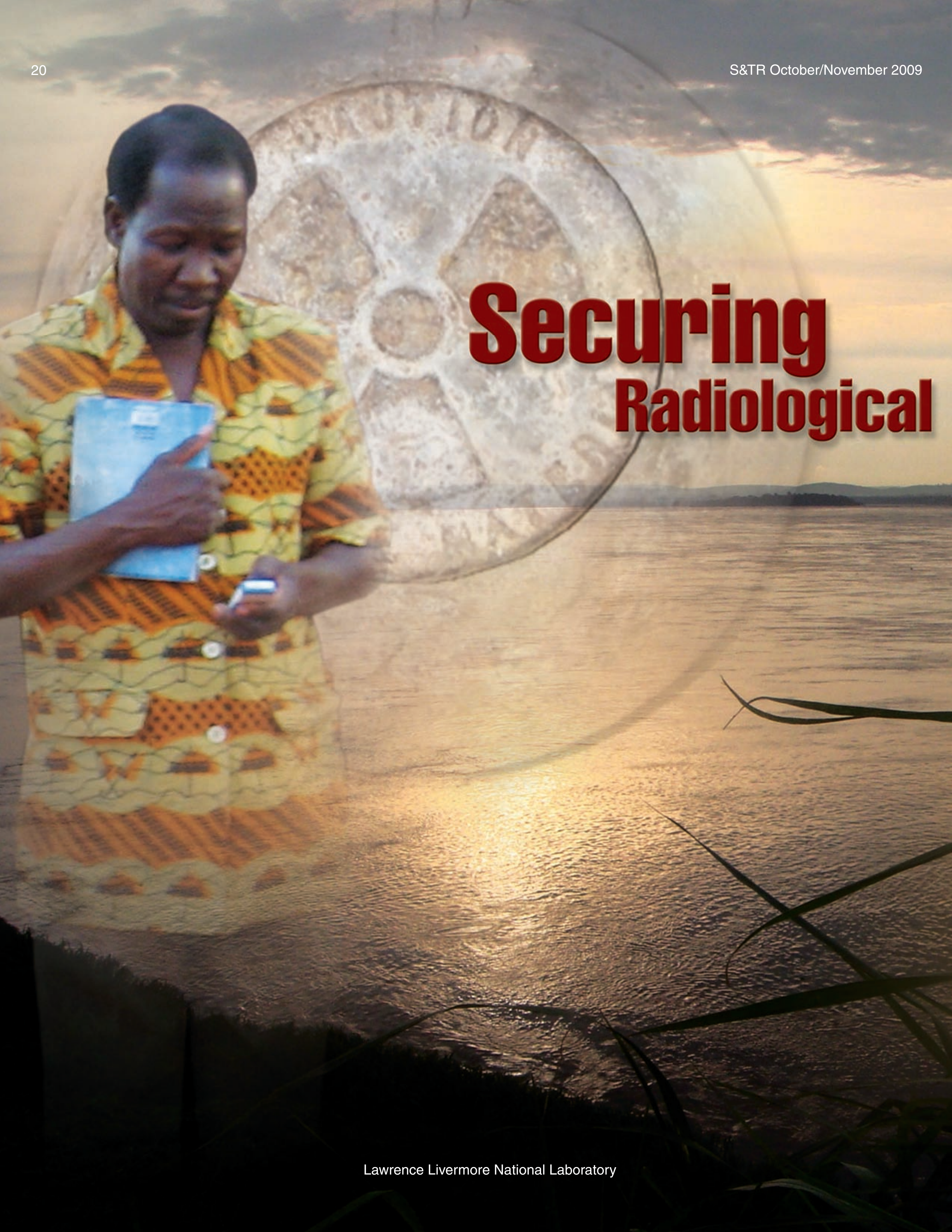


Securing Radiological

Sources in Africa

Safeguarding nuclear materials at civilian sites in Africa is part of the business of the National Nuclear Security Administration's Global Threat Reduction Initiative.

KEEPING radiological materials out of the hands of potential terrorists and other adversaries has long been a goal of the Department of Energy's National Nuclear Security Administration (NNSA). NNSA's Global Threat Reduction Initiative (GTRI) is tasked with reducing and protecting vulnerable nuclear and radiological materials at civilian sites worldwide. GTRI works closely in this endeavor with the International Atomic Energy Agency (IAEA), which issues international standards and guidance on how to safely control radioactive sources. Lawrence Livermore, Sandia, and Pacific Northwest national laboratories, among others, have been active contributors to GTRI for years.

