Lieutenant Colonel Teong How Hwa, Director of the Hazardous Materials Department of the Singapore Civil Defence Force (SCDF), shares Singapore's response to dirty bomb incidents with *CBRNe World*

DiRDDy job, but somebody's got to do it...

CBRNe: What does the dirty bomb response consist of in Singapore's context?
THH: Response to dirty bombs will require the elements of speed and co-ordination to detect, identify, mitigate and contain the source, to prevent its further spread and ill-effects on people. Speed is critical in incidents involving radiological substances, as it affects time – one of the three key strategies for protecting people from over-exposure, which are time, distance and shielding. Besides management of the radiological source, quick rescue, evacuation and decontamination of casualties are paramount. Although the effects of low-level radiation may not be immediately apparent, there is a need to ensure affected casualties do not carry the radiological particles out of the contaminated zones and cause cross-contamination. Minimising cross-contamination is important considering the high population density of Singapore. By conducting personnel decontamination at site, affected persons will also be protected from ingesting or inhaling particles trapped on their clothes or body, which may cause internal contamination that would result in greater tissue damage. Management of casualties with trauma injury or internal radiological contamination would then be followed up at hospitals. Once rescue and mitigation of the source is completed, there is the mammoth task of terrain decontamination to make the site habitable.

CBRNe: What agencies are involved and how would response effort be co-ordinated?
THH: Such civil emergencies call for the involvement of various government agencies dealing with various matters, including security, health, environmental and social issues. In Singapore, the Government has assigned the SCDF to assume the role of Crisis Manager for all civil emergencies, and the SCDF has developed a national contingency plan to address any civil emergency situation – including CBRNE scenarios. This plan defines clearly the responsibilities of all the agencies that are involved in managing the incident. The plan gives the SCDF the mandate to co-ordinate and spearhead the overall mitigation and

To enhance the decontamination capabilities of SCDF, fire engines have been retrofitted with the necessary accessories like shower heads and canopy to enable decontamination of casualties in a CBRN incident ©SCDF

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TCV is fabricated with lead cladding to shield gamma radiation emitting from radioactive material present in a dirty bomb ©SCDF

intervention efforts. The plan is regularly updated and tested through annual exercises so we can continually validate operational principles and tactics, and hone co-ordination across agencies.

CBRNe: How long does it take for response to be mounted?
THH: To achieve an expedient response, the SCDF has trained and equipped all frontline responders to manage radiological incidents. This means there would be a response force arriving at any incident site within five-to-eight minutes of notification, which is the response time from the nearest fire station to almost every corner in Singapore. Each responder is equipped with an individually issued dosimeter and radiological detectors to locate and identify the radionuclide released. Lead bins are also available for containing the source to prevent it from spreading. Besides the frontline firefighters and rescuers who are trained to operate in CBRNe conditions, there is also a team of specialists who are on duty round-the-clock to provide on-site advice and situation analysis to ground commanders. The specialists will conduct predictive analysis through modelling tools to provide a quick assessment of the hazard zone. At the same time, they would respond to a site in the Hazmat Control Vehicles which are equipped with advanced detection and monitoring devices to provide accurate situational picture. One such vehicle which became operational last year caters specially for radiological incidents like a dirty bomb incident. Equipped with radiological detectors integrated through monitoring software, the vehicle can cover large areas quickly to identify the "hot" spots that needs attention. Germanium detectors on board also allows for high resolution identification of the radiological source.

Being the Incident Manager, the SCDF can deploy its fleet of five Forward Command Vehicles (FCVs) close to the site of any major incident to support on-scene command. To ensure a high state of readiness, the FCVs are placed on 24/7 standby within a notice-to-move time of ten minutes. At the site, the FCV can be deployed and fully set up for operations within 15 minutes. Meanwhile, officers from other related agencies would be activated through an automated recall system and would report to the FCV within one hour.

CBRNe: Things such as containment devices are heavy and not particularly mobile. Does this impose a logistic delay on the team?
THH: As an emergency response force, the SCDF needs to be ready to deploy its forces quickly. As such, all operational turnout appliances are designed with mobility in mind. This includes the Total Containment Vessel (TCV) which is fabricated with lead cladding to shield gamma radiation emitting from radioactive material present in a dirty bomb. The TCV, which weighs six tons, is pre-loaded onto a long-bed trailer – ready for turnout at all times. Once activated, a response vehicle will hook up the trailer and the system will be ready to roll out within ten minutes. Deployment of the TCV at an incident site is also made simple, as the operator is able to control and manoeuvre the TCV wirelessly into the hazard zone to carry out containment operations. The TCV can be operated by just one officer. Our officers also conduct regular drills to ensure readiness to respond to emergencies when it strikes.

