How, and Please Explain. Whether you are a safety professional, occupational hygienist, or someone with any level of WHS responsibility in the workplace, maybe you are a user of safety equipment or maybe you are a bit of a safety nerd who finds this stuff really interesting, then this is a podcast for you.

(R) Today we're talking all about CBRN respiratory protection with David Crouch. Welcome, David.

(C) Hi Mark, it's great to be here.

(R) Now you're all the way over in the UK and I'm here in Australia. I hope you're doing well. So we're using the power of technology to have this chat. But can you please introduce yourself? Who are you and where you from?

(C) Thank you very much for that kind introduction Mark. So, my name is David Crouch. I am 3M's global subject matter expert in application engineering for our defence and public safety vertical. My background - I'm based in the UK. I'm a professional chemist by trade. I have more than 25 years' experience in CBRN and with filter science and aerosol delivery science as well, so my background is heavily respiratory protection with decontamination and disinfection. And that's both at the academic level and the end user level. So I have got extensive experience of working in extreme hazardous environments. So CBRN, civil, nuclear and this is across the globe with I've worked formerly with NATO, with the U. S. Government, UK government and other agencies, and as a result, I've got a lot of external activities. So I'm a professor of the Defence Academy of the UK and a senior associate fellow within the Royal United Services Institute and I also represent 3M at a lot of other external agencies such as CBRN UK - which is the UK's trade forum for companies involved in CBRN protection - and also many international ISO and CEN committees on CBRN from a respiratory protection perspective. So that's kind of me as a background.

(R) Now you have mentioned CBRN or “C-Burn”, as it’s sometimes pronounced, but what is CBRN for those that may not have heard of this acronym before?

(C) So that's often a forgotten question Mark, so that's a very good one to start with. As you mentioned, CBRN, or sometimes pronounced, “C-Burn” is an acronym for Chemical, Biological, Radiological and Nuclear, and it commonly used, worldwide to refer to malicious incidents or weapons in which any of the four types of hazards have been used. We're talking here about malicious intent, so terrorism-type activities.

(R) So where does that term come from? Is there a history behind that term? Is it known as other things in the past as well?

(C) So C-Burn or CBRN was a replacement for the older Cold War terms, so previously it was known as NBC, which stood for Nuclear, Biological and Chemical, and then, prior to that, in the 1950s and 1960s, it was known as ABC, so Atomic, Biological and Chemical.

(R) So has there been, a long history of chemical warfare to have such, a history of terms for respiratory protection in this space. I mean, does this come up that often in the world?

(C) In terms of actual events, it's quite rare. There have been ones more topical recently, such a Salisbury. But in terms of a history, it stems from antiquity. So, the Spartans were the first recorded nation or country, depending on which, where you look at life in terms of, the first use off a chemical to provide some sort of incapacitation of fellow man or human beings. So in 429 BC in Plataea, they used liquid fire, so pitch and sulfur powders were burnt to provide an incapacitant to besiege the city. But in modern use of chemical warfare agents, the history for mass use of these agents really stems from the First World War and its use on the battlefield. So the often traditional view in northern France and Belgium is the release of things like chlorine gas and other chemical agents, but that's not where it stopped. It's being used all throughout the last century, so it was used in Ethiopia, Africa for example, the Iran-Iraq war in the 1980s. And there’s also been terrorist releases of chemical warfare agents. So Tokyo, in 1995 and it has been released from a malicious terrorist type activity in both Syria and Iraq from 2014 onwards, and legacy munitions from both the 1st and 2nd World War are still being found today in places like France and Belgium, even Germany and as far afield as China.

(R) So if we bring it to today's time, are the different types of chemical threats that in this space these agents get classified as?

(C) So again, very good question, Mark. Traditionally, there are three types of chemical threats that the world considers. There's chemical warfare agents themselves, which are listed under the Chemical Weapons Convention of 1993. The Organization for the Prohibition of Chemical Warfare, they look after what is known as the articles within the convention, schedules one, two and three. They are chemical warfare agents, and then we have toxic industrial chemicals and materials which do have some legitimate industrial purposes, but they're still highly toxic. And then we have things like chemical toxins. Chemical toxins are toxic chemicals, but they're produced by living organisms. Ricin, for example, is considered as a chemical toxin because it can be extracted from castor beans, which is essentially a living organism. And then, in terms of chemical warfare agents themselves, depending on their mode of action on a human being, they can be then classified into things such as nerve agents, which effect obviously, nerve transmission. Then we have things like blister agents, the infamous mustard gas, even though it's not a gas, it's a persistent liquid that is known as a blister agent. And then we have other agents such as pulmonary agents, which affect your ability to breathe, things like phosgene or chloropicrin. And then finally, we have things like blood agents such as hydrogen cyanide, cyanogen chloride, which will prevent the transfer of energy within the body. They bind and interact and affect your haemoglobin within your blood system so they're preventing the transfer of oxygen within the system.