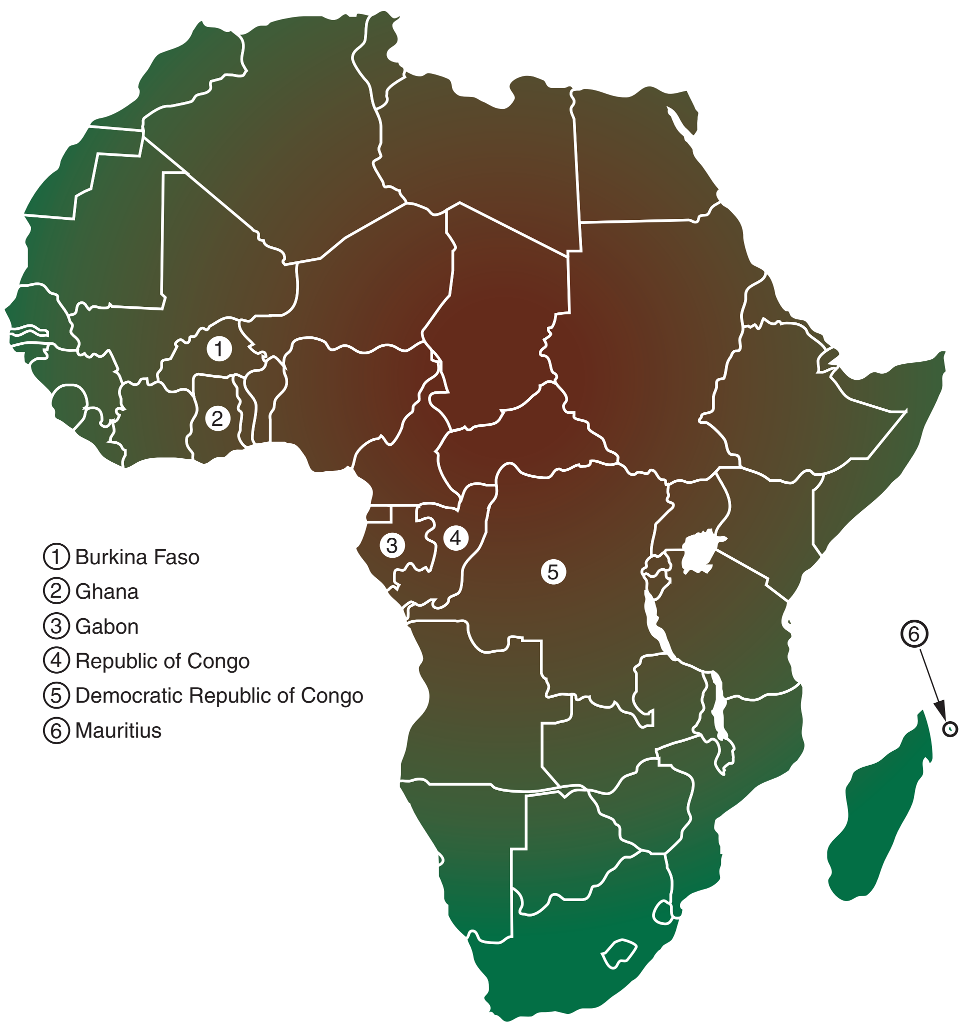
According to Phil Robinson, who is NNSA's GTRI regional coordinator for Africa and the Middle East in Washington, DC, more than 120 countries worldwide are participating in GTRI efforts. "Work started in Russia in the 1990s and branched out to other former Soviet Union republics," says Robinson. "Then we began efforts to protect radiological sources in ever-larger concentric circles, including Africa, South America, and the Far East." GTRI provides international support in the form of equipment and funding (for low-income countries) so that each country's own national programs can secure their nuclear and radiological materials.

The kinds of radiological materials that typically make the news are weapons-grade plutonium and uranium or fuel from nuclear power plants. However, radiological sources come in all shapes and sizes. Millions of radioactive sealed devices are used worldwide for legitimate and beneficial commercial endeavors such as cancer treatment, food and blood sterilization, oil exploration, remote electricity generation, radiography, and scientific research. To prevent radiological materials from being diverted for malicious use, countries must keep these sources in secure locations and maintain them under regulatory control.

