DETECTION OF NUCLEAR OR OTHER RADIOLOGICAL MATERIALS OUT OF REGULATORY CONTROL AS CRIMINAL/UNAUTHORIZED THREATS TO MAJOR PUBLIC EVENTS

S. BUNTMAN
United States Department of Energy / National Nuclear Security Administration, Office of Nuclear Incident Policy and Cooperation
Washington, D.C., United States of America
Email: Steven.buntman@nnsa.doe.gov

R.J. MAURER
United States Department of Energy / National Nuclear Security Administration, Mission Support and Test Services, LLC, Remote Sensing Laboratory
Maryland, United States of America

Abstract

Major Public Events (MPEs), by their nature, draw great public interest and receive intense media attention. They can be anything from sporting events (e.g., Olympics, World Cups) to political summits to large festivals. The threat of nuclear or other radiological materials out of regulatory control during these events is of particular concern. A terrorist could use this material as a dirty bomb to disperse radioactive material in a stadium, or hide dangerous radioactive sources in a garbage can to expose people to harmful radiation, leading to fear and uncertainty. The requirements for nuclear security, preparedness, and operational capabilities for nuclear/radiological detection at MPEs have steadily increased in recent years. Many countries have gained considerable experience in recent years in nuclear security operations at MPEs when hosting these events. Dozens of MPEs hosted around the world each year now provide some level of nuclear security as part of their overall security plan. Several training workshops and courses, co-sponsored by the U.S. Department of Energy / National Nuclear Security Administration and the International Atomic Energy Agency, and conducted through bilateral agreements, are offered each year. These workshops and courses provide the opportunity to share best practices and lessons learned and aid countries to build capacity for nuclear security at their MPEs. Additionally, the International Atomic Energy Agency provides guidance for the detection of radiological threat materials out of regulatory control through the *Nuclear Security Systems and Measures for Major Public Events, IAEA Nuclear Security Series No. 18.*

1. INTRODUCTION

The United States Department of Energy / National Nuclear Security Administration (DOE/NNSA) works to reduce global nuclear dangers by engaging countries and advancing capabilities through cooperative and capacity building activities to prevent, deter, counter, and respond to nuclear and radiological proliferation, terrorism threats, and related incidents worldwide. MPEs are attractive targets to terrorist groups because they have a political or symbolic importance and present an opportunity to inflict mass casualties. An attack with a radiological device, a so-called “dirty bomb” or a radiological exposure device, would cause panic and disruption. Due to this threat, the U.S. DOE/NNSA and the International Atomic Energy Agency (IAEA) have provided nuclear security support since 2006 to countries hosting MPEs. This support includes specialized training workshops and courses, detection technologies, technical and advisory support, and assistance with procedures to support national infrastructures to detect and respond to criminal and unauthorized activities involving nuclear or other radioactive materials out of regulatory control (MORC). The Competent Authority should be prepared to provide the appropriate detection and adjudication capabilities for both deterrence and detection of potential nuclear/radiological threats from MORC.

2. MAJOR PUBLIC EVENT PLANNING

Not all MPEs are equivalent, and planning will vary based on the potential threats, size, audience, media coverage, public perceptions, international awareness, and politics. The actual setting or venue also varies from event to event and impacts planning, detection arrangements and operational procedures, and nuclear security response measures. Each setting presents unique challenges and may require specialized training, technical support and assistance, and security assessment to determine the appropriate nuclear security measures.

The U.S. DOE/NNSA and the IAEA sponsor MPE training workshops and courses at the IAEA, and in the United States and other countries that are designed to cooperate on enhancing capabilities to address nuclear security at MPEs. These training courses emphasize the need to begin with an initial meeting involving all the key ministries and agencies responsible for MPE nuclear security operations to review the nature of the event to include the type of venue and security challenges, size and length of the event, media coverage, public perceptions, international awareness, political environment, and safety/security issues. The initial meeting also includes a review of the available personnel and equipment resources with regards to event security personnel, regulatory and laboratory technical experts, law enforcement, emergency managers, etc., and the resident inventory of radiation detection equipment. The objective of the initial meeting is to conclude with an agreed Plan of Action or similar agreement for the nuclear security measures and emergency preparedness arrangements for the upcoming MPE.