(R) You mentioned a couple of how many in total roughly is there of these type of chemical warfare agents. I mean, you've mentioned some, but I'm sure there's a lot more people probably don't appreciate.

(C) Officially, there's 43 registered compounds on schedules one, two and three of the Chemical Weapons Convention. But there are others, that aren't listed on the Chemical Weapons Convention. So Novichok, the Soviet newcomer agents. They are not formally listed on the Chemical Weapons Convention yet, but they are going through the ratification stage as a result of the Salisbury incident of 2018. At the moment, there's 43 registered on the Chemical Weapons Convention.

(R) Probably a bit more than I thought, but I don't really spend too much time thinking about all these nasty toxic chemical agents that are out there. Talking about biological threats. What are some of those different types that you think about in this particular space?

(C) Biological is very much nature's cauldron. Here we're talking rather than kind of man-made chemicals, we are talking about natural diseases that have been perverted for use as biological weapons. Within the biological weapon and toxin convention, which is a similar structure to the Chemical Weapons Convention, we're looking here at almost any disease-causing organism can be used as a bioweapon. So here we're talking about bacteria, viruses, fungi, prions and rickettsia and toxins themselves. I've already mentioned ricin there are others. But in terms of bacteria, we are looking at things like anthrax. Anthrax is a natural disease, very prevalent in cattle. It can be found all over the world. Australia, for example, has natural outbreaks of anthrax every now and again. And then there's other agents, which are topical in the news at the moment. So, yersinia pestis, which is commonly known as pneumonic plague, that occurs now and again as a natural outbreak, and then other bacteria can include tularemia, glanders and brucellosis. And then viruses - very topical within the world at the moment with coronavirus. Obviously, that's not a biological weapon, but in terms of bioweapons that are recognized are things like smallpox and viral hemorrhagic fevers, such as ebola or marburg and then with the rickettsia, things like Q fever and typhus. And I've also mentioned toxins. So there are others. There's SEB intoxication and things like botulinum and I've already mentioned ricin.

(R) Do they all have a similar incubation period, like obviously being natural biological agents, are they similar and how they affect people. Or have we got a whole range of different impacts and why these would be selected as a biological weapon.

(C) It's very much as with any CBRN agent for malicious use. It's very much what you're trying to achieve. So from a biological perspective, the incubation period for something like pneumonic plague is very short. We're only talking a few hours. And you don't need many organisms per se. You're only talking between 100 and 500 organisms to give you an infectious dose, however, things like anthrax and tularemia can be anywhere between 1 and 14 days for tularemia or between two and seven days for anthracis - so for anthrax. And again, for something like anthrax, you need a much bigger dose, typically between 8,000 and 50,000 spores or vegetative bacteria to give you an infectious dose. So again, it's very much what the would-be realeaser is trying to achieve. So again, there's very different broad spectrum of ranges of incubation periods and modes of transmission and also infectious doses.

(R) Now moving on to the radiological threats. Can you explain those type of hazards from a chemical warfare point of view of the different types of radiation that people should be aware of when thinking about protection in this space?

(C) So radiological is kind of a lot more developed and understood because it's commonly used from a non-malicious perspective - so, the civil nuclear world. So it is used, radiation is used in medical healthcare, power generation. So again it's been much more widely studied than, say, chemical warfare agents. So radioactive materials are natural, or most of them are natural anyway. They can emit various types of hazards so they can emit both the particulate hazard and electromagnetic radiation. So the four kind of common hazards that we look at within a radiological sphere - there are others - but the four most common ones are alpha radiation, which is essentially a helium nucleus that is ejected under certain conditions from, an atom trying to maintain stability. So, alpha radiation, it's a big molecule that it's quite slow in terms of its speed, but it can only travel a few centimeters in air or micrometers in human tissue, but they can be highly charged. So again they can transmit a lot of energy locally, so they're quite dangerous as a short range hazard. Then we move on to the more energetic beta particles, beta radiation, which is essentially a negatively charged electron. So here we're just talking about electrons. There are anti-particles such as positrons, which are positively charged electrons. But I don't want to get into a discussion on nuclear physics today. But beta radiation can travel several centimeters in air to some meters, depending on the energy of the particle. So again, alpha and beta particles can be stopped with normal type materials. And then we move into the very high energy regime such as neutron radiation and gamma radiation. Now, gamma radiation is very, is electromagnetic radiation of very high frequency. So gamma radiation will pass straight through a human being and it's very difficult to attenuate. So here we're talking protection about things like concrete, specialist concrete and extreme lead lining. So again, radiation hazards. These are the hazards that are omitted by radioactive materials and isotopes. However, we must also consider the actual isotope itself because radioisotopes can be one of different chemical background. So again there's a radiation exposure hazard and then there's a chemical exposure hazard.

