



Safety and Security issues during the return of contaminated scrap metal to Brazil

M. C. ALMEIDA¹, P. R. PERROTTA², R. SANTOS³, D. A. ANDRADE⁴, M. A. V. WASSERMAN⁵

¹*madison.almeida@hotmail.com* ²*patrick.perrotta@ird.gov.br* ³*raul.santos@ird.gov.br* ⁴*delvonei@ipen.br*
⁵*maria.wasserman@ird.gov.br*

^{1, 4}*Instituto de Pesquisas Energéticas e Nucleares*
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP

^{2, 3, 5}*Instituto de Radioproteção e Dosimetria*
Av. Salvador Allende 3773
22780-160 Rio de Janeiro, RJ

1. Introduction

The response to radiological or nuclear emergency presupposes the use of a set of facilities, techniques, and procedures. In Brazil, the nuclear regulatory body, the National Nuclear Energy Commission (CNEN) is responsible for these actions, considering both national standards and the safety standards from the International Atomic Energy Agency (IAEA). Specialized teams, members of the CNEN's Technical and Scientific Units, carry out planned and unexpected actions, which generally result in the identification, characterization and eventual recovery and storage of radiation sources and radioactive waste. CNEN has the legal responsibility for the service mentioned here, as well as for the storage of eventual radioactive wastes [1].

In December 2021, CNEN was notified of a detection alarm in the Port of Malta during transshipment operation [2], originated from a container of scrap metal, exported from Brazil to Bangladesh. Initial information reported a hot spot of 400 microSievert/hour and the isotope Ra-226 was identified as the responsible for the alarm. No contamination was found at the external surface of the container. It was then necessary to return the container to Brazil, according to international protocols for the maritime transport.

From this moment on, coordination was carried out with the cargo agent, the maritime operator, and the port operator, in Suape (municipality of Ipojuca, State of Pernambuco). The Port of Suape was designated as the recipient by the cargo agents, due fact that the owner of the shipment was a scrap company based in the interior of the State of Pernambuco (city of Caruaru). Subsequently, police and port authorities were also notified, and coordination actions took place. The protocols followed, in these cases, are included in CNEN Standard 3.01-Basic radiological protection guidelines – and the CNEN's Emergency Response Plan.

Recycled scrap is described as one of the most traded “commodities” worldwide, representing a multibillion-dollar industry [3]. The IAEA has established an online tool to record cases in which metal scrap is exported between countries and, inadvertently, a source of ionizing radiation is found among the material that will be recycled [4].

2. Methodology

There was exploratory bibliographic research, in specialized literature on the topic and in the normative framework as well, in which the collection of information about cargo with suspicion or evidence of radioactive material inside is dealt. In terms of standards, those relating to radiological protection and safety

were the basis for the study.

The Division of Radiation Emergency Preparedness and Response (DIEME), from the Institute of Radiation Protection and Dosimetry (IRD) of the CNEN was designated to coordinate the operations of the recovery of the source. Many scenarios were analyzed considering the information received from the Malta's authorities. Conversations and virtual meetings were conducted to prepare the response to the incident, during it and after its ending also substantiated the research. In terms of standards consulted, it should be noted that the CNEN regulatory body covers: (i) supervision of activities related to materials and minerals of interest to the nuclear area as well as supervision of radiological protection conditions for workers in such fields; (ii) licensing of nuclear and radioactive installations; the regulation and control of the transport, treatment and storage of radioactive waste; (iii) responding to requests for assistance, complaints and emergencies, with sources of ionizing radiation; (iv) issuance of regulations concerning the broad framework of nuclear and radiological safety, covering the inspection and licensing already addressed.

An innovative proposal, in terms of radiometric conduct, was made during the inspection; with measuring equipment in a casing, attached to the claw that would remove the scrap from the container.

3. Results and Discussion

As soon as information was received at CNEN, through the cargo agent, that the Commission for the Protection from Ionizing and Non-Ionizing Radiation of the Government of the Island of Malta had discovered an abnormality in a cargo, actions and planning began, with the opening of an administrative process at the CNEN Research and Development Directorate. Documentation was provided, enabling discussions and referrals.

