INTEGRATED MANAGEMENT PROGRAM FOR RADIOACTIVE SEALED SOURCES IN EGYPT*

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ABSTRACT

The radioactive materials in “public” locations are typically contained in small, stainless steel capsules known as sealed radiation sources (RS). These capsules seal in the radioactive materials, but not the radiation, because it is the radiation that is needed for a wide variety of applications at hospitals, medical clinics, manufacturing plants, universities, construction sites, and other facilities in the public sector. Radiation sources are readily available, and worldwide there are hundreds of thousands of RS.

The accidental mismanagement of RS has caused a large number of people to receive very high, and even fatal doses of ionizing radiation. As an example, in Goiania, Brazil, four people died, and hundreds more were injured when a stolen radiation source deliberately opened.

The deliberate mismanagement of RS is also of growing international concern. Because of their small size, potency, availability, and “nuclear” nature, there is concern that a terrorist could use a radiation source to create a “radiological weapon,” or “dirty bomb.” The ruthlessness of the Sept. 11 attacks makes it clear that the risks of a nuclear terrorist act are higher than previously thought, says Mohamed ElBaradei, Director General of the International Atomic Energy Agency (IAEA).

The IMPRSS Project is a cooperative development between the Egyptian Atomic Energy Authority (EAEA), Egyptian Ministry of Health (MOH), Sandia National Laboratories (SNL), New Mexico Tech University (NMT), and Agriculture Cooperative Development International (ACDI/VOCA). SNL will coordinate the work scope between the participant organizations.

The EAEA, MOH, SNL, ACDI/VOCA and NMT propose to work cooperatively to develop an integrated program for managing RS in Egypt. The IMPRSS Project will enable Egypt to manage all aspects of RS, from an education awareness program to recovery, storage, and ultimate disposal of unwanted sources.
INTRODUCTION

In the spring of 2000, three people died in Egypt because of a sealed source that came into the possession of a farmer. As this incident illustrates there is possibility of death and injury to the public due to sealed sources. Other incidents around the world show the possibility of sealed sources adversely affecting the health of hundreds or thousands of people and causing very large environmental contamination problems. Mismanaged sealed sources can have a devastating effect on health and environment. Maliciously used sealed sources pose an even greater risk. Therefore a program is needed in Egypt, which leads to the safe and secure management and use of sealed sources.

For over half a century, nuclear and chemical technologies have been contributing to a better quality of life in Egypt in a wide variety of fields including energy, medicine, agriculture, economic development, and environmental protection. Almost all IAEA Member States use sealed sources in medicine, industry, agriculture, and scientific research, and these countries remain responsible for safe handling and storage of both the sources themselves and all radioactively contaminated waste that result from their use.

Sealed sources must be managed and disposed effectively in order to protect human health and the environment. Effective national safety and management infrastructures are prerequisites for efficient and safe sealed sources transportation, treatment, storage, and disposal.

Mismanaged sealed sources could result in severe environmental degradation; affect the quality of water, and over-expose humans to radiation. Egypt’s Environment Law 4 of 1994 specifies a process and timeframe for meeting air and water pollution standards. Other recent policy reforms directly address Nile water quality, the reuse of drainage water, improved irrigation practices and other critical water management improvements. Despite these advances, poor enabling conditions and weak implementation detract from even greater regulatory applications, and the current laws that regulate the handling and managing of sealed sources are not strong enough. The current responsibilities for sealed sources are divided between the Ministry of Health that awards the licensing for importing sealed sources, and the EAEA that handles unwanted sealed sources.

