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RADIATION REALISM

Steven Pike describes simulation to support training and compliance

In the rare event of exposure to high levels of radiation, contamination or a spill or release due to accident, nature or a deliberate act of aggression, it is crucial that exercise scenarios ensure those charged with initial response are trained to recognise, react to and contain the situation

Most radiation detection instruments are in themselves fairly straightforward to use. They ensure that trainees understand the full significance of detector readings that initiate any decisions or actions and the importance of changes in units of measurement. However, the effects of shielding, practice of survey, dose reduction, contamination avoidance, and decontamination procedures can be challenging to comprehend.

Hands-on experience

Equally important is the need to ensure those accountable for response management and stakeholder liaison with local and national authorities are well rehearsed in their organizational, decision making and communication processes. While theoretical understanding and classroom teaching will always have its place, nothing beats the experiential learning that can be acquired from life-like, hands-on search, monitoring and survey scenarios that accurately replicate both the complex physical conditions and the demanding psychological challenges of a live radiation incident.

The vast array of legislative, administrative and health and safety implications associated with storing, transporting and using live radiological sources or dispersing radioactive contaminants makes the use of live sources a challenging, if not unviable option for radiation safety training that simulation can help overcome.

Some typical scenarios

Training scenarios should be as simple as possible to set up – with the potential to be carried out in any location, perform consistently, and in the context of an individual or group exercise, provide the ability to review trainees' performance to enhance learning outcomes.

Students need to interpret instrumentation readings, understand the significance of any changes in the units of measurement, the importance of personal dose, and the significance of shielding, time, distance and inverse square law (1/r2). They also need to practice relaying their findings accurately to those further up the chain of command.

Response teams may be called to identify and contain an accidental release of an isotope as the result of damage to equipment containing a sealed radioactive source – such as a cell irradiator, which can contain a 137Cs source >2000 Ci [74 TBq]), or a laboratory X-ray machine. Accidental releases may also occur due to the incorrect storing, handling, transport, or disposal of radioactive material or waste.

Industrial incidents that response teams may need to manage include a leak of ionizing radiation due to damage to an X-ray generator used for security inspection, or Positive Materials Identification (PMI) of the accidental release of radioactive isotopes, or sources during non-destructive testing (NDT).

Incidents can also result from road traffic accidents involving vehicles that transport radiological sources.

CIVIL NUCLEAR FACILITY INCIDENTS

Since 2014 there have been more than 100 serious nuclear accidents and incidents from the use of nuclear power. These include:

Three Mile Island – 28 March 1979: the nuclear emergency in Unit 2 (TMI-2) of the TMI power plant near Middletown, Pennsylvania: the most serious incident in US commercial nuclear operating history

Chernobyl, Pripyat, Ukraine – 25-26 April 1986: the world's most severe facility incident was attributed to a combination of human error and violation of procedures. These have been well documented and underpin the need for thorough training and testing of all procedures and drills

Fukushima, Japan – 11 March 2011: the tsunami that followed the Tohuku earthquake disabled the generators that would have powered the cooling system pumps at the Fukushima-Daiichi nuclear power plant in Okuma, resulting in catastrophic failure and subsequent release

German THW using the FH40G simulator

Acts of aggression

While deliberate acts involving a radiological source are rare, the potentially devastating impact of nuclear terrorism makes it crucial for response teams to be comprehensively trained to handle such events. Threats include use of an explosive or similar means to deliberately distribute radionuclides, a mobile radioactive source carried on a person or in a vehicle, the deliberate placing or dumping of a container of radioactive material in a public place, or the theft of a radioactive source – such as the suspected inadvertent theft of an iridium-192 medical source in Mexico in April 2015.

Practical application

Safe and environmentally friendly radiation training systems can be used in a variety of scenarios, both indoor and outdoor, for beta/gamma search and survey, radionuclide identification, contamination monitoring, and dose and dose rate measurement.

Simulators offer significant time-saving advantages. They mitigate – indeed eliminate – the costly and time consuming administrative effort associated with the transport, deployment, safe handling of radionuclides to the training facility and source end-of-life costs. Renting locations where sources are permitted, transporting and accommodating students is also expensive.

Replicating radiation

Radiation behaves as it does due to the portion of the electromagnetic spectrum in which it exists, coupled with the nature for the source. A single isotropic or directional emitter or particles producing contamination/fallout or liquid presents specific challenges when we try to implement simulation.

