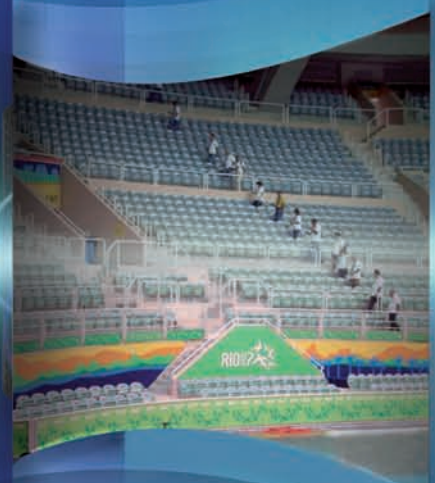
Nuclear Security Measures at the XV Pan American Games: Rio de Janeiro 2007



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NUCLEAR SECURITY MEASURES AT THE XV PAN AMERICAN GAMES: RIO DE JANEIRO 2007

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FOREWORD

Venues where large numbers of people congregate, such as major public sporting events, have been the target of terrorist attacks, the most notable example being the Olympic Games in Munich in 1972. In recent years, terrorists have turned their attention to the use of less conventional weapons than guns and explosives, an example being the use of Sarin gas in the Tokyo underground in March of 1995. However, during the 1990s, a series of incidents of illicit trafficking in nuclear material occurred in a number of States and it was against this background that the IAEA launched a major initiative to address this problem. Following the events of 11 September 2001 in New York, there was increasing evidence that terrorists were interested in using not only nuclear material but other radioactive material for malicious purposes. Consequently, States are giving serious consideration to the need to protect people, property and the environment from terrorism involving nuclear or other radioactive material at major public events.

Security arrangements are primarily the responsibility of the security services of a State within which the major public event is being held. Nevertheless, the IAEA provides assistance to States in establishing the nuclear security arrangements on request. Several States have in fact already done so. Such assistance was requested for the Olympics Games in Athens in 2004, the FIFA World Cup in Germany in 2006, the XV Pan American Games in Rio de Janeiro in 2007 and the Olympic Games in Beijing in 2008.

Thus, awareness among States of the need to establish nuclear security arrangements as part of the overall security arrangements for major public events is growing rapidly. If, as seems likely, this trend will continue, then in order to respond to requests for assistance from States, the IAEA will need to rely more and more on assistance from those States that have already gained experience in establishing nuclear security arrangements at such events. An example of where this assistance has occurred is in 2008 when, with the experience gained during the XV Pan American Games, the Brazilian National Nuclear Energy Commission (CNEN), through its Institute of Radiation Protection and Dosimetry (IRD), provided assistance to the Peruvian authorities regarding the nuclear security arrangements for the Latin American Caribbean — European Union Summit, and the Asia Pacific Economic Forum (APEC) both of which were being held in Lima.

By its very nature, details of security arrangements need to be kept confidential. However, there are general approaches and lessons that can be shared without compromising national security arrangements. With the agreement of the Brazilian Government, this report provides a broad account of the arrangements made to protect people, property and the environment

from malicious acts involving nuclear or other radioactive material during the XV Pan American Games in 2007, in order to assist States that may host future large sporting events.

This report was prepared with the help of A. Bezerra Neto from the Federal Police (currently retired) and L. Antonio Mello, L. Fernando de Carvalho Conti and R. dos Santos from CNEN. Their contribution and the support of the Brazilian Government in making the information on the nuclear security arrangements during the Games widely available are greatly acknowledged. The IAEA officers responsible for this publication were C. Nogueira de Oliveira and R. Abedin-Zadeh.

EDITORIAL NOTE

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1. INTRODUCTION

1.1. BACKGROUND

From 13–29 July, 2007, the City of Rio de Janeiro, Brazil, hosted the XV Pan American Games Rio 2007. The III Para Pan American Games took place from 12–19 August, 2007. Together, these events were undoubtedly the largest undertaking in the city's history, eclipsing the 1950 FIFA World Cup in terms of the numbers of people involved and the numbers of events held. An estimated 8 700 participants — athletes, coaches and referees — from 42 countries were involved; more than 300 competitive events in total were held at 17 different venues; almost 5000 reporters, journalists, etc, covered the events; approx. 18,000 volunteers helped in the organization; and approx. 2 million tickets were distributed.

For an event of such magnitude, security was a major concern, requiring considerable effort. For example, approximately 18 000 federal agents and state and municipal officers were involved; 1 500 cameras were installed for monitoring the city and the main access roads; a major communications network was established involving the installation of 1227 antennas; and 28 criminal data banks were interconnected. The cost to the federal government was approximately 230 million US dollars. Fourteen percent of this was invested in prevention, the remaining 86% in infrastructure of the different security agencies involved. Additional police cars, helicopters and airplanes were obtained for observation and policing. Through partnerships with other sectors, the cost rose to around 360 million US dollars.

Nowadays, there is the need to consider not only the possible use by terrorists of bombs and guns, but also the threat[1] of attacks with chemical, biological, radioactive or nuclear material[2] (CBRN threats). Security with

[1] The word 'threat' is used in this report to indicate potential or possibility of an unwanted event, specifically here, a malicious act, against which measures should be taken to prevent, detect and interdict, as well as measures to respond to them should they in fact occur. It does not however give any indication of the probability of occurrence of that event.

[2] Nuclear material is any special fissionable material (i.e. plutonium-239, uranium-235, uranium enriched in the isotopes 235 or 233 or any material containing one or more of these radionuclides) or source material (i.e. uranium containing the mixture of isotopes occurring in nature, uranium depleted in the isotope 235 or thorium in the form of metal, alloy, chemical compound or concentrate) that may be used for the development of a nuclear weapon.

respect to these threats has a number of components, namely, prevention[3], detection[4], interdiction[5] and response[6] and these involve a range of national and local authorities and agencies. The approach to dealing with each type of threat and these components was integrated into the overall security scheme for the XV Pan American Games Rio 2007 and the III Para Pan American Games (jointly referred to throughout this report as the Rio 2007 Games). This report presents a detailed description of the nuclear security[7] measures that were implemented.

1.2. OBJECTIVE

The objective of this report is to describe the nuclear security arrangements established and implemented for the Rio 2007 Games. These arrangements may serve as an example of the arrangements that need to be made for Member States hosting major public events in the future. The information is intended for use by national authorities such as counter terrorism agencies, national radiation measurement and assessment institutions, bomb squad, police and other relevant law enforcement agencies.