CBRNe: Since personnel decontamination is conducted at the site, how is this carried out effectively, considering the high population density in Singapore, which would likely result in hundreds or thousands requiring decontamination?
THH: Given our high population density, an attack – if it occurs at an urban centre – would result in a mass-casualty scenario. Decontamination procedure needs to be quick and effective so casualties can be released from a contaminated site as quickly as possible. To achieve this, we maximised the use of our most available resource, which is our fire engines, especially since they are able to arrive quickly at scene within five-to-eight minutes. We have retrofitted our fire engines since 2002 with purpose-built decontamination facilities, using an integrated shower system. The decontamination facilities can be deployed within three minutes, and can clear up to 36 ambulant or six non-ambulant casualties per hour. In addition to the fire engines, we also designed a fleet of specialised vehicles known as the Personnel Decontamination Vehicle (PDV). This is a three-in-one appliance that can operate either as a mass-casualty decontamination facility and a mass-casualty ambulance, as well as a troop and equipment carrier. The PDV can be set-up in just seven minutes. The speed of deployment is a key advantage, as the PDV is able to render support swiftly. The PDVs are equipped with radiation walk-through portals which are useful for sifting out people who are contaminated who would require decontamination. This ensures there is no unnecessary waiting for those who are not affected. Besides the casualties who are still at site upon the SCDF's arrival, we are also mindful that some of those affected would have self-evacuated. To manage this group, instructions would be issued through the media for them to take appropriate action to wash and bag their clothes as soon as possible. Hospitals are also equipped with decontamination facilities and will be

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alerted to monitor walk-in casualties to check the need for conducting decontamination so as not to risk contaminating the hospitals.

CBRNe: Unlike conventional incidents like fire and industrial accidents, dirty bomb incidents are not encountered on a frequent basis. How does the SCDF ensure readiness of her forces to respond in the event of such an incident?
THH: Response to radiological incidents, like chemical or biological incidents, would entail the donning of personal protective clothing which is essential for protecting responders as they work in a hazardous environment. To ensure our responders are well trained to work in their protective gear, drills are conducted daily at all fire stations. They will don the full suits, masks and respirators and carry out physical activities, which include the carrying of hoses, stretcher drill with casualties, buddy rescue and aerobic exercise like jogging. This acclimatisation drill serves to ensure that our responders are well accustomed to don and operate in their protective suits while performing strenuous activities in our hot and humid equatorial climate.

Besides the acclimatisation drills, responders also attend certification tests twice annually. The certification test includes both theory and practical components to ensure responders' skills and knowledge are kept current. In addition, exercises based on a dirty bomb scenario are also conducted to validate various aspects of our contingency plans.

CBRNe: Is "dirty bomb" shorthand for just radiological dispersal devices (RDD), or is this for all explosive dissemination devices?
THH: Our use of the phrase "dirty bomb" focuses on radiological materials being dispersed through improvised explosive devices that are likely to cause mass casualties and panic due to its visibility and immediate effects from the bomb blast. It would be appropriate to classify a dirty bomb as a subset of RDDs, as the latter employ covert means of dispersion such that it may go undetected until deterministic effects of radiation starts exhibiting in victims, as in the Litvinenko case.

CBRNe: Is this the start of a capability or a complete package? What are the next growth steps?
THH: We started building our capability to handle TIC incidents in 1992. At that time the expertise was confined to only the fire stations that are near to industrial sites. Then came the Sarin attack in the Tokyo subway in 1995, which served as a catalyst for us to reshape our operational focus and priorities because we recognised such incidents could also happen in Singapore. In 1996, we started to expand our capability to handle chemical agent incidents. That was followed by biological agent response capability development, where detectors were acquired to detect, identify and mitigate the source. Basic levels of radiological capability were also available in the form of radiological detectors and dosimeters, but that was confined to only a few fire stations. Dirty bomb capability development took a quantum leap when the government appointed the SCDF as lead in building up the national capability for dirty bomb response in 2005. The project involves the development of a response doctrine, definition of different agencies' roles and responsibilities, and the training and procurement of specialised equipment and vehicles for the effective management of a dirty bomb incident. The doctrine and procurement has since been completed and relevant response agencies are now equipped and trained to carry out the full range of consequence management activities including detection and monitoring; casualty management; radioactive source and waste management and terrain decontamination.

Although skilled personnel and adequate equipping are important factors to ensure efficient response, there is a need to maintain an accurate overall situational picture in order to ensure effective incident management, especially in the event of a major incident. To enhance consequence management, the SCDF has employed advanced technology to develop the Hazmat Incident Management System, or HIMS. HIMS provides an intelligent knowledge fusion and visualisation interface for on-scene commanders and responders to access real-time situational information. Specially designed sensor interface boxes can be attached to detectors, like radiological detectors, chemical detectors and weather monitors for wireless transmission of real-time readings from the incident site. The readings would be used in predictive simulation models to provide a comprehensive situational picture to commanders to indicate how large an area might be affected by the hazard. HIMS greatly assists commanders during major emergencies in making informed decisions to ensure the most appropriate actions are taken to protect the public.

Going forward, the SCDF will continue to enhance her capabilities in consequence management through the development of both hardware and "heartware". Hardware development would be achieved through the continuous exploration of the latest technologies and also through innovative ways of doing things. Heartware will involve the upgrading of responder's skill and knowledge. Training must continue to evolve as new techniques are developed and new challenges emerge.

The HCV is equipped with a computer-aided zone modeling software mounted within the vehicle ©SCDF