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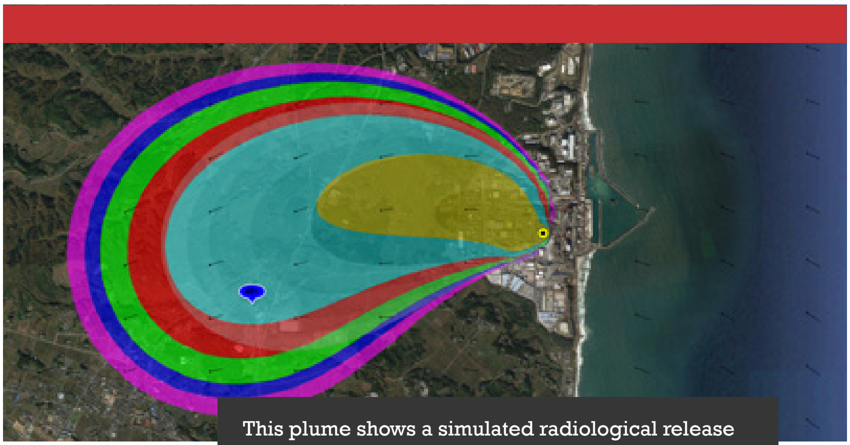
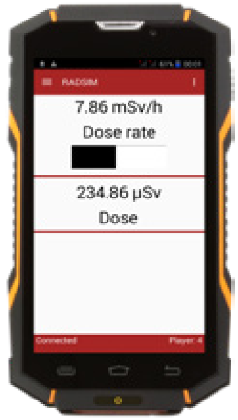


This plume shows a simulated radiological release from a nuclear power station for survey training.



The app-based PlumeSIM-SMART radiation simulator is shown in field exercise mode.

Ultimately you will want to consider what you want your trainees to experience during the exercise and the learning outcomes you seek, and accept that achieving this has priority over specific physical representations of what occurs in reality. For many operatives the detailed physics are inappropriate.

Replica detectors ensure that trainees learn to trust the values displayed on their instruments and that they develop an understanding of the relationship between the measurements on their survey meter and their own personal dose readings. They will also experience and understand the real-time effects of Time, Distance, Shielding and any dose alarms that may be activated.

Simulating contamination

For contamination exercises, options include the placement of powder or liquid substances that can represent an actual contaminant – not just on people, but also food and being soluble, to simulate contaminated water. These substances have the advantage of simulating cross-contamination and are often ideal to teach the handling of open sources in a laboratory environment, for example.

Alternative methods include the ability to hide a safe item underneath a surface such as clothing or a protective suit, to simulate contamination for the instructor to influence the maximum level or reading – and to simulate partial or full decontamination based upon observation of the task.

Simulating gamma and beta emitters

Simulation of gamma and high-energy beta emitters present their own unique challenges – but within reason, is feasible. Simulation sources are able to represent either specific radionuclides or mixes, which can present simulated readings on simulated dose, dose-rate meters and spectrometers.

While shielding effects may not be 100% accurately simulated, the results achieved certainly provide training value with shielding represented to a reasonable degree. This enables students to appreciate its importance for protection; however, instructors need to clarify the appropriate differences for the lesson being delivered.

Better learning outcomes

Practical training sessions, especially when team-based, always reinforce learning. Software based tools that facilitate table-top and field exercises in particular make powerful use of after- action review (AAR), which can help ensure trainees follow clearly set out procedures, and understand where improvements to be implemented in future training exercises.

Immersive training that replicates all the elements of a real-life incident, exposing trainees to the range of emotional responses they may encounter in high-stress settings, imparts great impact upon students. Ultimately what is important for all aspects of simulation is the need to clarify your training objectives to apply the most suitable technology to achieve the desired outcomes; enhance training, and verify procedures.

Simulated radiation safety training has a crucial role to play in efficient and effective response to any radiological incident or emergency, whether small or large in scale -either accidental release or a deliberate terrorist act – in addition to enhancing day-to-day practices.

ABOUT THE AUTHOR

Steven Pike is the founder of Argon Electronics and has been granted a number of international patents in the field of hazardous material simulation. Established in 1987, Argon has become a world leader in the development and manufacture of hazardous material detector simulators.