U.S. DOE/NNSA offers a 5 day bilateral training workshop in the host country comprised of classroom lectures and hands-on practical experience for Preventative Radiological/Nuclear Detection (PRND) operations. On Days 1-2 of the workshop, participants review the basic concepts of radiation and its biological effects, principles for operating radiation detectors, radiological hazards and threats, and operational procedures and best practice techniques. The participants are introduced to a wide range of radiation detection instruments to include radiation pagers, backpacks, and vehicle mounted systems, as well as low and high resolution radioisotope identification instruments (RIID) that are commonly used at MPEs around the world. The training reviews the use of personal protective equipment and the steps involved in the recovery of radiation sources. Days 3-4 are focused on practical field training at the main location of the upcoming MPE, if available, or a similar type of venue. Day 3 focuses on equipment operation and operational techniques that are used for pedestrian portal monitoring using radiation pagers and operator checklists, baseline search/survey of the venues using backpacks and radioisotope identification instruments, and search/survey of associated parking lots and roadways using vehicle mounted detection systems. Day 4 of the training workshop is a field exercise that requires identifying a command staff, developing a Concept of Operations (CONOP) for nuclear security operations, organizing team structures and assignments, distributing detection equipment, and deploying teams. As part of the exercise, the teams encounter radiation sources, and the command staff responds by deploying technical experts with advanced identification instruments to adjudicate the alarms. The field exercise allows the participants to conduct a full scale test run of the nuclear security operations at the MPE locations with their key ministries and agencies. Day 5 allows participants the opportunity to debrief the field exercise and identify lessons learned.

Countries hosting MPEs may request additional support from the U.S. DOE/NNSA and the IAEA during the MPE to include scientific and technical advisory personnel, detection equipment to supplement the host country capabilities, and technical reach back capabilities as outlined in the following sections.

3. DETECTION EQUIPMENT AND OPERATIONAL TECHNIQUES

One of the key considerations to effective planning and response is radiation detection equipment. The equipment may consist of a variety of instruments, such as radiation pagers, backpack detectors, and vehicle mounted detection systems. Each radiation detection instrument is designed with a specific purpose. Some instruments are designed for operational safety, such as personal dosimeters to measure radiation exposure or health physics instruments to survey for radiation contamination. These instruments generally are readily available at most radiation facilities and laboratories but are not that useful for PRND operations at an MPE.

The best practice for PRND operations at a MPE is to use high sensitivity detectors for the detection of gamma and/or neutron radiation. Fig. 1 shows a radiation pager, a backpack detector, and vehicle mounted detection system. Each of these instruments was specifically designed to search for and locate radiation sources. The personal radiation pager (PRD) is the least expensive radiation detection instrument and the most commonly used instrument at MPEs worldwide. It should be noted that these are not gas-filled ionization chambers or Geiger counters, which are low sensitivity detectors. The PRD contains a high sensitivity, solid material scintillation detector. Scintillation detectors are 1000 times denser than gas detectors and, as a result, have much higher stopping power for energetic gamma rays. The detector, however, is relatively small (1 cm diameter x 2 cm length), but provides the sensitivity required for detection when the radiation source is in close proximity. As such, these detectors are used to monitor people entering an MPE through a single file checkpoint.

FIG 1. Examples of a radiation pager (left), a radiation backpack detector (middle), and a vehicle mounted detection system (right).

The best practice for performing radiation monitoring of people at an MPE is at the entrance checkpoint where the individuals are screened by a magnetometer and their bags and other items are sent through an x-ray machine. The most common practice is for the security officer at the checkpoint to wear the PRD on their belt. It should be noted that it is important for the security officer to be in close proximity to those entering the checkpoint in order to provide the highest probability of detection. As an individual approaches the checkpoint, the security officer, who is controlling the flow of traffic, directs them to the magnetometer and x-ray machine. While the individual is next to the security officer, the PRD is scanning for radiation from both the individual and their bag contents. The standard security checkpoint then becomes a scan for radioactive materials in addition to the magnetometer to check for metals and the x-ray machine to check the contents of the bags (Fig 2). If an alarm occurs on the PRD, the security officer follows the security protocols to interdict the individual and request technical assistance. A technical expert assigned to that location, along with a police officer, will escort the individual to a secondary inspection area to conduct an interview, take additional radiation measurements to determine the dose rate and identify the radioisotope, and adjudicate the alarm.