1.3. SCOPE

This report covers the nuclear security measures taken at the Rio 2007 Games. Nuclear security is taken to mean the prevention, detection and

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[3] Prevention is a term intended here to include measures to maintain control over radioactive material (including nuclear material) that will be undertaken by regulatory bodies competent in radiation protection, and safety and security agencies, as well as those measures that are undertaken by police, customs and other law enforcement bodies.

[4] Detection in this report relates to the sensing of a potentially malicious or otherwise unauthorized act by a person or some physical means such as an instrument for measuring radiation.

[5] Interdiction is to intercept once detection has occurred, with the intent to stop activity from occurring.

[6] Response is the collection of actions recognized as necessary to respond to alarms, threats and detection of unauthorized acts involving radioactive material.

[7] Nuclear security involves the prevention and detection of and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities.

interdiction of malicious acts[8] involving nuclear or other radioactive material[9] and the response to such acts should they occur.

1.4. STRUCTURE

Section 2 provides a description of the arrangements made during the preparatory phase: the overall security concept; the evaluation of the threat; the policy decisions taken; the organizational arrangements; the nuclear security plan; and the cooperation with the IAEA. Section 3 describes the concept of operations: the strategy for choosing the targets to be protected; the different lines of defence; the coordination and management of activities; and the actions to be taken to prevent, detect, interdict and respond to malicious acts and other unauthorized acts involving nuclear or other radioactive material. Section 4 covers the logistics including the radiation detection instruments used, their deployment, testing and maintenance and training in their use. Section 5 presents the results of the surveys undertaken prior to the Rio 2007 Games and of the access controls of the venues during the Rio 2007 Games. Section 6 provides the conclusions that may be drawn from the work undertaken. Section 7 gives recommendations to other national authorities facing similar challenge in the future.

[8] A malicious act is a wrongful act or activity intentionally done or engaged in without legal justification or excuse, such as smuggling, or an act or activity intended to cause death or physical injury to any person, material damage to any person, such as theft, or damage to property or to the environment. In most jurisdiction, a malicious act is often a criminal act.

[9] Radioactive material means nuclear material, radioactive sources, and other radioactive substances which contain significant quantities of radionuclides which undergo spontaneous disintegration (a process accompanied by emission of one or more types of nuclear radiation, such as alpha- and beta- particles, neutrons and gamma rays – see Annex A). Often the term is used to designate material that is subject to regulatory control because of its radioactivity.

2. PRE-EVENT ARRANGEMENTS

2.1. OVERALL SECURITY CONCEPT

The overall security concept applied to the Rio 2007 Games was composed of two basic principles. The first was that there should be a unified Command and Control security structure that integrated the various authorities and agencies involved. The second was that the security measures, while being apparent, should be discreet and not detract from the spectacle of the events and the overall spirit of the Games, which was to foster friendship among peoples through competition.

The first principle, that there should be a single focus for all security matters, is perhaps obvious but is a lesson that has been drawn from a number of previous major events affecting the public. Security involves many different authorities and agencies, each with its own responsibilities and effective management and coordination of the activities of these bodies is essential. The command and control structure should therefore congregate all security organizations (federal, state and local), civil defence and the intelligence agency. In the Rio 2007 Games, this was done under the National Secretary for Public Security (SENASP/MJ)[10] coordination.

To achieve the second principle, channels of dialogue were established with community leaders in the City of Rio de Janeiro, particularly those in the areas surrounding the venues, so that they could provide their input regarding the security measures to be taken and would support the actions that were to be taken to ensure security during the Games. With this cooperation the authorities were able to provide security that blended in seamlessly with the local community.

These two principles underpinned the General Security Plan that was developed for the Rio 2007 Games.

2.2. EVALUATION OF THE THREAT

Immediately after the decision was taken for the City of Rio de Janeiro to host the Rio 2007 Games, the government of Brazil started working on an

[10] This Secretary is directly linked to the Ministry of Justice and its main objective is to define and implement public security policies

evaluation of the security threat. Based on the results of this work, the following vulnerabilities[11] were identified in the city:

- Borders.
- Ports (2) and Airports (3).
- Particular highways (10).
- Mass urban transportation (trains, subway, buses).
- Venues (17, including the Pan American Village).
- Strategic locations (VIP`s hotels, coordination centres, etc.).
- Infrastructure installations such as utilities.
- Public (2,000,000 spectators).
- Delegations (42 with athletes and officials).
- Authorities

The General Security Plan for the Rio 2007 Games was developed to protect these vulnerabilities.

2.3. POLICY DECISIONS

In 2005, the President of Brazil assigned to the Ministry of Justice (MJ) the responsibility for the overall security of the Rio 2007 Games. Based on directives of the National System of Public Security (SUSP), the General Security Plan for the games was developed and carried out by the SENASP/MJ, in cooperation with institutions and experts in public security from Brazil and other countries.

2.4. ORGANIZATIONAL STRUCTURE

The organizational structure that was established for the Rio 2007 Games, based on the overall security concept and the policy decision is shown in Figure 1.

The Security Operational Centre was installed at the headquarters of SENASP in the central region of City of Rio de Janeiro. It was the focal point for the coordination of all security activities and was responsible for planning

[11] Vulnerabilities are those locations, events, persons, installations, etc. that are considered to be susceptible to terrorist attack and therefore requiring nuclear security arrangements.

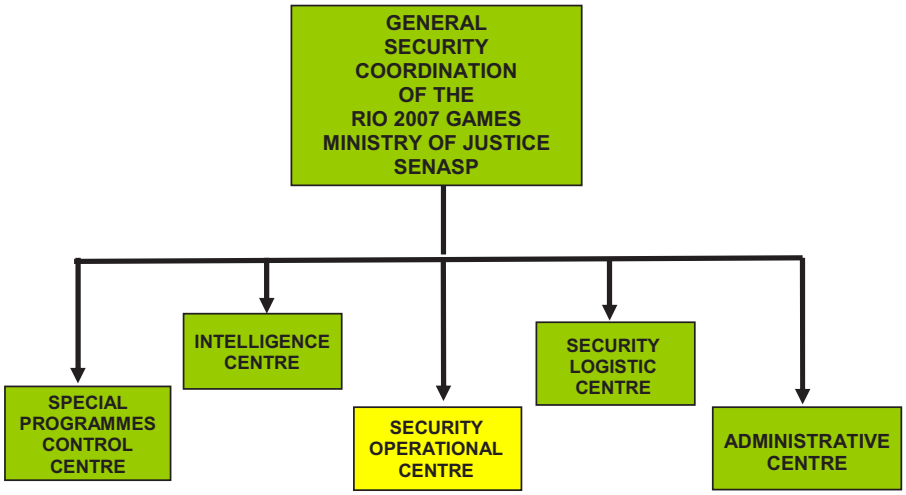

FIG. 1. Organizational arrangements for security for the Rio 2007 Games.

and implementing all measures to prevent, detect, interdict and respond to any illicit action or activity that might be intended to cause harm to persons, damage to property or an adverse impact on the environment, especially at venues, VIP's hotels, special routes, city airports, harbours and other strategic locations (i.e. vulnerabilities).