In order to address issues related to the effects of sealed sources management on the environment, the IMPRSS Project is aimed at helping the Government of Egypt formulate policies and regulatory standards as well as increase institutional capability for monitoring and tracking all operational and unwanted radioactive sealed sources. The Project will also help promote the adoption of best practices and technologies to perform the work. A far-reaching goal is cost recovery of management services for sealed sources, which is an important process to ensure the sustainability of the work in the future.
2. BACKGROUND

Sealed sources are used daily in a wide range of applications (Harris, 1994), which have enhanced human lives for the past 40 years. Table 1. shows the different types of radioisotopes and their applications. Sealed sources are:

- typically stainless steel capsules
- air-tight and very durable
- contain one of hundreds of elements or isotopes of elements (e.g., iridium, radium, etc.)

The capsules seal in the radioactive materials but not the radiation, because it is the radiation that is used by manufacturing plants, hospitals, and others.

Radiation sources have contributed to several incidents around the world that resulted in human over-exposure and/or environmental degradation. Accidents due to radiation from spent sources have led to amputation and death. If a sealed source is damaged, the effect on the environment may be contamination of buildings and the surrounding area. The high specific activity of the material in sealed sources means that the spread of as little as microgram quantities of its contents into the environment can generate significant risk to humans and inhibit the use of buildings and land. The cost of decontamination can be very high. Accidents with spent sources have already caused extensive and costly contamination of the environment.

Proper management of sealed sources will not only prevent such incidents in the future, but also ensure no environmental or health degradation resulting from their disposal. If improperly managed, these sources can cause serious injury, or even death. Within the past several months the mismanagement of sealed sources has resulted in a number of unfortunate deaths and serious radiation injuries. An additional goal of the project is to help create a mechanism by which a routine disposal option is available, such that future unwanted sealed sources would have a direct disposal path at a cost that encourages appropriate management by licensees.

2.1 Peaceful Applications of Sealed Sources

2.1.1 Medical Applications

Hospitals and medical clinics are among the largest users of RS. Radioactive sources are typically used for teletherapy and brachytherapy. Until the 1950's, the only significant sealed RS produced were the radium-226 sealed RS that were used for brachytherapy. Most of the old radium sources used in brachytherapy have been replaced by cobalt-60, cesium-137 and iridium-192. Cobalt-60 is the most common radionuclide used in teletherapy, although some cesium-137 sources are also in use. The cobalt and cesium teletherapy sources are some of the largest curie sources in public use (IAEA, 1991, p. 10).
Table 1. Application of radioactive sealed sources in medicine, industry and research fields, (Van Blerk et al., 1999)