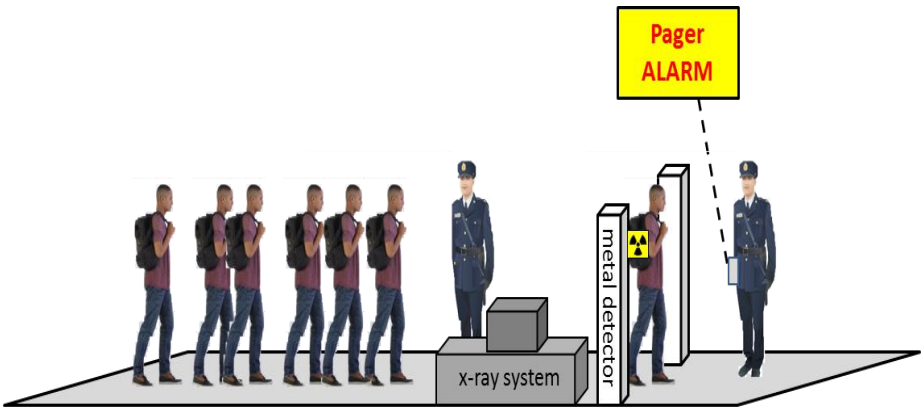

FIG 2. Examples of an MPE checkpoint with a magnetometer, an x-ray machine, and a security officer with a radiation pager.

The backpack radiation detector (Fig. 1) has a larger, more sensitive radiation detector (30 times more sensitive than the radiation pager) and is used to conduct pre-event baseline background search/surveys of the MPE venues. With its higher sensitivity, the backpack detector can detect radiation sources at greater distances, i.e. 10's of meters. For example, the backpack detector is an excellent tool to search/survey a large sports stadium or conference center. A team of 6-8 operators with backpack detectors are able to conduct a thorough, high sensitivity baseline search/survey of a stadium venue in 4-6 hours. The key to the baseline search/survey is understanding the backpack detector detection range. Using this information, the expert team leader formulates a survey strategy that is optimized to cover 100% of the stadium venue. For example, the operator does not have to walk every row of the seating area to conduct the survey as the backpack detector field-of-view extends over multiple rows. A common strategy with a backpack detector is to walk every 3-5 rows as shown in Fig. 3. The use of the backpack detector for baseline search/surveys at MPEs is a recognized best practice.

FIG 3. Backpack detector baseline search/survey of a stadium prior to an MPE using an optimized grid search pattern.

For building complexes such as conference centers, the backpack detector is used to search/survey the lobby, main hall, hallways, open areas, offices, storage areas, and mechanical areas, as well as the external grounds. At open area parks, fan fests, and outdoor festivals, the backpack detector is used to search/survey large crowds and parks. Open areas such as these mentioned present challenges for radiation detection since there are no controlled entry points. The open areas environments of a venue should also be monitored whenever activities are occurring during the MPE.

The vehicle mounted detection system has high sensitivity detectors to search/survey for radiation sources in parking lots and garages, and roadways and streets near the MPE. With even larger detector sizes, the sensitivity provides a detection range of tens of meters while moving at low driving speeds. The search/survey operations involve driving at speeds of 5-10 km/h through parking lots and garages to provide an effective survey for radiation sources concealed in vehicles (Figure 4). When driving the roadways and streets, the detection system is used to search/survey the vehicles parked along the streets as well as any containers or concealments near the street that could potentially be used to conceal a radiation source. Using the vehicle mounted detection system, a large roadway area can be surveyed in a short period of time. The best practice is to conduct multiple vehicle surveys leading up to an MPE and additional surveys during the event. The detector system should be mounted on the side of the vehicle closest to the parked vehicles in order to provide the highest probability of detection.