In addition to the Brazilian institutions responsible for public security, four special operational commissions were established:

- **National Commission for Public Security at Ports, Terminals and Waterways** (CONPORTOS): responsible for the security of maritime areas and the harbour of the City of Rio de Janeiro, and for maintaining records of illicit acts within its jurisdiction.
- **Aerial Police Commission** (AEROPOLICIAL): responsible for providing support to the security forces involved in intelligence operations, escorting of VIPs and delegations, and performing search and rescue operations.
- **Sniffer Dogs Commission** (PNCF): responsible for providing support to the security forces involved in searching and rescuing persons, surveying venues and other strategic locations, and searching for explosives.
- **Bomb Security Commission** (CSAB): responsible for planning, elaborating and executing integrated measures for the prevention, detection and interdiction of and response to all terrorist acts involving the use of explosive or incendiary devices, including those involving

chemical, biological, radiological or nuclear substances within mass transport systems, in public buildings, and at venues, ports and airports and other strategic locations.

2.5. DEVELOPMENT OF PARTNERSHIP AGREEMENTS

These four Commissions developed a series of working arrangements with other bodies to facilitate the effective implementation and coordination of their respective missions. Figure 2 shows the institutions with which CSAB established such working arrangements.

Specifically for nuclear and radiological matters, the CSAB and the National Nuclear Energy Commission (CNEN), the Competent Authority for nuclear matters in Brazil, worked jointly from the end of 2006 to the present evaluation of the success of their joint efforts.

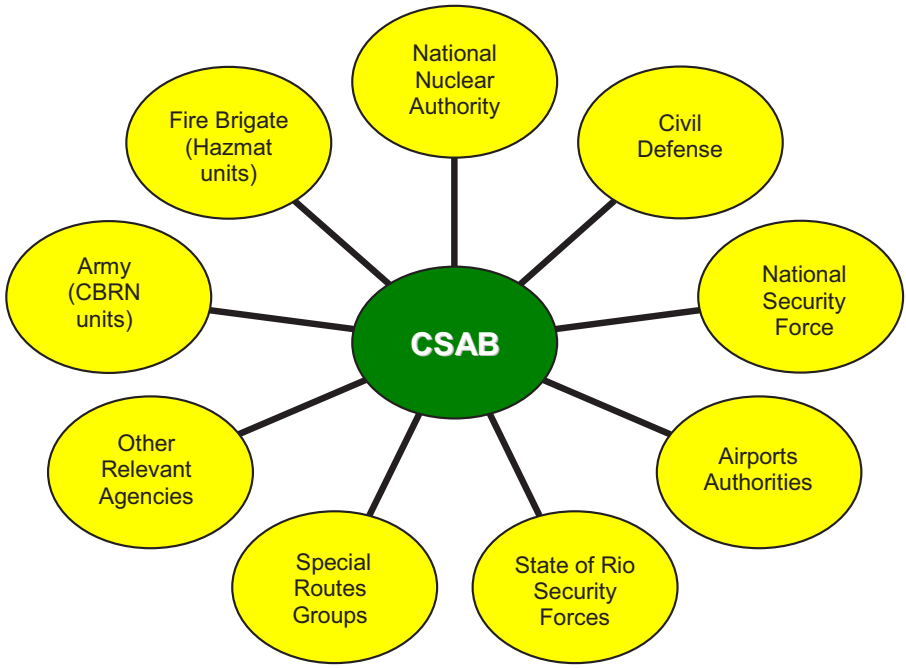

FIG. 2. The institutions with which CSAB established working arrangements for the Rio 2007 Games.

2.6. NUCLEAR SECURITY PLAN

The CNEN already had in place a National Response Plan to deal with emergencies involving nuclear installations or radioactive sources. This plan took account of the experience gained during the response to the Goiânia accident in 1987[12]. This however was not sufficient for the purposes of nuclear security for the Rio 2007 Games. Consideration also needed to be given to the prevention, detection and interdiction of malicious acts involving nuclear or other radioactive material. As a consequence, the CNEN developed a Nuclear Security Plan covering those aspects, as a component of the General Security Plan for the Games.

2.7. COOPERATION WITH THE IAEA

In December 2006, the Brazilian government, through CNEN, formally requested IAEA support in establishing the security arrangements for protection against nuclear and radiological threats during the Games. As a consequence, an IAEA expert mission met with officials from CNEN and SENASP/MJ in Brazil from 22 to 25 January 2007 in order to discuss in detail the nature of the support that it might give. This led to the establishment of a Cooperation Arrangement between the Brazilian Authorities and the IAEA for the provision of advice and technical support and the subsequent development of a Joint Action Plan. This plan defined the tasks to be jointly implemented by the Brazilian Authorities and the IAEA's Office of Nuclear Security.

Within the scope of the Joint Action Plan, two technical support missions were conducted. The first addressed radiation monitoring at venues and other relevant places; the second provided specific response plan for the local Mobile Expert Support Teams (MEST). In addition, one seminar, two train-the-trainers courses and one exercise, with instructors from IAEA and CNEN, were carried out with participants from all of the relevant institutions. The seminar was aimed at Senior Officials and covered the illicit trafficking

[12] This accident and the response to it are described in International Atomic Energy Agency, The Radiological Accident in Goiânia, IAEA, Vienna, (1988).

database (ITDB) [13] and any trends that had been identified in the analyses of the data. Such information provided an important input in the development of the threat analysis. One training course was aimed at security personnel and was concerned with radiation detection at strategic locations. The other was focused on response to criminal or other unauthorised acts involving nuclear or other radioactive materials. The field exercise was jointly conducted for the CNEN staff and security personnel (front line officers and bomb squad) and dealt with radiation detection and response. All of these activities were conducted during the period from 2 April to 22 June, 2007.