(R) So with these different types of radiation, is it a particulate or gas and vapor? I'm just trying to think of how I think about industrial hazards and what form that hazard takes. When we're talking about radiological protection, what are we looking at in that area ?

(C) So again, very good question. And again because I've mentioned the alpha and beta particles are particulate in nature, one would often assume that just using a P3 or P100 particulate filter will provide you with the correct protection. But again, as I mentioned, it's not just the radiation that is emitted that people must consider from a risk assessment perspective. The physical form of the isotope will dictate the respiratory requirement and that's a key learning point. So, yes, we can have, say, iodine 131 which will emit a beta particle so it's emitting particles. But it's still an iodine parent. So, in terms of respiratory protection, a P100/P3 particulate filter will not remove iodine vapor. We need a combination gas and particulate filter. We need the particulate filter to stop the beta particles, but we need the gas and vapor side of the cartridge or filter to protect against the iodine vapor that is emitting the beta particles. So again, this is where, from a radiological perspective, you must have stringent risk assessments when working with these materials to make sure that there's no excessive exposure from a dose perspective.

(R) And this is certainly not my area, but we start talking about Isotopes of Special Interest. What is that all about?

(C) So if you look at the basics of radiological science, there's a diverse range of radioactive isotopes. If you look in standard texts its around 2,800 isotopes that are known globally at the moment and increasing all the time with new elements that are discovered. And there's about 2,800 isotopes over about 100 different chemical elements. So some isotopes, like plutonium, will have different isotopes and the same with things like uranium. So, if we were considering as a company if 3M and wanted to produce a filter guide for 2,800 isotopes, it would be a very big document. So again, and a lot of these isotopes are so rare, you would very rarely see them in industry or if it all and some of them have such short half-lives that they won't exist for very long. So again, from a protection perspective, you're very unlikely to see them. However, from an Isotopes of Special Interest - and remember, here we're considering CBRN and malicious releases - so we can narrow the problem down from 2,800 isotopes to a relatively small number. And this is based on the isotope having a sufficiently long half-life to cause problems in the environment, if it was released and if it's available in quantity. So, whoever the would-be releaser is, we would be talking about significant quantities, grams, if not kilograms of material. So here we're talking about things from radioactive waste from a nuclear power station or things that exist within a medical setting. So, from a medical physics perspective, things like cobalt 60, selenium 75 or iridium 192. So, iridium and selenium are used in brachytherapy in certain types of cancer treatment, and then on the nuclear waste side, we're talking things like plutonium, americium, strontium and cesium. Strontium and cesium are highly active waste products from nuclear waste, so they emit beta particles to relatively high energy and half-life of around 30 years. So again, problematical from a first responder CBRN community perspective if they were encountered.

(R) That is a lot of different type of chemicals on top of the biological warfare. So, from a military/law enforcement/first responder hazard and risk assessment, what kind of the things that they are facing and how do they even start to prepare for this broad, diverse range of hazards to having one type of, protective product like a respirator?

(C) So again, very good question. And this has been a challenge for the first responder/first receiver military community for a long time and conversely, from an industrial perspective, from a company such as 3M to provide products and capability offerings that allows such responders to engage in such environments effectively and safely. So in terms of examples on a biological perspective, most biological agents are particulate in nature. So again, most radiological hazards within the confines of the materials I've just mentioned, things like plutonium and uranium are particulate in nature. So they're fine powders. So again, from a purely respiratory protective perspective, things like a combination filter will provide very good performance with a high-performance respirator. And these are examples of where enhanced capability can be provided to the first responder community. But a lot of the time when people initially respond to these environments, they don't necessarily know it's a CBRN environment until they've had confirmation or casualties, for example. So again, having modular respiratory protection that can provide lots of different forms of classifications of respiratory protection is important to give the first responders who are very highly trained and trained on lots of different scenarios on a daily basis throughout the world. So they will practice biological and chemical regularly. They will do interagency radiological responses with lots of different national agencies - nuclear power stations for example. So having that ability to have a modular… as a child, I loved Lego as a reference point, so having that Lego kit approach to respiratory protection is very, very important from a performance perspective and also an efficiency perspective in terms of, allowing the first responded to meet all requirements, if there is such a thing.

(R) So, David, do you have any examples of any specific military or law enforcement first responder scenarios and the specific hazards that may arise from those scenarios?