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Half-Life (a=years; d=days)</th>
<th>Source Activities</th>
<th>Applications</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>241Am</strong></td>
<td>433 a</td>
<td>1-10 GBq</td>
<td>Bone desitometry</td>
<td>Mobile units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-10 GBq</td>
<td>Density gauge</td>
<td>Fixed installations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-4 MBq</td>
<td>Static eliminators</td>
<td>Fixed and portable units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50-500 MBq</td>
<td>Lightning preventer</td>
<td>Fixed installations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.02-3 MBq</td>
<td>Smoke detectors</td>
<td>Fixed units</td>
</tr>
<tr>
<td><strong>241Am/Be</strong></td>
<td>433 a</td>
<td>1-800 GBq</td>
<td>Well logging</td>
<td>Portable units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1-2 MBq</td>
<td>Moisture detector</td>
<td>Portable units</td>
</tr>
<tr>
<td><strong>153Gd</strong></td>
<td>242 d</td>
<td>1-40 GBq</td>
<td>Bone desitometry</td>
<td>Mobile units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-10 GBq</td>
<td>Bone desitometry</td>
<td>Mobile units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50-1500 MBq</td>
<td>Manual Brachytherapy</td>
<td>Small portable units</td>
</tr>
<tr>
<td><strong>125I</strong></td>
<td>60 d</td>
<td>1-40 GBq</td>
<td>Bone desitometry</td>
<td>Mobile units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50-1500 MBq</td>
<td>Manual Brachytherapy</td>
<td>Small portable units</td>
</tr>
<tr>
<td><strong>129I</strong></td>
<td>1.57E+7 a</td>
<td>&lt;4 MBq</td>
<td>Calibration sources</td>
<td>Fixed or mobile units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 d</td>
<td>50-1500 MBq</td>
<td>Manual Brachytherapy</td>
</tr>
<tr>
<td><strong>137Cs</strong></td>
<td>30 a</td>
<td>50-1500 MBq</td>
<td>Manual Brachytherapy</td>
<td>Small portable units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.03-10 MBq</td>
<td>Remote Brachytherapy</td>
<td>Mobile units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>500 TBq</td>
<td>Teletherapy</td>
<td>Fixed installations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-100 TBq</td>
<td>Whole blood irradiation</td>
<td>Fixed installations</td>
</tr>
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<td></td>
<td></td>
<td>Up to 13 TBq</td>
<td>Research</td>
<td>Fixed installations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;4 MBq</td>
<td>Calibration sources</td>
<td>Fixed or mobile units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-100 GBq</td>
<td>Well Logging</td>
<td>Portable units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1-2 GHq</td>
<td>Moisture detector</td>
<td>Portable units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.14-40 GBq</td>
<td>Conveyor gauge</td>
<td>Fixed installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-20 GBq</td>
<td>Density gauge</td>
<td>Fixed installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1-20 GBq</td>
<td>Level gauge</td>
<td>Fixed installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1-400 PBq</td>
<td>Sterilization</td>
<td>Fixed installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-100 TBq</td>
<td>Dredgers</td>
<td>Fixed installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;100 TBq</td>
<td>Calibrating facilities</td>
<td>Fixed installation</td>
</tr>
<tr>
<td><strong>226Ra</strong></td>
<td>1600 a</td>
<td>30-300 MBq</td>
<td>Manual Brachytherapy</td>
<td>Small portable units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;10 MBq</td>
<td>Calibration sources</td>
<td>Fixed installation</td>
</tr>
<tr>
<td><strong>57Co</strong></td>
<td>271.7 d</td>
<td>Up to 400 MBq</td>
<td>Calibration sources</td>
<td>Fixed or mobile units</td>
</tr>
<tr>
<td><strong>60Co</strong></td>
<td>5.3 a</td>
<td>50-500 MBq</td>
<td>Manual Brachytherapy</td>
<td>Small portable units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>~ 10 GBq</td>
<td>Remote brachytherapy</td>
<td>Mobile units</td>
</tr>
<tr>
<td>Activity</td>
<td>Concentration</td>
<td>Application</td>
<td>Installation Type</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>---------------</td>
<td>------------------------------</td>
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<td></td>
</tr>
<tr>
<td>89Sr</td>
<td>50.5 d</td>
<td>Vascular Brachytherapy</td>
<td>Catheterization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50-1500 MBq</td>
<td>Manual Brachytherapy</td>
<td>Small portable</td>
<td></td>
</tr>
<tr>
<td>90Sr</td>
<td>17 d</td>
<td>Manual Brachytherapy</td>
<td>Small portable</td>
<td></td>
</tr>
<tr>
<td>103Pd</td>
<td>74 d</td>
<td>Manual Brachytherapy</td>
<td>Small portable</td>
<td></td>
</tr>
<tr>
<td>192Ir</td>
<td>0.1-1 TBq</td>
<td>Vascular Brachytherapy</td>
<td>Catheterization</td>
<td></td>
</tr>
<tr>
<td>198Au</td>
<td>2.6 a</td>
<td>Manual Brachytherapy</td>
<td>Small portable</td>
<td></td>
</tr>
<tr>
<td>252Cf</td>
<td>1.01 a</td>
<td>Manual Brachytherapy</td>
<td>Small portable</td>
<td></td>
</tr>
<tr>
<td>106Ru</td>
<td>2.7 d</td>
<td>Manual Brachytherapy</td>
<td>Small portable</td>
<td></td>
</tr>
<tr>
<td>32P</td>
<td>14.3 d</td>
<td>Vascular Brachytherapy</td>
<td>Catheterization</td>
<td></td>
</tr>
<tr>
<td>63Ni</td>
<td>96 a</td>
<td>Calibration sources</td>
<td>Fixed or mobile</td>
<td></td>
</tr>
<tr>
<td>147Pm</td>
<td>2.62 a</td>
<td>Calibration sources</td>
<td>Fixed or mobile</td>
<td></td>
</tr>
<tr>
<td>36Cl</td>
<td>3.01E+5 a</td>
<td>Calibration sources</td>
<td>Fixed or mobile</td>
<td></td>
</tr>
<tr>
<td>85Kr</td>
<td>10.8 a</td>
<td>Level gauge</td>
<td>Fixed installations</td>
<td></td>
</tr>
<tr>
<td>210Po</td>
<td>138 d</td>
<td>Static eliminators</td>
<td>Fixed installations</td>
<td></td>
</tr>
<tr>
<td>3H</td>
<td>12 a</td>
<td>Electron capture</td>
<td>Fixed or portable</td>
<td></td>
</tr>
<tr>
<td>55Fe</td>
<td>2.7 a</td>
<td>X-ray analyzer</td>
<td>Portable units</td>
<td></td>
</tr>
<tr>
<td>109Cd</td>
<td>463 d</td>
<td>X-ray analyzer</td>
<td>Portable units</td>
<td></td>
</tr>
</tbody>
</table>
2.1.2 Research and Education Applications