The information that was presented on the trends in illicit trafficking during the seminar was related to the time up to 12 April 2007. In order for Brazilian authorities to be kept up to date, IAEA provided periodic reports on more recent incidents of illicit trafficking and reports of lost or stolen radioactive sources from May 2007 onwards. Initially, these reports were provided monthly, but from June 2007, they were provided on a weekly basis and, from July 2007, they were provided in real time as events were reported to the IAEA. The emphasis of these reports was on events within the Latin American Region.

The IAEA also provided specialized technical assistance and equipment to the CNEN. For its part, the CNEN trained and equipped enforcement authorities and up-graded the capacity of its own personnel to detect nuclear or other radioactive material.

[13] The term 'illicit trafficking' is used in the database in a broad sense in nuclear security to mean the unauthorized movement of nuclear or other radioactive material, irrespective of whether this movement was due to a deliberate or clandestine activity of criminal nature. As a consequence, many of the unauthorized activities reported to the illicit trafficking database may have arisen as a consequence of breakdown of control rather than of any deliberate or clandestine activity of criminal intent. The value of the broad meaning given to the term is that the database gives an indication of the extent to which nuclear material and other radioactive material might be available for malicious purposes.

3. CONCEPT OF OPERATIONS

3.1. STRATEGY TO PROTECT AGAINST NUCLEAR THREAT

On the basis of the available information the CSAB and CNEN decided to protect all of the venues and some strategic locations against the nuclear and radiological threats. Any remaining vulnerabilities could have been covered if requested by the Security Operational Centre.

The venues for the Games were spread over four designated regions of the city, named Barra, Deodoro, Maracanã and Pão de Açucar, within a radius of 25 km, as illustrated in Figure 3.

- *Barra region* comprised the following venues:
  - Marapendi Club (Tennis);
  - City of Sports Complex of Autrodromo (Basketball, Cycling Track, Artistic Gymnastics, Swimming, Synchronized Swimming, Diving and Roller Skating);
  - Outeiro Hill (Cycling - Mountain Bike and BMX);
  - Riocentro Sports Complex[14] (Badminton, Boxing, Fencing, Futsal, Rhythmic Gymnastics and Trampoline, Handball, Judo, Weight-lifting, Wrestling, Taekwondo and Table Tennis);

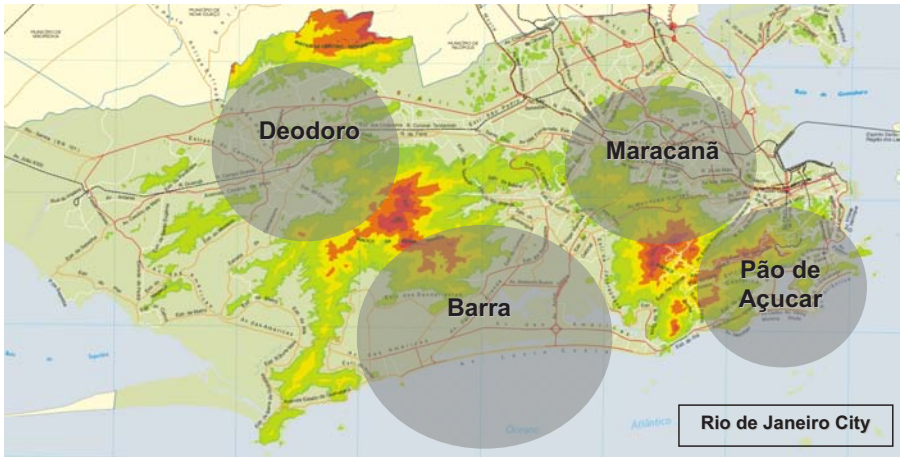

FIG. 3. The designated regions of the city of Rio de Janeiro where the venues were located.

[14] This venue also contained the Media Centre

- City of Rock Sport Complex (Baseball and Softball);
- Barra Bowling Centre (Bowling);
- Zico Football Centre (Football); and
- The Pan American Village.

- *Deodoro region* comprised the following venues:
  - Deodoro Military Club (Equestrian, Field Hockey, Modern Pentathlon, Sport Shooting and Archery); and
  - Miécimo da Silva 14Sports Complex (Football, Karate, Artistic Roller Skating and Squash).

- *Maracanã region* comprised the following venues:
  - João Havelange Sports Complex (Athletics and Football); and
  - Maracanã Sports Complex (Football, Water Polo and Volleyball

- *Pão de Açucar region* comprised the following venues:
  - Marina da Gloria (Sailing)
  - Flamengo Park (Marathon, Race Walking and Road Cycling);
  - Copacabana Arena (Swimming Marathon, Triathlon and Beach Volleyball);
  - Rowing Stadium (Flat-water canoeing and Rowing); and
  - Caiçaras Club – Water Skiing.

3.2. LINES OF DEFENCE

A strategy involving three lines of defence for each venue and strategic location was established. The first line of defence comprised the front line officers from the National Security Force, who controlled the access to the venues. At all entry points, both for pedestrians and for vehicles, the officers in charge of the metal detector portals and X ray inspection machines, were equipped with personal radiation detectors (PRDs), see Figure 4. These are small, lightweight, highly sensitive radiation monitors that are used for the purpose of alerting the user to the presence of radiation. The decision to use portable detection equipment rather than fixed monitors was due to the very short time available for the preparation of the nuclear and radiological security arrangements.

The second line of defence comprised the radiation protection professionals from CNEN (Triage Team, see Chapter 4) using radionuclide identification devices (RID). Their responsibility was to investigate any alarm by a PRD. Should an alarm occur, the line or lines of public entering the venue

FIG. 4. Security officers equipped with PRDs at an entry point..

would be stopped and each person would be escorted, one by one, by a member of the National Security Force, for investigation of the origin of the alarm by the Triage Team, see Figure 5.