(C) Because the topic of CBRN is so diverse, there can be a wide range of different environments that both the civilian worlds or law enforcement first responders, as opposed to military can operate in. So, for example, in a military environment, we're talking very much about battlefield operations here. So the more likelihood of something like a state-on-state requirement. So again, higher levels of protection from a military environment. But that's not to say that the law enforcement area and first responder isn't as important. So hazards they can face. A lot of the time it can be something as simple as, and it's covered under the CBRN specialism, is things like forensic recovery of malicious samples. So, if there's been a terrorist activity so people could be operating in, say, a public restaurant, so Salisbury's an example. So, when Alexander Litvinenko was unfortunately poisoned in London with polonium 210, police forces and first responders had to respond and recover samples in PPE in confined spaces. And that's not just from the forensic side, but also from the recovery side, the decontamination cleanup side. Other examples; law enforcement and first responders from an ambulatory perspective could turn up to chemically assisted suicides, where things like hydrogen sulfide and hydrogen cyanide may have been used, which again, high threat environments. So again, from an examples and risk perspective, CBRN operators can approach different environments, different concentrations, so it's a very diverse requirement set that they have to train for on a regular basis and have the equipment to provide the protection.

(R) I know when I think of typical industrial environments, where I probably spend most of my time helping our customers in that space, you're kind of dealing with a process and you know what's going into a process and likely, because it's very repetitive versus the environment you've just described. You've got to prepare for everything, not knowing where you may need everything. We may need a certain portion of that so really diverse and interesting… hence why it's a very specialist area and quite different to the typical industrial respirators that most of our listeners are probably familiar with and use themselves. But I've still got a lot more questions, so I might just wrap it up there. I was going to get you back to have another chat specifically about the products that are used in this space. But if you have to wrap up what we've spoken about this range of hazards, what would you want to leave with our listeners today?

(C) The key area for this is the hazard itself - your response needs to be appropriate to the hazard. And this is where key realistic, real time and regular training becomes very, very important, which is what we do with a lot of our 3M customers. So, for example, a biological threat is very likely to be a particulate hazard. So again, you only need a respirator and a particulate filter. You don't need to go in with kind of level A type suits and self-contained breathing apparatus all the time. There might be requirements, and this is again where your risk assessments and your respiratory protection program becomes really important. So understanding what pieces of equipment you need for which requirements. There's definitely no silver bullet with CBRN in terms of a full ensemble. It's very much an ongoing discussion and ongoing training requirement, so one size doesn't fit all. You need to have a flexible system to meet new cases all the time. So Salisbury, for example, that was against a brand new nerve agent. No one would have ever seen it in the field before. From a respiratory protection requirement, the products that were used were very much fit for purpose because a lot of it was down to the product itself being as good as it was, that was used as well as the training that went behind it. So that would be my key learning point for listeners who were interested in this area.

(R) Now we only spent a short amount of time chatting about some of this stuff. But is there any places online that you could recommend people who were interested to delve a bit deeper into this topic?

(C) Very much so. So, the Center for Disease Control in the US and the Department of Homeland Security and NIOSH have a lot of very good information on their websites. And if people are interested more on the chemical warfare side and radiological side, the two sites I would go to for chemical, definitely the OPCW website and on a radiological, the International Atomic Energy Agency, their website has a lot of really useful information on radiological protection in general, not just from a CBRN perspective.

(R) And we'll make those links available on our blog post for those so please do jump to that page and we'll have all those links available there. And for those listeners that would like to get in contact with you directly and have some very specific questions, what would be the best way to do that?

(C) If people want to contact me for further information, I'm more than happy. So just contact me through my email address, which is dcrouch@mmm.com or you can if you're on LinkedIn, I have a LinkedIn profile, which I'm more than happy to field questions there as well, or through yourself. Mark.

(R) Excellent. Well, thank you so much for your time. I am going to get you back to chat a bit more about the specific requirements around some of these actual products. But thank you so much for your time today, David. Really do appreciate it.

(C) No, that's my pleasure, Mark. Thank you very much for inviting me.

(R) Well, thanks for listening, everyone. You can get in contact with the show by sending an email to scienceofsafetyanz@mmm.com. If you have any questions, topic suggestions, or you'd like some assistance in your workplace when it comes to the appropriate selection, use and maintenance of PPE in your workplace. You can also visit our website mmm.com.au/sospodcast for further resources on CBRN respiratory as well as the transcript of the chat that David and I have just had. Plus, it has all the other episodes we have recorded. Be sure to subscribe, rate, review and share through Apple Podcast, Spotify, Google Podcast or wherever you get this podcast from. And as the Dalai Lama says, "Happiness is not something ready-made. It comes from your own actions." Well, thanks for listening and have a safe day.

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