Radioactive sources that contain a very wide variety of radionuclides are used in education and research. A RS is often purchased for a specific project, and then set aside after the project is completed. During the 1960's, gamma irradiators, containing large quantities of cobalt-60 were used for research purposes. Soil moisture gauges used for agricultural research contain cesium-137 sources, and neutron-producing americium-241/beryllium sources.

2.1.3 Industrial Applications

Irridium-192 is typically used in for industrial radiography, such as the non-destructive imaging of pipe welds. Cobalt-60 and cesium-137 sources are also used for industrial radiography. Large neutron and gamma sources are used in mining oil and gas "well logging." These neutron sources contain either plutonium-238 / beryllium or americium-241 / beryllium; there are also a few radium-226 / beryllium neutron sources. The U.S. americium neutron sources have maximum activities up to 60 Ci (Kirmer, 1994, B-10).

Figure 1. RS cases used in oil “well Logging”

The most common industrial RS are in level and thickness gauges. If these gauges are not removed when a factory is closed, the gauges can, and have ended up in metal recycling facilities.

Radioisotope thermoelectric generators (RTGs) use heat generated by decay of radioactive isotopes to produce electrical power. RTGs have no moving parts and can operate for over a decade without refueling. They are used as a power supply where frequent maintenance, or refueling is expensive or impossible. Most terrestrial, U.S. RTGs are fueled with strontium-90. The largest known U.S. RTG (the BUP-500) was fueled with 685,000 curies of strontium-90; however the typical U.S. RTG contains about 50,000 Ci of strontium.
Industrial irradiators, containing americium-241, cobalt-60 or cesium-137 RS are used to sterilize medical products, as well as meat, fresh vegetables, and other foods. Although physically small (say 40 cm\(^3\)), the RS in irradiators are high-activity. The highest activity cesium irradiator in the U.S. contains 213,000 Ci of cesium-137 (Harris, 1994, page B-13), although most contain less than 12,000 Ci.

### 2.2 Number of Sealed Sources

Sealed sources are commonly available and are used daily in the public sector. The IAEA estimated that there are approximately 500,000 sealed sources worldwide (IAEA, 1991, p. 12). Of the 500,000 RS, the IAEA estimates that approximately 100,000 are "excess." (IAEA, 1991)

Table 2, lists the inventory of spent sources in Egypt, Algeria, Tunisia, and Ghana (IAEA, 1999, p.17-19). As in all countries, the actual number of RS in Egypt is not known, and is probably much higher than what is reported in official records. For developing countries, the IAEA estimates that the total number of RS may be ten times the official, recorded inventory (IAEA, 1991, p. 25).

