SECURING RADIOACTIVE SOURCES THROUGH A PROPER MANAGEMENT

Rogério Pimenta Mourão

1 Serviço de Gerência de Rejeitos
Centro de Desenvolvimento da Tecnologia Nuclear, CDTN
Av. Presidente Antônio Carlos, 6627
30.161-970 Belo Horizonte, MG
mouraor@cdtn.br

ABSTRACT

The safety and security of radioactive sources have become a hot issue for the nuclear community in the last two decades. The Goiania accident in Brazil and the September 11th attack alerted governments and nuclear agencies around the world to the vulnerability of the thousands of disused radioactive sources ill-stored or misplaced in a myriad of ways, especially in countries with less developed infra-structure. Once the threat of environmental contamination or malevolent use of these sources became clear, the International Atomic Energy Agency and the American Government spawned initiatives to reduce this risk, basically stimulating the proper conditioning of the sources and, whenever possible, seeking their repatriation to the countries of origin. Since 1996 Brazil has been participating actively in this effort, having carried out hands-on operations to condition old radium sources in Latin American and Caribbean countries and also repatriated its own neutron sources to the United States. A new operation is presently being organized: the reconditioning of the high activity sources contained in teletherapy units stored in the country using a mobile hot cell developed in South Africa. Also an agreement is being negotiated between the US National Nuclear Security Agency and the Brazilian CNEN to repatriate hundreds of radioactive gauges presently stored at CNEN’s source storage buildings.

1. INTRODUCTION

Two unfortunate events occurred in the last twenty years attracted the attention of the global nuclear community to a specific class of radioactive materials. In fact, the Goiania accident in Brazil in 1988 and the September 2001 attack showed that the safety and security of the thousands of disused radioactive scattered around the world were in no ways to be taken as guaranteed. Once it became clear that environmental contamination or malevolent use of these sources were more likely than so far thought, the International Atomic Energy Agency and the American Government spawned initiatives to reduce this risk, basically stimulating the proper conditioning of the sources and, whenever possible, seeking their repatriation to the countries of origin [1].

The Centro de Desenvolvimento da Tecnologia Nuclear (Center for the Development of Nuclear Technology) – CDTN – has been actively engaged in cooperation programs for disused source management throughout the Latin American and the Caribbean region since 1996. The CDTN source conditioning team participated since the beginning in the IAEA-sponsored radium sources conditioning effort in the region, which included the preparation of the technical procedures for the operations and the performance of the operations in the different countries in the continent. Also one operation was carried out in Nicaragua to safely condition three Cobalt teletherapy heads stored under very precarious conditions in the premises of an old hospital. In another initiative, the team started its participation in an US State Department-sponsored program for the repatriation of disused transuranic sources.
presently stored at users’ premises or under regulatory control in different countries in the region. The first operation of this program was carried out in Brazil on September 2007, resulting in the repatriation of about 130 neutron sources to the United States. The next steps to be followed are the repatriation of US-origin industrial gauges and the reconditioning of old teletherapy heads in a mobile hot cell developed in South Africa.

2. SECURING BRACHYTHERAPY SOURCES IN LATIN AMERICA AND THE CARIBBEAN

Old radium sources represent a particular safety problem because of the generation of radon gas due to the radioactive decay of Ra226. The resulting pressure increase in the interior of the sources often resulted in the appearance of cracks in the source cladding and in the consequent radioactive material leakage. This problem was fully recognized in the decade of 1990, when a worldwide program to safely condition these sources was launched by the IAEA.

The operations for the safe conditioning of old disused radium sources were carried until 2008 and over 50 conditioning operations were conducted in about 45 countries, resulting in the conditioning of approximately 10,000 individual sources [2]. Besides radium sources – the main focus of the program – also a few disused caesium sources were also found and separately conditioned.

