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The importance of nuclear forensics against terrorism related radioactive and nuclear material illicit trafficking and smuggling

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Introduction

Nuclear and radioactive material smuggling has been a challenge for intelligence services and polices around the globe since the 1990´s [1]. Last year, the International Atomic Energy Agency (IAEA) held two meetings dedicated to nuclear security and detecting sources which are currently out of regulative power [2][3]. Nuclear forensics is a relatively new study field. It was born out of the need not only to identify illegal nuclear and radioactive material, but also to understand its origins and its intended use [4], so that future similar incidents will not occur.

When a suspect material is intercepted, several questions must be answered during the investigation. This process can be divided into five stages: categorization, forensic analysis, characterization, nuclear interpretation and attribution. Categorization consists in analysing the threat posed by certain event, not only to the emergency team, but also to the public and to the environment, as well as predicting if there is any crime against national security. Therefore, this paper presents an analysis on how to relate features of nuclear and radioactive materials, such as activity and fissibility, in order to understand the risk offered when they are used for criminal intentions.

Methodology

Information on safety and security standards and nuclear forensics were gathered on manuals and protocols provided by agencies like the IAEA and the American Physical Society. They were then related, compared to recent papers and knowledge on nuclear physics, radiochemistry and public security. From that, four different types of material were analysed: natural uranium ore, enriched uranium and plutonium, burned nuclear fuel and commercial radioactive sources. They were analysed as far as their features are concerned, in order to predict the threat to public health and security when they are found to be used for criminal purposes.

Results

Using information collected in all steps of the nuclear forensic process, it is possible to relate some material's features with the risks they imply to public health and security, as well as projecting intended criminal uses depending on the type of material intercepted.

Natural uranium

Natural uranium ore is not very useful nor for constructing atomic bombs or radiological dispersal devices (RDDs). However, the interception of large quantities of this material can characterize smuggling due to its high price in the commodity market. Besides, it can be further enriched in proper facilities, becoming, then, more dangerous.

Nuclear fuel

Most nuclear reactors operate on low enriched uranium (LEU), which stands for ^{235}U concentrations of 3-5%. Some universities and research institutes, however, use concentrations as high as 12% or 19,75% [5], since experiments must be efficient with lower quantities of material. Although those materials cannot be directly used for weapon purposes, if furtherly enriched to more than 20%, they can become a threat. Furthermore, universities and research facilities, unlike nuclear installations, have low security levels, offering more opportunities for robbery and theft.

Burned nuclear fuel

Irradiated nuclear fuel is highly radioactive, since it contains transuranic fission products generated on the reactor core [5]. However, while turning it into an interesting candidate for RDDs, with a large number of victims and exclusion zones, this same feature makes it difficult to manipulate, since absorbed doses in a short period larger than 1 gray (Gy) can lead to acute radiation syndrome (ARS). This can disable individuals involved in production, transport and actual use even before the implementation of such devices. Nonetheless, an attack to a spent fuel storage facility can result in tragic consequences, such as radiation exposing, large number of victims and exclusion areas [6].

Commercial radioactive sources

Although a significant number of norms and regulations as far as transport and storing of radioactive sources exist, along with radiological protection and dosimetry [5], security is still mostly neglected. As a result, most thefts and losses occur during transport. This is worldwide problem [7]. The Goiânia radiological accident is an example of the threat posed by these largely available materials when in wrong hands – be it for ignorance or criminal intentions. Although the actual number of victims is low compared to a nuclear weapon attack, this kind of incident relies, mostly, on another terror weapon, the psychological effects of panic [6], leading to overcrowded hospitals and disturbances in the public order.

Conclusions

It is possible to predict the uses and comprehend the threat offered by illicit trafficking and smuggling of radioactive and nuclear materials using their characteristics as guide. This can be performed combining knowledge of nuclear physics, radiochemistry and public security with material information collected onsite. The identification of the intercepted material and its origin can prevent or turn more difficult terrorist acts which would apply materials provided by the same sources [1]. Besides, effective nuclear forensic analysis can avoid that certain agents necessary to nuclear terror be reached by malicious individuals, since it encourages states to improve their materials and nuclear facilities security.

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