Since the early 1990s, NNSA and its national laboratories have focused on three goals: to convert, remove, and protect nuclear and radiological materials. Converting materials entails developing low-enriched uranium fuels to replace the highly enriched uranium fuels currently used in many research reactors. Each reactor that is converted, or where possible shut down, eliminates a source of bomb material. Removing and disposing of excess nuclear and radiological materials from civilian sites reduces the risk of such materials falling into the hands of potential terrorists. Protecting high-priority nuclear and radiological materials from theft and sabotage is accomplished by improving security at civilian sites.

"The countries of Africa present some serious challenges for us," says Robinson. "In the former Soviet Union, a single overarching infrastructure was responsible for nuclear weapons, reactors, and other radiological materials. In Africa, 56 countries each have their own regulatory organizations."

Lawrence Livermore has worked to protect civilian radiological sources in six African countries.



From IAEA to Livermore

Health physicist Carolyn Mac Kenzie leads the Livermore team, which includes Con Turner, a specialist in physical protection, and Tim Horgan, who is responsible for arranging security upgrade contracts with local African vendors. Both Turner and Horgan spent several years helping to secure radiological sources in the former Soviet Union. (See *S&TR*, December 2007, pp. 4–10.)

Mac Kenzie, a longtime Laboratory employee, spent three years at the IAEA in Vienna, Austria, and another year on assignment at NNSA's GTRI headquarters in Washington, DC, as a Livermore contractor. She returned to the Laboratory in October 2007. While in Vienna, she led the IAEA Orphan Source Search and Secure Program and worked in more than 35 countries to establish strategic plans for locating and securing orphan and legacy radiological sources.

An orphan source is typically a small volume of radioactive material that may be in an uncontrolled situation, leaving it vulnerable to theft. For example, the responsible party for an orphan source may not be readily identifiable, or the security of a source may not be assured. Another situation that creates an orphan source is when the responsible party is not licensed to possess it.

Orphan radiological sources can be found in all sorts of places. For example, a measuring device containing radioactive materials may be disposed of as scrap metal and found at a metal recycler. Or, a gauge containing radioactive material used in road or building construction may be discarded and found on the side of a road or in a river. Also, sealed radiological sources previously used in oil and gas exploration may be found abandoned and forgotten in old warehouses. Many developing countries simply do not have radioactive-waste storage facilities, in which case local options do not exist for disposing of disused sources. Orphan sources abound and are often the trickiest to locate.

"Orphan sources are a serious concern, because they are outside of regulatory control," Mac Kenzie says. "The IAEA Orphan Source Search and Secure Program focused on large, highly radioactive sources that could seriously injure or kill people. The program first focused on republics of the former Soviet Union and then moved into the Balkans, China (in preparation for the 2008 Olympic Games), and Africa."

When Mac Kenzie left the IAEA to work at GTRI in Washington, DC, she continued her efforts to locate and secure sources in Africa. Since returning to the Laboratory, her team has worked through GTRI in six countries: Burkina Faso, Gabon, Ghana, Democratic Republic of Congo, Mauritius, and Republic of Congo. "We had started a project in Madagascar but a coup derailed our work," says Mac Kenzie. "We are awaiting more peaceful times before returning."

Into a New Country

Mac Kenzie's team follows a well-established process when beginning work in a new country. The first step is coordinating with the U.S. Embassy to gain their approval and cooperation. "We sometimes meet with the ambassador of the country," says Mac Kenzie, "and the economic officer may participate in our meetings with the country's ministries."

The Livermore team, plus GTRI's Robinson or NNSA representative and Sandia employee Michael Itamura, meet with the staff and leadership of the relevant ministries. Together, this team gets "the lay of the land" during the weeklong initial visit to the country. The team works closely with the country's regulators to locate and visit sites with large radiological sources, such as teletherapy machines used in cancer treatment, industrial irradiators, or instrumental calibrators.