The CDTN team operated from 1996 to 2005 in Latin American and in the Caribbean region, completing twelve missions abroad, which, added to the in-house operations, resulted in the conditioning of a radium activity of 525 GBq [3]. The visited countries were Uruguay, Nicaragua, Guatemala, Ecuador, Paraguay, Costa Rica, Jamaica, Venezuela, Dominican Republic, Colombia, Barbados and El Salvador. Besides, CDTN sent the necessary shields and containment capsules to Chile, Peru and Cuba, whose local teams, under the supervision of IAEA officers, carried out sources conditioning operations.

As a result of the operations conducted by the CDTN team, 26 packages suitable for transport and for long-term storage were produced. These packages are now under the control of the respective national authorities. Figs. 1 and 2 show typical packages generated during the radium conditioning operations.
3. NEUTRON SOURCES REPATRIATION

The security of high toxicity sources has been the subject of an increasing concern by the nuclear community. In line with this reality, the Brazilian Nuclear Energy Commission (CNEN), the US Department of Energy and the IAEA have been conducting since June 2007 a cooperation agreement aiming at the repatriation of the disused neutron sources presently stored in Brazil and other Latin American countries. Due to the previous experience gathered in the conditioning of disused radium sources, CDTN has been chosen to be the implementer of this program.

In the first phase of the program, the Brazilian source inventory was conditioned for repatriation to the United States. The sources and source-containing gauges had being kept in intermediate storage buildings at CDTN in Belo Horizonte, and IPEN, another Brazilian nuclear institute in São Paulo. The national inventory consisted of 85 Am241-Be moisture gauges, 14 Am241Be-Cs137 moisture/density gauges, six Ra226-Be moisture/density gauges, three Pu239-Be and six Cf252 sources, one Pu238 pacemaker and three other Pu238 sources. Figure 3 illustrates the moment that a source-laden Plexiglas holder was loaded into an appropriate package. The used packages are certified in the United States for the transportation of Type A Fissile material.

As a result of this operation, 17 packages were generated, as detailed in Table 1. The packages were conditioned in an ISO container and shipped to the United States.
Figure 3. Neutron sources being conditioned in a certified package.

Table 1. Packages generated during the neutron sources conditioning

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Number of packages</th>
<th>Total Activity (GBq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am241-Be</td>
<td>10</td>
<td>5,368</td>
</tr>
<tr>
<td>Pu239-Be</td>
<td>01</td>
<td>185</td>
</tr>
<tr>
<td>Pu238</td>
<td>01</td>
<td>95</td>
</tr>
<tr>
<td>Ra226-Be</td>
<td>01</td>
<td>6.5</td>
</tr>
<tr>
<td>Cf-252</td>
<td>01</td>
<td>5.4</td>
</tr>
<tr>
<td>Am241-Be-Cs137</td>
<td>03</td>
<td>33,674 (Am241) / 6,290 (Cs137)</td>
</tr>
</tbody>
</table>

4. TELEATHERAPY SOURCES CONDITIONING

Teletherapy sources are classified as Category 1 sources according to the IAEA’s categorization system [4]. As such, they constitute a primary safety and security concern. The radiological accidents in Goiânia, Brazil, in Turkey and in Thailand [5 to 7] highlighted the risks posed by orphan teletherapy sources.
Brazil participated in 1999 in an IAEA-sponsored operation to condition three old cobalt teletherapy heads stored under unacceptable conditions in Nicaragua. The approach chosen was to lodge the heads in portable units so that at any moment in the future the sources could be retrieved and treated or disposed of accordingly. The operation was carried out in the premises of the former El Retiro Hospital in Managua, from 20 May to 02 June 1999.

The available information about the heads is presented in Table 2 below.