As expected, some PRD alarms were set off by the legitimate use of radionuclides for medical purposes, either diagnosis or treatment of disease. Thus, one of the first actions to be performed by the Triage Team would be to

FIG. 5. Triage team member using an RID to identify the origin of the alarm.

determine whether the detected radiation was due to one or other of the radionuclides used in medicine. In the event that any one of the following was found, the investigation would move to the third line of defence:

- the radionuclide was not used for medical purposes;
- neutron radiation (which might indicate the presence of nuclear material), or
- the radiation dose rate was greater than 100 μSv h^{-1}, irrespective of the nature of the radionuclide[15].

The person, vehicle or object would be isolated in a secure place so that the further investigations could be performed. These would be undertaken by a field response team from CNEN (MEST, see Chapter 4). The Security Coordination Centre would be informed of any event of this nature prior to this further investigation.

3.3. COORDINATION AND MANAGEMENT

To develop the concept of operations and to coordinate the necessary actions, both before and during the Games, two working groups were established by the President of CNEN on 2 March, 2007. The first was the Supervision and Institutional Liaison Group comprising the Directors and General-Coordinators of the various groups involved in establishing and operating the nuclear security arrangements. This group was given responsibility for the overall management of the arrangements and the liaison with SENASP and all other external institutions. The second working group, the Tactic-Operational Group comprising senior staff members of CNEN, was given responsibility for the implementation of the actions in the field. The CNEN staff on both groups were from the CNEN headquarters and two of its Institutes; the Institute for Radiation Protection and Dosimetry (IRD), and the Institute of Nuclear Engineering (IEN). All three are located in the City of Rio de Janeiro, which facilitated the logistics of the operations.

The two working groups had 7 joint meetings to elaborate a plan of actions for the CNEN in which the concept of operations and the structure of the CNEN teams, shown in Figure 6, were defined.

The General Coordination Committee was the decision making group, comprising members of the Supervision and Institutional Liaison Group and

[15] The level of 100 μSv h^{-1} was established by CNEN.

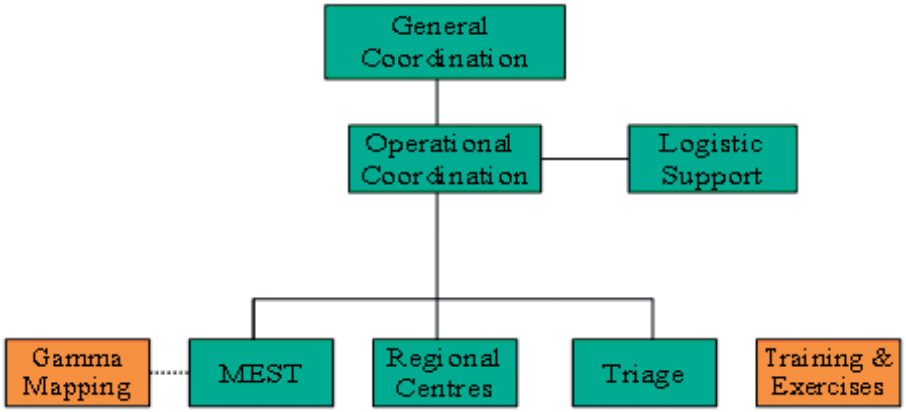

FIG. 6. Organizational structure of the CNEN teams for the Pan American Games.

the coordinator of the Tactic-Operational Group. It was responsible for communication with the President of CNEN and the Security Operational Centre for the Games. It was also the point of contact for the IAEA Illicit Trafficking Database (ITDB). The General Coordination Committee was based at the CNEN Headquarters.

The Operational Coordination Group was responsible for the execution of the plan of actions and providing support to the General Coordination Committee, Triage Team and Mobile Expert Support Team (MEST). It was also the point of contact with IAEA's Incident and Emergency Centre (IEC). For practical purposes, it had two operational sub-groups. The first was based at the IRD premises in view of IRD's general responsibilities and facilities for emergency preparedness and response and its proximity to many of the venues, including the Pan-American Village. It was composed by one coordinator, one secretary, three officers (instrumentation, logistics and communication) and two drivers. The second was based at the CNEN headquarters in order to facilitate the management of the deployment of the Triage Teams to the venues that were located farther from IRD. The group consisted of a coordinator, two support officers (logistics and communication) and two drives.

The Logistics Support Group, which worked closely with the Operational Coordination Group, was responsible for providing all the necessary logistical support to CNEN's technical teams —transportation, food and water, finance, etc.

3.4. ACTIONS TO PREVENT MALICIOUS ACTS INVOLVING RADIOACTIVE MATERIAL

The Southeast Region of Brazil in which the City of Rio de Janeiro is located, contains most of the Brazilian nuclear installations — two nuclear power plants, a nuclear fuel fabrication plant, a uranium enrichment facility, four nuclear research reactors and six nuclear research institutes — and approximately 70% of the sealed radiation sources that are used in industry, medicine, education and research in Brazil. Such installations and facilities could be regarded by terrorists as providing the basic material for nuclear terrorism.

The CNEN therefore advised all nuclear installations and facilities with radioactive material within the State of Rio de Janeiro about the need to reinforce their existing security arrangements, in order to minimize the risks of theft of nuclear or other radioactive material and sabotage[16]. They were also asked to minimize the transport of these materials shortly before and during the Rio 2007 Games.

The CNEN also advised nuclear medicine installations in the State of Rio de Janeiro to provide certificate to patients undergoing diagnosis or treatment with radionuclides detailing the radionuclide and activity used. These patients were advised to carry this certificate when accessing any venue. This would facilitate any subsequent investigation following the triggering of an alarm.

Prior to the imposition of full access control at the venues by the National Security Force, the Venue Survey Groups, comprising staff of the CNEN and of the Bomb Squad, undertook comprehensive surveys, including radiation surveys, of each of the venues. This work started with the Pan-American Village on 24 June, 2007, since that was to be the first venue to be occupied by the athletes, coaches and referees. For almost all of the other venues, the final survey (in some venues, more than one survey was undertaken) was conducted during the week immediately prior to the start of the Rio 2007 Games. The size of the Venue Survey Group was determined on a case-by-case basis and depended on the total area to be surveyed. The equipment used by the Group

[16] Sabotage is any deliberate act directed against radioactive material and their associated facilities which could directly or indirectly endanger the health and safety of personnel, the public or the environment by exposure to radiation or release of radioactive material.