### 2.3 Accidental Misuse of Radioactive Sources

Accidental misuse of RS has caused significant environmental contamination, thousands of overexposures, and many deaths. The high specific activity of the material in many RS means that the spread of as little as microgram quantities of its contents can generate significant risk to humans and inhibit the use of buildings and land. The cost of decontamination can be very high.

Because sealed RS are small, steel, and appear harmless, a significant number are accidentally melted in steel recycling operations. In 1983, a steel recycling plant in Juarez, Mexico accidentally melted a cobalt RS during steel recycling operations. The recycled steel products were not immediately identified as being contaminated.

Because recycled steel is traded internationally, the recycled steel was sold in Mexico and the U.S. The accident caused significant pollution in both countries. Although there were no deaths, the pollution was estimated to affect the health of several thousand people and tens of millions of dollars were spent cleaning up contaminated soils, and buildings on both sides of the border. The contaminated steel was used in the manufacture of furniture. All of this furniture had to be managed as radioactive waste, and some houses had to be demolished because of their construction with contaminated steel rebar. (IAEA, 1991)

Even in the U.S., with its advanced infrastructure, radioactive materials have been discovered more than 2,400 times in scrap yards and steel mills since the accident in Juarez. Not all these sources were discovered prior to recycling; U.S. steel plants and
Table 2. Summary of the available sealed source inventories of a number of African countries.

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Egypt</th>
<th>Algeria</th>
<th>Tunisia</th>
<th>Ghana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Total Activity (Ci)</td>
<td>Number</td>
<td>Total Activity (Ci)</td>
<td>Number</td>
</tr>
<tr>
<td>$^{60}$Co</td>
<td>266</td>
<td>2.22E+1$^a$</td>
<td>2</td>
<td>2.00E-1</td>
</tr>
<tr>
<td>$^{57}$Co</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>2.00E-5</td>
</tr>
<tr>
<td>$^{137}$Cs</td>
<td>44</td>
<td>3.17E+1</td>
<td>36</td>
<td>9.44E+0</td>
</tr>
<tr>
<td>$^{241}$Am/Be</td>
<td>40</td>
<td>3.05E+2</td>
<td>5</td>
<td>2.50E-1</td>
</tr>
<tr>
<td>$^{241}$Am</td>
<td>-</td>
<td>-</td>
<td>569</td>
<td>2.94E-3</td>
</tr>
<tr>
<td>$^{226}$Ra</td>
<td>124</td>
<td>536 (mg)</td>
<td>9</td>
<td>6.09E-4</td>
</tr>
<tr>
<td>$^{192}$Ir</td>
<td>-</td>
<td>-</td>
<td>22</td>
<td>2.20E+3</td>
</tr>
<tr>
<td>$^{238}$Pu</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1.00E-1</td>
</tr>
<tr>
<td>$^{226}$Ra/Be</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>4.20E-1</td>
</tr>
<tr>
<td>$^{241}$Am-Be</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$^{137}$Cs</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$^{169}$Yb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$^{137/147}$Pm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>$^{90}$Sr</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$^{109}$Cd</td>
<td>-</td>
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<td>-</td>
</tr>
</tbody>
</table>

$^a$ Corrected for decay

Note: The number of sources in actual use is not known but is expected to be much higher than the number of spent sources.
other metal fabricators have accidentally melted nuclear materials more than 30
times, forcing them to pay an estimated U.S. $300 million in cleanup costs. (Fitzgerald
and Pillets, November 22, 1999)

In Brazil in 1987, a sealed RS containing cesium-137 was stolen from a closed medical
clinic and deliberately cut open. Children were allowed to play with the glowing material
inside. Within day’s four people had died, several hundred suffered health effects and
there was public hysteria. Contaminated soils and many buildings had to be cleaned-up,
generating approximately 3,500 m³ of radioactive wastes. (IAEA, 1991 and Cameron,
2001)