### Table 2. Cobalt teletherapy heads conditioned in Nicaragua

<table>
<thead>
<tr>
<th>Head Nr.</th>
<th>Manufacturer</th>
<th>Activity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neutron Products Inc.</td>
<td>4,140</td>
<td>Donated by Organization of the American States</td>
</tr>
<tr>
<td>2</td>
<td>Westinghouse</td>
<td>180</td>
<td>Installed in 1963, use discontinued in 1993</td>
</tr>
<tr>
<td>3</td>
<td>N/A</td>
<td>20</td>
<td>Buried 2m deep for long period</td>
</tr>
</tbody>
</table>

The heads were conditioned individually in containers consisting of internal and external stainless steel cylinders, the void space filled with concrete (Figure 4). To avoid unintentional or unauthorized removal of the cobalt head, the internal cavity is locked after loading by two steel bars cross-welded upon the cavity. The container’s lid and body are fixed together by welding.

![Figure 4. Conditioning of cobalt heads](image-url)
Another conditioning operation for teletherapy sources is planned for the near future in Brazil. Approximately 70 disused teletherapy units are presently stored at CNEN’s institutes and the reconditioning of this inventory would mean an optimization of storage space and an improvement of the safety and security of the intermediate storage buildings. The activity contained in these units represents more than 90% of the total activity of the countries disused sources.

The planned operation will consist of the transfer of the sources from the heads to a specially designed long term storage shielding. The transfer operation will be carried out in a mobile hot cell developed in South Africa under the scope of an IAEA regional project for Africa [8]. Figs. 5 and 6 show respectively the mobile unit, not completely set up, and the long term storage shielding.

A fact-finding mission was carried out by the IAEA in February to gather information on the Brazilian teletherapy source inventory and available infra-structure and to discuss safety and security issues related to the conditioning operation. It is foreseen that the operation in Brazil can be carried out in 2010, if the necessary funds are available. Two operations are previewed for the present year – 2009 –, both in Africa, specifically in Sudan and Tanzania.

**Figure 5. Mobile unit for high activity source dismantling**  
**Figure 6. Long term storage shielding**

5. REPATRIATION OF DISUSED INDUSTRIAL GAUGES

In another initiative, CNEN and the US National Nuclear Security Agency are also considering starting cooperation for the repatriation of American-origin disused industrial gauges containing Categories 1 and 2 sources. Similar operations have already been carried out in other Latin American countries, e.g. Chile and Ecuador.

There are hundreds of such equipments presently stored at CNEN´s institutes, therefore Brazil would benefit from this cooperation.
6. CONCLUSIONS

The proper management of radioactive sources is paramount in the success and public acceptance of the nuclear industry around the world. Experience has shown that disused sources, especially those still at the users’ premises, are the most prone to accidents or to be used for unwanted purposes. It was also realized by the countries that experienced accidents with these sources that the remediation operations can be dramatically costly and traumatic to the communities or persons affected.

One effective way to minimize the risks of accidents involving unwanted radioactive sources is to collect them in a centralized facility, preferably under the supervision of the local nuclear authority, keeping a good-quality database with the main information about the sources. Another path to be sought whenever possible is to send the sources back to the manufacturer or repatriate them to the country of origin. Countries with less developed infrastructure or little use of nuclear techniques can request assistance from the International Atomic Energy Agency or from countries with more advanced expertise.

In this context, Brazil has been actively involved in its geographical region, carrying out source conditioning operation in Latin America and the Caribbean under international cooperative projects. Since 1996, twelve radium sources conditioning operations, as well as one cobalt teletherapy conditioning operation, have been carried out in the region. Besides, Brazil has repatriated its entire surplus neutron sources inventory, during an operation carried out with the assistance of the US Department of Energy.

The next previewed steps involve the repatriation of the industrial gauges of American origin presently stored at the Brazilian intermediate stores and the re-conditioning of teletherapy sources using a mobile unit. This operation can also be carried out in the future in different Latin American countries, by a Brazilian team to be trained during the operation planned to Brazil in 2010.

7. ACKNOWLEDGMENTS

Work supported by the Minas Gerais State FAPEMIG – Fundação de Amparo a Pesquisa do Estado de Minas Gerais.

REFERENCES

5. INTERNATIONAL ATOMIC ENERGY AGENCY, “The radiological Accident in Goiânia”, Vienna, 1988  