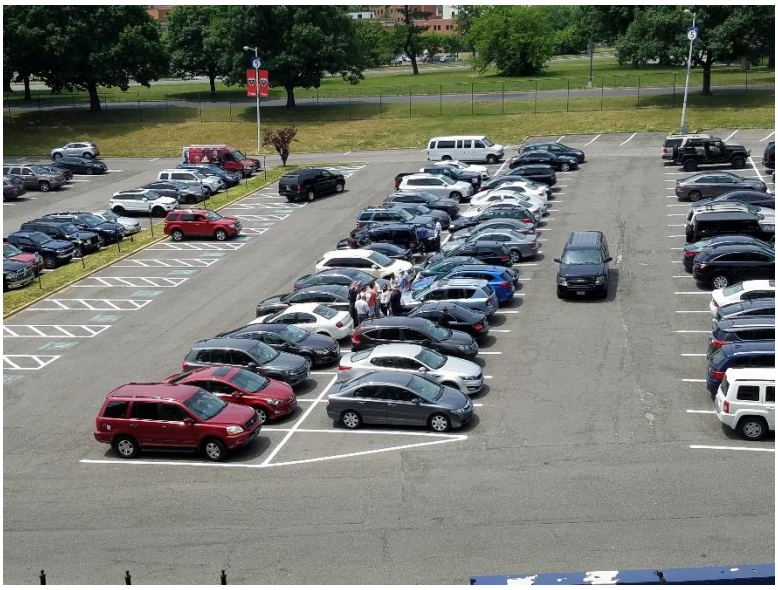

FIG 4. A vehicle mounted detection system is used to conduct a baseline search/survey of cars in parking lots and garages and parked along roadways.

4. PRACTICAL EXPERIENCE

The U.S. DOE/NNSA and the IAEA have provided nuclear security support since 2006 to countries hosting MPEs. This support includes specialized training, detection technologies, technical and advisory support, and assistance with procedures to support national infrastructures in order to detect, and respond to criminal and unauthorized activities involving nuclear or radioactive (MORC). The IAEA, U.S. DOE/NNSA, and other Member States have been working to develop guidelines based on best practices and lessons learned from previous MPEs. The U.S. DOE/NNSA also may offer technical and advisory assistance, such as detection equipment to augment the Host Countries capabilities, an advisory team to support nuclear security measures, and technical reach back capabilities at the request of the host country or IAEA.

5. CASE STUDY – U.S. SUPER BOWL CHAMPIONSHIP GAME

Every year, the United States holds the National Football League (NFL) Championship Game, "Super Bowl", in a different city. The U.S. DOE/NNSA has gained a lot of practical experience and lesson learned by supporting PRND security operations for the annual event. The NFL, local state/city, and federal agencies work together to provide a wide range of security measures which include PRND security operations that involve a combination of city, state, and federal resources. PRND operations are conducted at the main stadium, venues hosting fan fests and other high profile events, practice fields, team hotels, and many other locations. Some locations have well defined entrances and control points, whereas others may be outdoor fan fests in large parks with open access. The nuclear security operations are divided into pre-event, main event, and emergency response activities. The PRND pre-event activities include pedestrian and vehicle baseline radiation search/surveys of the venues, parking areas, and nearby roadways prior to security lock down. During the main event, pedestrian and vehicle portal monitors are operated, and roving patrols are deployed. For these large stadium events, there are multiple pedestrian entrances and vehicle checkpoints as shown in the example in Fig. 5. The personnel and equipment resources to conduct nuclear security measures for large scale events are considerable and may strain the resources of any country. There are multiple radiological emergency response teams on stand-by during the main event to respond to incidents.

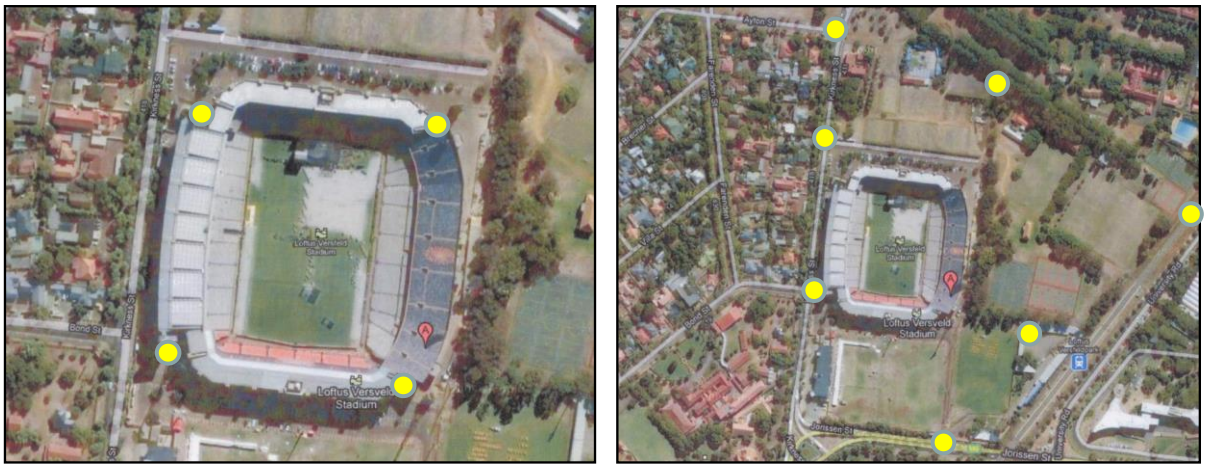

FIG 5. Example of a football stadium with multiple pedestrian entrances (left) and multiple vehicle checkpoints (right).