In 1997, eleven Georgian border guards had to be hospitalized after being exposed to
radiation from hidden RS at a military site. Health officials found other RS lying in the
open countryside and in populated areas. Georgian officials have found more than 300
discarded RS since Georgia achieved independence in 1991. (Lluma, 2000)

In the summer of 2000, Egypt has witnessed one of those incidents where an Ir-192
source was mismanaged and resulted in the death of three persons and radiation over-
exposure for many other villagers (Figure 3). The ultimate goal of the IMPRSS Project is
to prevent these kinds of hazardous incidents in Egypt involving sealed sources, (Perera,
2000).

Figure 2. A down-hole source failure at a drill site in Texas in 1995 resulted in significant
environmental contamination and the need for emergency recovery of the source.

An additional goal of the project is to help create a mechanism by which a routine
disposal option is available in Egypt, such that future unwanted sealed sources will have
a direct disposal path at a cost that encourages appropriate management by source
owners.
Figure 3. Description of an incident in Egypt, where an Ir-192 source was mismanaged and resulted in the death of three persons and over exposure for many other villagers.
2.4 Deliberate Misuse of Radioactive Sources

A water cooler at the National Institute of Health in Bethesda, Md. was deliberately contaminated with radioactive phosphorous in 1995. Twenty-six employees were exposed. The FBI and other agencies were never able to identify the culprit. (Fitzgerald and Pillets, November 21, 1999)

Just before Christmas 1995, dissidents from the breakaway republic of Chechnya sought to strike terror in Russia. They took a cesium RS and planted it in Moscow’s Izmailovsky Park, a popular marketplace. Their plan was foiled when Russian authorities were tipped off and recovered the RS. (Fitzgerald and Pillets, November 21, 1999).

In addition to causing overexposures by hiding a potent RS in a public location, there is also concern that a terrorist could attach a conventional explosive to a RS and create a “radiological weapon,” or “dirty bomb.” A large curie RS, coupled with conventional high explosives, or incinerated, could be used to radiologically contaminate a large area or building, resulting in human exposures and costly cleanup activities.

The detonation of a radiological weapon would be a psychological victory for the terrorists, creating public panic, and demonstrating “nuclear capabilities.”

Security at medical clinics, universities and other locations may be less than ideal and a terrorist could steal a large-curie RS. Once stolen, a RS could be a valuable commodity on the black market and such a source could also be trafficked illegally across country boundaries.

3. WORK ACTIVITIES

Because of the real threat of accidental or deliberate misuses of RS, we are working on a comprehensive project to manage RS in Egypt. The results of the work will be an enabling environment for local enforcement of higher standards for tracking, awareness, physical security, storage, and disposal of sealed RS. Only proper disposal permanently removes unwanted sealed RS from the human biosphere. Additionally, the project will support emergency response capabilities.

The program plan for the IMPRSS Project in Egypt contains four major tasks with nine subtasks. These elements and their goals and proposed activities are listed below:

3.1 Safe Management of In-use Sealed Sources

3.1.1 Tracking and Inventory Control

GOAL: Comprehensive database on the kinds and locations of all sealed sources in Egypt

- Develop computerized database
- Update and validate database
Update data on a periodic basis

3.1.2 Awareness

GOAL: An informed public and sealed sources owners who understand the benefits and hazards of sealed sources

- Provide free training for sealed source owners, physicians, and operators
- Increase public awareness by providing information programs for schools and civic organizations

3.1.3 Security

GOAL: Upgrades to security for high-risk RS at the EAEA storage facilities and evaluate the security arrangement of high-risk RS in the public sector

- Prioritization the RS in Egypt to identify those at greatest risk for accidental or deliberate misuse (potentially use the RS prioritization system that the IAEA is developing)
- Provide training in physical security to EAEA staff
- Provide a review and recommendations for upgrades of physical security at the RS facilities in the public sector