It was a delivery of metal scrap amount, shipped by the company on December 14, 2021, from Manaus harbor to Bangladesh, detained in Malta, due to the discovery of radioactive material inside the cargo container, when passing through a detection portal, during transshipment from one vessel to another.

A CNEN professional for the operational coordination was allocated, as its leader, with a sub-coordinator and an assistant, beyond the monitoring, logistics and transport groups. Protocols comprised the need to isolate the cargo after unloading, establishing a protected area in the premises (surveillance included), and convenience of expediting the arrival at the landing site in Brazil, starting necessary actions to locate and identify the material immediately after unloading the container.

Successful actions undertaken can be consolidated here:

- 1) designated a single CNEN interlocutor with the company responsible for receiving the container;
- 2) director of CNEN making contacts at the decision-making level, with the participation of the authority's Deliberative Committee;
- 3) the operational coordination of the Nuclear and Radiological Emergency Response System (SAER) established a detailed work plan, with:
 - (i) definition of SAER team members;
 - (ii) initial assessment of the occurrence;
 - (iii) assessment of logistical needs;
 - (iv) prediction of the final destination of the material;
 - (v) planning to material transport to its destination (shield, vehicle, transport plan, etc.).

Coordination with the Pernambuco Social Defense Secretariat was essential, as well as with the port police authority, formalizing the need for escort by the Federal Highway Police, for the land transport stages: Ipojuca-Caruaru and, later, Caruaru-Recife.

Caruaru, PE, was the place of origin of this cargo, where is located the company that owned it. It was the recommended location for the source recovery operation (opening the container), in safe conditions. The identified material would then go to Recife-PE, for storage at the Regional Center for Nuclear Sciences – Northeast (CRCN-NE) Intermediate Radioactive Waste Deposit.

3.1 Planning and execution

The CNEN-NN-3.01 standard allowed the preparation of SAER Initial Assumptions (AI) for the occurrence:

AI-01: The information sent by the freight forwarder and Maltese authorities was the starting point for the work plan: (i) dose rates at the hot spot on the surface of the container; (ii) identification of the nuclide Ra-226; (iii) assumption that there was no contamination on the external surface of the container. All three to be confirmed during the operation.

AI-02: To be conservative, CNEN team would consider that the operation is about a recovery of a dangerous source;

AI-03: Initially, it was used the operational intervention level of 100 microSv/h to establish the safety perimeter;

AI-04: Planning possible radiation doses for everyone involved in the operation will comply with the criteria of Standard CNEN-NN-3.01.

Regulatory position 3.01/006:2011 – Protection measures and intervention criteria in emergency situations – complements the aforementioned standard, in terms of its requirement “6.1.3”, concerning to interventions to protect individuals from the public. Relevant protective measures include “shelter, evacuation and administration of stable iodine, which can be complemented by additional actions, such as access control, respiratory protection and decontamination” [5], if necessary.

The operation was also conducted with reference to the International Atomic Energy Agency (IAEA) document entitled EPR-Method-2003 [6], in particular the action guide “recovery of an uncontrolled dangerous source”.

A radiometric survey was carried out to characterize the background radiation, especially in the area planned for the unloading of the container, the day before disembarkation. If “hot spots” (with radioactive emissions) were found, which could affect the container monitoring work, the unloading area would be switched.

Disembarkation at the Port of Suape took place on 06/23/22, at 01:30 AM. On the same day, in order to save time, CNEN team went to the port again. It was planned, for the same day, with an agile operation to unload the ship, confirm the issue and, with agile logistics, identification and segregation in Caruaru and subsequent transportation to Recife. What happened, indeed.

3.1.1 Port inspection and container inspection in Caruaru-PE

The operation began on June 23, 2022, at 5:00 AM. After carrying out radiological monitoring, with external radiological monitoring of the container and identification of radioactive material, the container was taken to Caruaru-PE by road transport.