Presented below are several best practices and lessons learned from the pre-event, main event, and emergency response aspects that the U.S. DOE/NNSA has gained by supporting numerous national and international MPEs. Each venue will be different, but the basic strategy is the same to develop a robust nuclear security plan that addresses a wide range of security concerns, practices the plan in advance through tabletop exercises and field training events, and implements a unified interagency command structure incorporating both security official and radiation experts.

Pre-Event

Best Practices

- Pre-event baseline search/surveys ensure venues are clear of anomalous radiation sources and provide the response team situational awareness of the venues in case a response is required during the event. These surveys also are used to identify in advance of any natural radiation hotspots caused by naturally occurring radioactive material (NORM);
- Pre-event baseline search/surveys are coordinated in advance with venue and vehicle checkpoint security and occur prior to lockdown;
- Security teams are briefed in advance and understand the basic survey requirements to ensure 100% survey coverage;
- Radiation backpacks and vehicle mounted systems allow for high sensitivity surveys of large venues in minimal time;

Lesson Learned

- Lack of coordination with venue security in advance causes delays in the survey team accessing the venues;
- Security should be notified in advance of the types of survey equipment that is brought into the venue. Often they are not aware of the number and size of the detection equipment used and required for these events;

Main Event

Best Practices

- Pedestrian portal monitoring is effectively accomplished by training security screeners with radiation pagers and basic response protocols;

— Security screeners are supported by technical experts working with police to escort individuals causing alarms to the secondary inspection area for an interview, additional radiation measurements, and alarm adjudication;
— Assess shortfalls and obtain detection equipment via loans to supplement resident inventory;
— Be prepared for medical alarms, the rule of thumb is 1 in 10,000 people attending the event will have had a radiopharmaceutical diagnostic test;
— Questionnaire checklists and alarm logs provide a concise, expedient method for adjudicating and documenting alarms;
— Vehicle mounted systems also function as high sensitivity portal monitors for car, truck, and VIP entrances;
— Roving patrols with backpacks or pagers can provide low profile monitoring in large open public access venues;

Lessons Learned

— Security screeners with radiation pagers should be positioned at checkpoints close to the flow of pedestrian traffic to maximize their probability of detection;
— Pagers operating in the vibration mode allow monitoring to be low profile;
— Alarm reporting protocols to police and technical experts should be well defined and practiced by the security screeners;

Emergency Response

Best Practices

— Expert response teams should be equipped with an equipment suite with the flexibility to search, locate, identify and survey for contamination, and are outfitted with personal protective gear and dosimetry;
— Expert response teams require access credentials/vehicle placards to rapidly move through the venues and law enforcement pedestrian and vehicle checkpoints;
— Expert response teams should have access to reach back technical assistance;

Lessons Learned

— A variety of types of credentials are issued for an MPE event. Ensure the expert team has credentials/placards similar to law enforcement for all venue access or equivalent;
— Integrate expert teams with law enforcement for safety and security;

The above listed best practices and lessons learned have been identified over the years from U.S. practical experience supporting MPEs in the United States and at international locations.

6. SUMMARY

Nuclear security measures for MPEs have increased significantly in the last decade. Specialized training and detection equipment are available to assist Host Countries in preparing for and enhancing their security posture. The detection of nuclear or other radiological materials out of regulatory control as criminal/unauthorized threats to MPEs is of great concern to countries hosting these events. Nuclear security detection architecture requires interagency cooperation, especially among law enforcement personnel and radiation emergency responders whose work areas may not normally overlap. The U.S. DOE/NNSA and the IAEA co-sponsor workshops and courses that provide practical field training for nuclear security operations for MPEs and also may provide advisory experts and advance radiation detection equipment to supplement a host country's resources and capabilities.

This work was done by Mission Support and Test Services LLC, under Contract No. DE-NA0003624, with the U.S. Department of Energy. DOE/NV/03624--0330