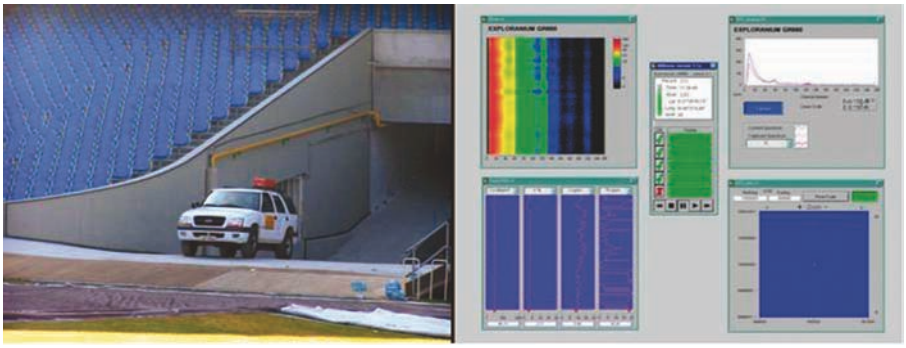

FIG. 7. Car borne gamma survey system used at the Maracanã stadium and a display example.

included RIDs, backpacks[17] and car borne survey systems depending on the nature of the venue. Figure 7 shows a car borne gamma survey in progress at the Maracanã stadium.

3.5. ACTIONS TO DETECT AND INTERDICT MALICIOUS ACTS INVOLVING RADIOACTIVE MATERIAL

A Triage Team, together with the front line officers from the National Security Force, was stationed at all access control points of the venues. Each Triage Team was composed of two CNEN staff members. Their function was to respond to any radiation alarm triggered by the personal radiation detectors (PRD) carried by the security officers at all entry points, both for pedestrians and for vehicles, to determine whether further detailed investigation would be necessary.

3.6. RESPONSE MEASURES

The Mobile Expert Support Team (MEST) was based at IRD and was responsible for the prompt and coordinated response to any event, whether accidental or malevolent, with potential or actual radiological consequences for

[17] 'Backpacks' is a term used to indicate a type of system of detection that is carried on a person's back. They include gamma and neutron detection equipment capable of radionuclide determination and global positioning systems (GPS).

the population, property or the environment. A particular responsibility in the context of the Rio 2007 Games was to undertake further detailed investigations of any events identified by the Triage Team.

The structure of the MEST was based on an already established system designed to respond to nuclear accidents or radiological emergencies and comprised two senior radiation protection experts acting as Field and Deputy Field Coordinators, 2 radiation detection officers and 3 experts on environmental assessment, internal and external dosimetry. For the Rio 2007 Games, 4 teams worked on the basis of 12 hour shifts.

The roles and responsibilities of the MEST were to:

- Support the bomb squad to identify and classify any radioactive material that causes an alarm: naturally occurring radioactive material; radionuclides used in medicine; industry or research; nuclear material;
- Categorize radioactive material according to the hazard that it presents (using the IAEA categorization of radioactive sources[18]);
- Assist bomb squad in the handling a radioactive dispersal device;
- Perform car borne or backpack surveys to localize the radioactive material;
- Control operations involving radiation exposure;
- Assess doses and environmental impact; and
- Recommend countermeasures: isolation of areas, sheltering and evacuation, etc.

The equipment used by the MEST in order to fulfil its responsibilities included:

- 2 portable HPGe systems with associated electronics and software;
- 3 car borne gamma mapping equipment with large NaI(Tl) detectors
- 2 neutron search detectors
- 5 backpacks with gamma and neutrons detectors and GPS capabilities
- 5 RIDs

[18] The Safety Guide, International Atomic Energy Agency, Categorization of Radioactive Sources, Safety Standards Series No. RS-G-1.9, Vienna (2005), provides a risk-based ranking to radioactive sources so that risk-informed decisions can be made, in a graded approach to the control of radioactive sources for the purposes of safety and security. The categorization is based on the potential of radioactive sources to cause harm to human health and is intended to assist in ensuring an appropriate level of control for each source.

- Individual dosimeters
- Personal protection equipment

To assess the environmental consequences of any releases of radioactive material, including those resulting from explosions, two computer programs from the National Atmospheric Release Advisory Centre / Lawrence Livermore National Laboratory (NARAC/LLNL) had been made available by US/DOE for use by IRD. The first was a tri-dimensional model that uses meteorological data from the US National Oceanic and Atmospheric Administration (NOAA). The second, called Hot Spot, uses a bi-dimensional Gaussian plume model with the meteorological data provided by the user. In addition, the code SIEM– Integrated System for Radiation Emergency Assessment, developed at IRD, was available for the evaluation of doses from the dispersion of radionuclides both in urban and rural environment using dynamic models. Codes were also available for internal and external dose assessment, if necessary.

Due to the distances between venues, a second equipped group was set up at the IEN to provide back up to the MEST. This group also worked on the basis of 24 hour shifts and was made responsible for the recovery and safety and secure storage of any nuclear or other radioactive materials that might be detected during the Games.

4. LOGISTICS

4.1. RADIATION DETECTION INSTRUMENTS

In addition to the equipment that was available locally, IAEA sent the following to be used during the Games:

- 2 kits (HPGe, neutron search detector, RID) for use by MEST;
- 5 DG5 gamma search detectors for vehicle searches at checkpoints;
- 1 IAEA-IEC ARC System for terrestrial mobile search and gamma mapping;
- 180 PRDs for detection at access control points;
- 26 RIDs for determination of radionuclides at access control points (21) and use by MEST (5); and
- 5 backpacks for pre-event area survey and use by MEST.

4.2. DEPLOYMENT, TESTS AND MAINTENANCE OF DETECTION SYSTEMS

All equipment was verified and tested by IRD before use. Prior to the Games, the equipment was kept at IRD but during the games the equipment was distributed among the CNEN Headquarters, IRD and IEN for logistical reasons.

4.3. HUMAN RESOURCES DEPLOYMENT

A substantial amount effort was involved in establishing and operating the nuclear security arrangements for the Rio 2007 Games. Altogether, 250 CNEN staff members were involved. In addition to the significant amount of time spent before the Games in planning, surveying and training. During the competition period, an overall 210 staff contributed a total of 30,000 man-hours.

4.4. TRAINING, DRILLS AND EXERCISES

Due to the specificities of this operation, a special training programme was established for each of the different groups involved. A group composed

by 22 staff members, selected on the basis of their knowledge and experience, attended train-the-trainers courses provided in conjunction with IAEA (see Section 2.7). This group provided training to the following:

- 600 Front line officers from the National Security Force;
- 160 Bomb Squad members from Federal Police, State Police and National Security Force;
- 120 Triage and Local Supervisors Teams from CNEN; and
- 28 MEST members from CNEN.