Upon arrival, a search, identification, characterization, and segregation of the radioactive material was carried out. Professionals from the two units mentioned here participated in the operation. CRCN-NE is the CNEN Institute closest to the incident and with technical service capacity. Institute of Radioprotection and Dosimetry (IRD) is the CNEN Institute that centralizes the SAER, in Rio de Janeiro. The team was made up of technologists, researchers, and technicians, with a total number of 14 professionals from the two Institutes.

3.2 Finding

Transport of the container was carried out after taking measurements of dose rates (around 400 microSv/h) and identification of radionuclide (Ra-226) in Suape, as already mentioned, for evaluation in Caruaru. Radiometric survey was previously carried out in that city, before the container arrived, to characterize the background radiation (found normal level) of the site, especially in the area planned for the container opening and searching for the radioactive material (same protocol carried out at the port). A set of shields was made available for the initial storage and subsequent transport of the source. Depending on its volume and weight, additional shielding could be necessary. Which didn't happen.

With the container positioned in the company's yard, the operation began. After 18 removals with a mechanical winch shovel (figure 1) – each removal being monitored – the emission source was identified using a detector protected and positioned, like a pendulum, in the claw that removed the material (figure 1). The detector warned when the emission source was found, which was confirmed by a professional, who was positioning a rod with another detector (figure 2). After removal with detection, the material was segregated, and the source

was then found; identifiers gauged dose values previously obtained, confirming Ra-226 emission. Characterized as a source for industrial use: a lightning rod with Ra-226. It was then placed into a container and transported to the Northeast Regional Center for Nuclear Sciences.



Figures 1 and 2 – Respectively, arrow indicating the packed detector, attached to the winch claw; and measurement made with rod.

4. Conclusions

The activity of responding to radiological and nuclear emergencies, crucial for the country's security, lays in global and national normalization. At an international level, the IAEA is the body issuing guidance and good practices to its Member States. CNEN rules all Brazilian nuclear and radiological activity in terms of safety and security. Teams from the two CNEN institutes that carried out this mission complied with the prescribed procedures, resulting in a standardized process that brought security to everyone involved, directly or indirectly.

The occurrence covered in this study originated from a maritime transshipment of containerized cargo, exported from Brazil to Bangladesh. The detection occurred in Malta, and from then on, all protocols were activated to return the cargo and safely investigate it. The main lessons learned from this operation were the importance of adequate coordination, information and cooperation of public bodies. Centralized dialogue and coordination, meticulous planning, the transmission of accurate information to those involved and the subdivision of professionals into thematic groups were also major success factors.

Acknowledgements

Acknowledgements are granted to the CNEN Radioprotection and Nuclear Safety Directorate, Institute of Radioprotection and Dosimetry, and Regional Center for Nuclear Sciences - Northeast.

References

- [1] BRASIL. Lei nº 10308, de 20 de novembro de 2001. Brasília, DF: Diário Oficial da União, 2001.
- [2] COMISSÃO NACIONAL DE ENERGIA NUCLEAR. Processo SEI nº 01341.000507/2022-89. 2022.
- [3] KOPSIK, D., CHEN, S. Y., TURNER, R., MAGOLD, M., POPE, R. B. International approach to monitoring for radioactively contaminated scrap metal. WM'05 Conference. Tucson: U.S. Environmental Protection Agency, 2005.
- [4] DOJCANOVA, Lenka. Behind the Scenes of Scrap Yards: IAEA Launches Online Tools on the Control of Radioactive Material Inadvertently Incorporated into Scrap Metal. Vienna: IAEA, 2020.
- [5] COMISSÃO NACIONAL DE ENERGIA NUCLEAR. Posição regulatória 3.01/006:2011. Rio de Janeiro: Diretoria de Radioproteção e Segurança Nuclear. CNEN, 2011.
- [6] INTERNATIONAL ATOMIC ENERGY AGENCY. EPR-Method-2003. Vienna: IAEA, 2003.