Some radiological sources are well known to the team before they arrive in a country. Burkina Faso has an irradiator for sterilizing tsetse flies, which is helping to rid Sub-Saharan Africa of sleeping sickness in both people and livestock. (See the box on p. 25.) Mauritius currently has an inactive irradiator for Mediterranean fruit flies (medflies) but is obtaining a new one, for which it will need a radioactive source. Ghana has a food irradiator for promoting longer shelf life and is in the process of obtaining a new radioactive source for it. A hospital in Gabon has a machine for delivering radiation to treat cancer, but the machine's radioactive source is depleted. The depleted source will be secured in place, and the country hopes to replace it in the future.

The team also visits locations with large accumulations of smaller sources, such as radioactive-waste storage facilities, mining sites, ports, and oil-drilling regions. Gauges and well-logging devices containing radioactive materials are more commonly present in these locations. In addition, if a country has a research reactor facility, the team may offer security upgrades for the facility.

A variety of orphan radiological sources used in mining have been found in the six African countries where Livermore has worked.

The IAEA has established various threshold levels for different radionuclides. Consequently, not every radioactive source needs the same degree of attention. Radionuclides of particular interest are americium-241, which is widely used in industrial gauges; plutonium-238 and -239, which are well-known fissile materials; and californium-252, which is used in downhole well logging for oil exploration. Other common radionuclides include radium-226, which was used in medical applications in the past; cesium-137, which is found in moisture and density gauges, calibration devices, and industrial irradiators; and cobalt-60, which is used in radiation treatment for cancer. Also of interest are iridium-192, an industrial radioisotope used to locate areas of weakness in metal pipes, and strontium-90, which is used extensively as a radioactive source in radioisotope thermoelectric generators for powering lighthouses and in radiotherapy for some types of cancer.

Inventorying can be a challenge. "One country thought it had about 100 sources in their inventory, but they in fact had close to 400," says Mac Kenzie. Often the problem is orphan sources. Some countries do not have regulators or regulations in place, or they have people who are still new to their jobs. "New regulators may understand the safety concerns of nuclear sources but are not fully aware of the threat of theft and the need for physical protection," says Mac Kenzie.

Developing Indigenous Expertise

To assist countries with their own search efforts, GTRI offers a one-week "Search and Secure" workshop, which teaches local officials how to search for, locate, and identify orphan sources. Search equipment is provided based on a country's needs. The workshop includes instruction on organizing and implementing a search for orphan sources, use of search equipment, and packaging and transportation of orphan sources to secure storage facilities. The workshop curriculum includes hands-on field training and exercises. GTRI may also offer workshop participants help in developing verified inventories by visiting suspected orphan-source locations in their country.

GTRI's Search and Secure project was launched in 2004 and is closely coordinated with IAEA to avoid duplicating efforts and to maximize assistance in each country. A goal is to help countries develop their own indigenous capabilities for assessing orphaned and disused radiological sources. The project was first deployed in the republics of the former Soviet Union. Since 2004, equipment has been deployed in 30 countries, approximately 550 people have been trained, and thousands of orphan sources have been found.

Safe and Secure

"When working in a particular country, local officials will take us to where radiological materials are located," says Turner. "If the quantities of radionuclides present in these materials exceed the established thresholds, my job kicks in." Turner's task is to assess the security of such facilities. For example, cobalt-60 may be found in a teletherapy bunker. (In the U.S., cobalt-60 has been replaced with accelerators for cancer treatment.) "We work from the source outward, examining the security of the source itself, the teletherapy bunker, and then the hospital," says Turner. "When we approach security from the material of interest outward and concentrate security elements close to the

The National Nuclear Security Administration's Global Threat Reduction Initiative (GTRI) offers a "Search and Secure" workshop in participating African countries. (left) A workshop student is trained to use a piece of equipment. (center) A GTRI staff member provides instruction in the field. (right) A student searches for a radioactive source hidden in the field by an instructor.

target material, we can protect radioactive materials not only from outsiders but also from insiders such as employees."

Several ways exist to reduce the threat of diversion of radioactive materials. They include detecting intrusion, such as with motion detectors; assessing intrusions with cameras; installing cages or tie-downs to delay adversaries until appropriate security forces can respond; and improving response capabilities with radios and other communication equipment. The goal is for all security upgrades to be simple, low-tech, locally available, and easy to maintain.

Once radiological sources have been inventoried in a country and Turner has

A newly installed alarm system sends a message to a security staff cell phone. Better communication equipment for security personnel is just one example of the improvements that help to secure radiological sources.