The training courses covered the principles of radiological protection, the instrumentation to be used (PRD, RID and backpacks), the concept of operations and the specific procedures for each team. Practical exercises were used to reinforce the training. The courses were held at IRD and IEN, and involved groups of 30 participants at a time.

During the whole of the period, MEST exercises were conducted at different venues. In addition, some tabletop exercises for the assessment group were conducted at IRD. The outcomes from the exercises were used for reviewing, and, as necessary, amending, the MEST procedures.

5. RESULTS

5.1. VENUE SURVEYS

All venues were surveyed before the beginning of the Games. This work was important, not only to provide reassurance that the venues were clear of radiation sources that might have been present for possible malicious purposes but also to provide data on the baselines variations in natural background levels at those venues. These data were essential for any subsequent measurements by the MEST during the Games. The results shown in Figure 8 which are for the gamma dose rate measurements made with one RID in one of the buildings of the Pan American Village, which contained a total number of 1480 apartments, in 14 buildings, are typical of the variations in natural background radiation levels that were observed.

The figure indicates the time when measurements were made. However, since the measurements were made as the team moved around the building, the time may be correlated with the location within the building. The significant peaks in the figure occurred when the team was on the stairs between floors and were due to the increased amount of surrounding concrete in those locations.

For large areas, such as the seats of a large arena shown in Figures 9, the strategy used for the survey was quite different but the data analysis remained the same. A large number of persons were involved, each one using a RID with a controller noting the position of each person and the start and end time of each run. For the soccer field, the same strategy was adopted, adding one

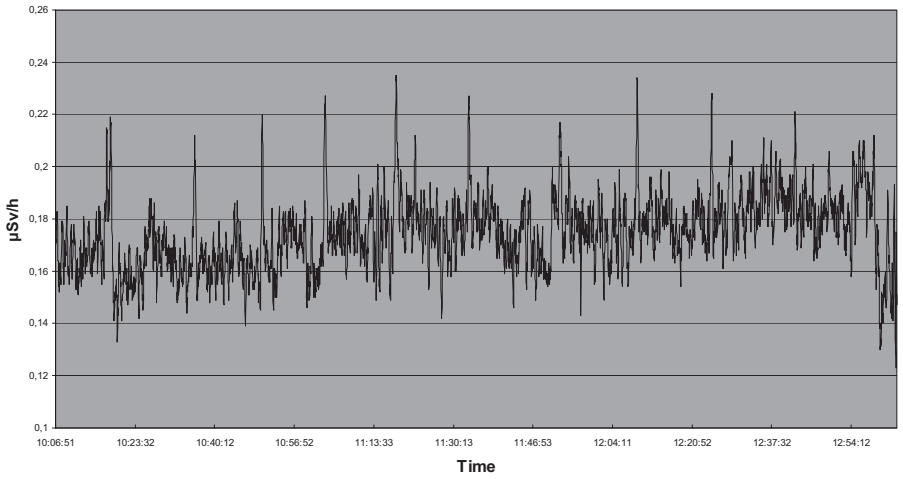

FIG. 8. Result from the survey of one of the buildings from the Pan-American Village.

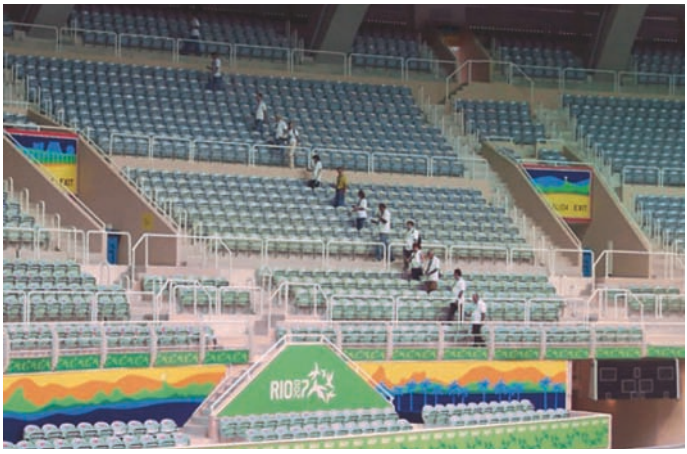

FIG. 9. Survey of the Maracanãzinho arena seats using a line of RIDs.

person with a backpack as shown in Figure 10. For open areas and venue surroundings, both backpacks and the car borne gamma mapping equipment were used. An example of the results of an open area survey is shown in Figure 11.

FIG. 10. Survey of the João Havelange soccer field using a line of RIDs and backpack.

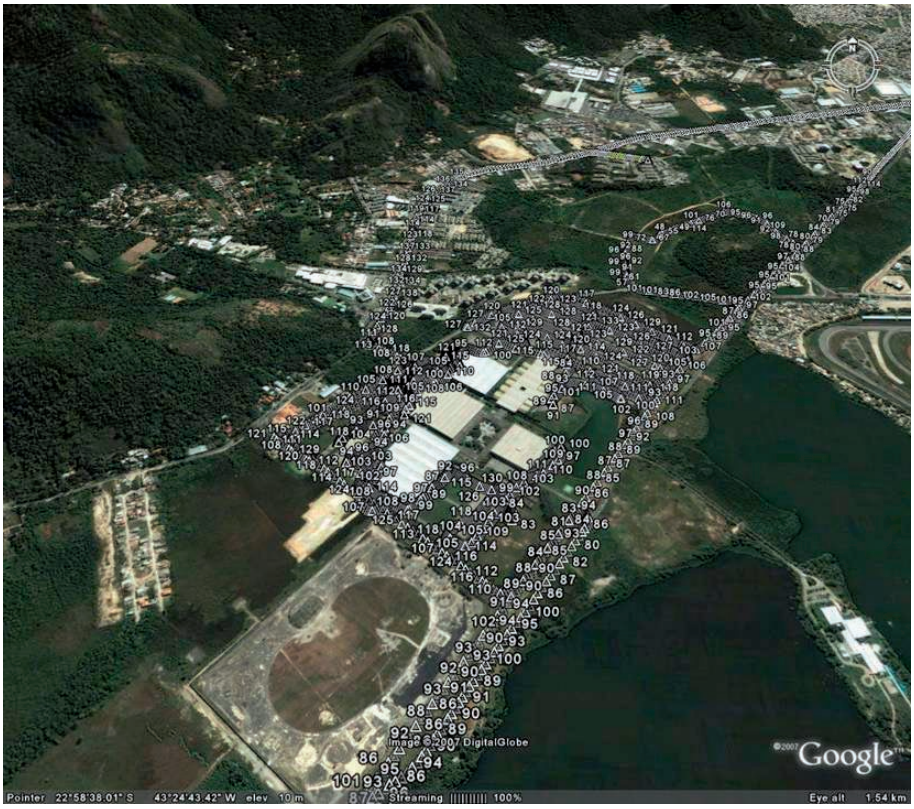

FIG. 11. Survey of the RIOCENTRO surrounding area performed with the car borne gamma mapping system. (Photo courtesy of Google.)