3.2 Safe Management of Unwanted Sealed Sources

3.2.1 Sealed Sources Recovery

GOAL: Equipment and trained manpower to recover unwanted sealed sources in Egypt

- Evaluate capabilities of EAEA for recovery tasks
- Conduct training in Egypt and in the United States
- Update EAEA equipment for full-time operations

3.2.2 Storage and Conditioning of Sealed Sources

GOAL: A safe conditioning and storage facility in Egypt for recovered sources

- Evaluate current storage facilities
- Update storage facilities
- Review conditioning techniques and facilities
- Update conditioning equipment and facilities

3.2.3 Recycling

GOAL: Recycling of unwanted RS to minimize the need for importing new ones and limit the problems related to their storage, conditioning, and disposal.

- Evaluate the recycling options
- Requalification and testing
- Register and distribute recycled RS
3.2.4 Disposal of Sealed Sources

GOAL: A licensed facility in Egypt for disposal of unwanted sealed sources
- Review existing international practices (for example, IAEA guidelines)
- Define selection criteria for disposal site
- Conduct site selection process
- Conduct safety analyses
- Develop site recommendation and begin licensing process

3.3 Emergency Response

GOAL: Capabilities for immediate response to breached or uncontrolled sealed sources in Egypt and remediation of the consequences on human health and the environment
- Furnish EAEA with the necessary equipment for emergency response (for example, survey instruments, protective suits, decon. equipment, etc)
- Conduct training on emergency response techniques and equipment
- Certify first responder

3.4 Policy and Regulatory Reform

GOAL: Policies and regulations governing all aspects of sealed sources management in Egypt
- Review existing regulations
- Review international standards
- Suggest changes in regulations

The IMPRSS Project will focus directly on implementation of integrated management program for sealed sources. Implementation will handle all tracking, monitoring, packaging, transporting, storing, and disposal of unwanted sources. Figure 4, presents the major tasks for integrated management of sealed sources. The last step of the management program, disposal of radioactive sources, is a complex process that will ensure the suitability of the selected site for disposal without any potential for environmental degradation or human exposure.
Integrated Management Program for Radioactive Sealed Sources

- Safe Management of in-use sealed sources
- Regulatory Reform
- Safe Management of Unwanted Sealed Sources
- Emergency Response

- Tracking
- Awareness
- Security
- Recovery
- Conditioning and Storage
- Recycling
- Disposal

Figure 4. Integrated Management of Sealed Sources
4. OBJECTIVES and DELIVERABLES

The IMPRSS project will produce the following deliverables:

4.1 Safe Management of In-Use Sealed Sources

4.1.1 Tracking

1. Up-to-date database that lists all types of radioactive sealed sources in Egypt, types, activity, location, custodian information, and their state of safety and security.
2. Operating procedure for tracking, validating, and maintaining the sealed sources database
3. Quality assurance and quality control procedure for registering and tracking of RS.

4.1.2 Awareness

4. Joint workshop for the Egyptian officials and staff to elevate their awareness of sealed sources: benefits and potential hazards.
5. Manual containing the training material developed for sources owners, operators, physicians and others.
6. Manual containing the training information developed for the EAEA staff members.
7. Manual containing general awareness campaign information for specific stakeholders in the public sector.

4.1.3 Security

8. Secure storage facility at the EAEA and properly trained EAEA staff.

4.2 Safe Management of Unwanted Sealed Sources

4.2.1 Recovery

10. All unwanted RS in the public sector recovered and stored at a secure and safe government facility.
11. Operating procedure and trained staff for safe recovery of different types of sealed sources.
12. Quality assurance and quality control procedure for recovery of RS.

4.2.2 Conditioning and Storage
14. Properly furnished conditioning and storage facilities at the EAEA.
15. Quality assurance and quality control procedure for storing and conditioning of RS.