Ridding the Continent of Tsetse Flies

African countries operating tsetse fly irradiators must ensure the safety and security of these radioactive sources, and irradiators have proved to be the best method of eradicating the tsetse scourge. Therefore, these countries have a particular interest in cooperating with the International Atomic Energy Agency and the National Nuclear Security Administration's Global Threat Reduction Initiative (GTRI).

For centuries, the tsetse fly has been the bane of both people and livestock in Central Africa. Trypanosomiasis—the disease spread by 22 species of the tsetse fly and commonly known as sleeping sickness or nagana—is still widespread, especially in Sub-Saharan countries. These large biting flies feed on the blood of vertebrate animals and are the primary transfer agent of trypanosomes. Tsetse flies make livestock production—cattle, sheep, goats, and horses—difficult or impossible throughout large areas of Africa. Agriculture in these areas must function without the many benefits of livestock, such as crop byproduct utilization and manure production. The human population must also do without meat and milk.

Male flies are sterilized with doses of radiation in this tsetse fly irradiator in Burkina Faso.

Until recently, the two most common methods for controlling the tsetse fly have been the spraying of insecticides and baiting and trapping the flies, both of which are costly in chemicals and personnel. Today, the sterile insect technique is the most promising solution. Vast numbers of tsetse flies are reared in "fly factories," and the males are sterilized with carefully controlled doses of cesium-137 gamma radiation. The gamma radiation is sufficient to induce sterility but does not reduce the treated insects' ability to fly, compete with native males, or mate. Mating between the sterile released insect and the native population produces no offspring. Females can mate only a few times in their life, and generally mate only once. If enough sterile males are released, the tsetse population eventually dies off. Burkina Faso, a small, remote, sparsely populated country, now has a fly irradiator that generates income. "Keeping the irradiator operating and safe is essential," notes Tim Horgan, Livermore's contracting officer for GTRI, which helps countries such as Burkina Faso protect their civilian nuclear and radiological materials.

On the island of Zanzibar, which is part of Tanzania, the last tsetse fly was seen in the mid-1990s thanks to efforts to eradicate the flies through radiation-induced sterilization. Routine blood samples taken from cattle have tested negative for trypanosome parasites. Milk production has tripled, local beef production has doubled, and the use of animal manure for crop farming has increased fivefold, according to the Ministry of Agriculture of the island.

evaluated the existing security measures, the team produces a Statement of Work that describes specific recommendations, ranging from moving or securing sources to building or improving storage facilities.

Local Responsibility

During that first weeklong visit to a country, Horgan begins to seek out local vendors who are qualified to undertake necessary security upgrades. As Livermore's contracting representative, Horgan is authorized by NNSA to commit funds and sign agreements, monitor progress of work, resolve agreement issues, and process invoices for payment.

Once a country's appropriate ministries have agreed to undertake the necessary security upgrades, Horgan begins the process of hiring local security firms to implement physical protection or move sources. He issues requests for proposals from local firms, reviews the resulting proposals with Turner, and then negotiates such

Livermore's Tim Horgan visits a source storage facility. (Opposite page, top) A local contractor tests security upgrades installed at a hospital. (Opposite page, bottom) Livermore's Carolyn Mac Kenzie and Zephrin Ouedraogo, a radiation protection regulatory authority in Burkina Faso, examine a tsetse-fly irradiator.

contractual terms as scope, schedule, and price. When an award is finalized, Horgan may authorize advance purchase of up to 100 percent of the equipment and materials. Labor costs are reimbursed after the work is completed.

While work is under way, Turner acts as the technical representative, resolving technical issues and reviewing the acceptability of contract deliverables. Once work is complete, Turner returns to the country to verify that all contract deliverables have been met.

GTRI hopes to begin cooperative work with many more African countries in the near future. According to Horgan, "All of the countries we have visited have been grateful for our help." GTRI pays for ongoing support for three years but after that period has expired, the African countries agree to maintain and sustain the security devices and storage facilities. Says Mac Kenzie, "The participating countries understand that they hold ultimate responsibility for the safety and security of their radiological sources."

—Katie Walter

Key Words: Africa, Global Threat Reduction Initiative (GTRI), orphan source, radiological source, search and secure.

For further information contact Carolyn Mac Kenzie (925) 422-7618 (mackenzie5@llnl.gov).