5.2. SECURITY CONTROL AT VENUES

During the Games 42 PRD alarms were registered, 40 of which were found to be due to patients who had undergone medical diagnostic examination or treatment with radioactive compounds; the remaining 2 were found to be false alarms[19]. In 50% of the cases, the persons involved had medical certificates confirming that they had been undergoing medical

[19] A false alarm is an instrument response that is not due to the presence of an increased level of ionizing radiation. This can be due to statistical fluctuations in the background response of the instrument, radio-frequency interference or misuse of the instrument.

treatment with radioactive compounds and, in all those cases, the radionuclide identification provided by the RID was in perfect agreement with the certificates. The other 50% did not have medical certificates probably because they came from other Brazilian States or different countries.

In addition, on 3 occasions during the Games, the MEST was requested to undertake further action. Investigation and technical procedures carried out in conjunction with the security forces concluded that the alerts were false.

6. CONCLUSIONS

The fact that no event involving nuclear or other radioactive material intended for malicious purposes was detected during the Games is in itself an important result. However, more important is the fact that this work demonstrates that with appropriate planning, satisfactory arrangements can be made for the purposes of nuclear security. A key component of this was establishing effective cooperation between the different authorities — those concerned with nuclear issues and those concerned with security — that had not previously had to work together in a major public event. This involved a clear definition of the roles and responsibilities of each organization and their interactions. The value of devoting considerable attention to ensuring that all those involved in the nuclear security arrangements were adequately trained and adequately provided for during the Games was also clearly demonstrated.

The experience also demonstrates the value of cooperation between the IAEA and the Brazilian Government. Nuclear security, particularly when extended to cover all radioactive material, is a relatively new concern and, as such, many States are not well equipped to deal with the matter. In the case of the Rio 2007 Games, the Brazilian authorities were able to draw on the considerable resources of the IAEA for the purposes of training and provision of expert advice. The IAEA was also able to provide essential equipment that either previously did not exist in sufficient quantity or complemented Brazil's own equipment capabilities.

During the Rio 2007 Games, professionals from CNEN were responsible for investigating any PRD alarm using RIDs. This was feasible because CNEN had a sufficient number of such professionals. The question however arises whether such screening could have been carried out by front line officers themselves in order that the radiation professionals could focus on the third line of defence. This question is particularly pertinent for countries where there are only a limited number of professionals available with experience in radiation monitoring. The conclusion from the experience gained during the Games was that this work could only have been done by the front line officers if they had been appropriately trained beforehand in the use of the equipment and interpretation of the results of measurements.

The work done during the Games also confirms that it is relatively common for innocent alarms[20] due to the use of radioisotopes for medical diagnosis or treatment to occur. Such alarms can be readily identified if the person involved carries a certificate indicating the nature of radioactive material involved (radionuclide and activity) and the measurements made during any subsequent investigation are in accord with the information on the certificate.

[20] An innocent alarm is a verifiable response to an actual increase in radiation levels, but for reasons that are not due to the unauthorized presence of radioactive material. This can arise due to legitimate uses of radiation, particularly, the use of radioisotopes in medicine.

7. LESSONS LEARNED

The following lessons were learned in developing and implementing the nuclear security arrangements for the Rio 2007 Games:

- States hosting major public events should consider establishing nuclear security arrangements aimed at preventing, detecting, interdicting and responding to criminal or unauthorized acts involving nuclear or other radioactive material;
- If the policy decision is taken to establish such arrangements, then it is essential that they be fully integrated into the overall security activities. This requires clear definition of the roles and responsibilities of each of the organizations involved and the way in which they should interact and cooperate;
- Early planning is essential. For an event of the size of the Rio 2007 Games, at least 18 months prior to the event would appear to be appropriate;
- Consideration should be given to the training needs of those involved in establishing and operating the nuclear security arrangements;
- Consideration should also be given to the equipment needs for the nuclear security arrangements;
- In those States in which nuclear security expertise does not exist, consideration should be given to requesting assistance from another State that already has such expertise or from the IAEA for providing the necessary training;
- Some days prior to the start and throughout the games, medical facilities providing diagnosis or treatment with radioisotopes should issue, in agreement with the nuclear regulatory authority and the security apparatus, certificates to patients detailing the radioisotope and activity used. This would facilitate any subsequent investigation following the triggering of an alarm.

ABBREVIATIONS

AEROPOLICIAL	Aerial Police Commission
ARC	Airborne Radiological Computer System
CBRN	Chemical, biological, radiological, nuclear
CNEN	National Nuclear Energy Commission
CONPORTOS	National Commission for Public Security at Ports, Terminals and Waterways
CSAB	Bomb Security Commission
FIFA	International Federation for Football Association
GPS	Global Positioning System
HPGe	High Purity Germanium (used in radiation detection devices)
IEC	Emergency and Incident Centre
IEN	Institute of Nuclear Engineering (of the CNEN)
IRD	Institute for Radiation Protection and Dosimetry (of the CNEN)
ITDB	Illicit Trafficking Database
LLNL	Lawrence Livermore National Laboratory
MEST	Mobile Expert Support Team
MJ	Ministry of Justice
NARAC	National Atmospheric Release Advisory Centre
NOAA	National Oceanic and Atmospheric Administration
PNCF	Sniffer Dogs Commission
PRD	Personal Radiation Detector
RID	Radionuclide Identification Device
SENASP/MJ	National Secretary for Public Security of the Ministry of Justice
SIEM	Integrated System for Radiation Emergency Assessment
SUSP	National System of Public Security

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