4.2.3 Recycling

16. Comprehensive list of recalibrated sealed sources available for reuse.
17. Quality assurance and quality control procedure for recycling of RS.

4.2.4 Disposal

18. Waste acceptance criteria, and site selection criteria developed for Egypt.
19. Screening analysis for various potential disposal sites in Egypt.
20. Safety assessment of a selected disposal facility in Egypt
21. Possible license application for the potential disposal site.
22. Quality assurance and quality control procedure for safety assessment of disposal site.

4.3 Emergency Response

23. Evaluate and update emergency response capabilities, and draft emergency response plans.
24. Properly furnished emergency response mobile unit.
25. Operating procedure for emergency response and trained EAEA staff.
26. Quality assurance and quality control for emergency response

4.4 Regulatory reform

27. Report comparing existing Egyptian regulations to U.S. and EAEA regulations for safe handling of radioactive sources (transport, conditioning, storage and disposal).
28. Recommendations for updating the Egyptian regulations infrastructure and suggested path for implementation.

5. Sustainability

The IMPRSS project is designed to assure self-sustainability after funding from the USAID ceases. These design elements include:

a. Human capacity development: The IMPRSS project will be implemented by Egyptians, using U.S. project-based management techniques. Egyptian staff will be assigned to work groups with specific work activities and milestones. Team skills will be emphasized. The focus will be on training, procedures, quality assurance and a project-based thinking.
Ample training will be provided so that Egyptians can successfully implement all of the work activities. However, training, without the implementation of a broader project and regulatory infrastructure may fail to provide long-term human capacity development. IMPRSS seeks to develop human capacity, through technical training and the creation of a project and regulatory infrastructure that will foster sustainability.

b. **Infrastructure Development:** The physical infrastructure upgrades will include robust survey instruments, appropriate recovery equipment, a properly furnished mobile unit for emergency response, and a records center. The infrastructure will also include safety and security upgrades to the existing RS storage facilities. The storage facilities will be upgraded to handle existing and future inventories. At the end of the funding cycle, the Egyptian government will pose the physical infrastructure necessary for long-term operations.

c. **Disposal Path:** The safety and security hazards posed by unwanted RS can only be permanently eliminated through proper disposal. The IMPRSS project will leave the EAEA staff with the capability to assess the safety of a permanent disposal facility. The U.S. team will bring practical experience in both regulatory infrastructure and the technical assessment of disposal facilities. With the transfer of this expertise, EAEA staff can apply their knowledge to developing disposal facilities for other types of hazardous materials. EAEA could then provide their services to other government agencies that would support the long-term sustainability of the program.

d. **Recovery Fee:** The IMPRSS project will help the EAEA setup a fee system to recover nominal funds for the recovery of unwanted sources. The recovery fee will help provide long-term sustainability of the program.

e. **Regulatory Reform:** The IMPRSS project staff will work with their Egyptian counterparts and the Egyptian regulators to implement a regulatory infrastructure that is critical in assuring the long-term sustainability of the program. The development and enforcement of consistent safety standards will provide the foundation of a self-sustaining program to manage RS in Egypt.

6. **Summary**

The key points for the proposed IMPRSS Project in Egypt are the following:

- Sealed sources enhance human welfare.
- Many sealed sources are excess, and the number is increasing - most are properly managed.
- However, if mismanaged, sealed sources threaten human health and the environment.
• If stolen, they could be used for making a dirty bomb
• Improve physical security is needed to prevent unauthorized removal.
• The proposed IMPRSS Project is an integrated program. It incorporates
  — An integrated project approach
  — Partnership among interested parties
• The proposed IMPRSS Project would transfer skills and technologies - human
capacity development.
• The intent of the proposed IMPRSS Project is to develop a sustained program for
radioactive sealed sources management in Egypt.
9. References


8. IAEA Safety Series No. 115, The International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources.


