APPENDIX E
AGREEMENTS FOR COOPERATION WITH FOREIGN COUNTRIES

This appendix provides information on the quantities of HEU exported to foreign countries under international agreements for cooperation for peaceful uses of atomic energy. Under these agreements, the U.S. exported HEU to foreign countries for use in research applications, primarily as fuel for research reactors. As part of these agreements, the U.S. agreed to accept the return of this material primarily in the form of spent nuclear fuel. This appendix does not include HEU exported to foreign countries under mutual defense agreements and the acquisition of HEU from the former Soviet Republic of Kazakhstan.

For the purposes of this report, information on foreign countries is broken out into four geographical regions: (1) Middle East and South Africa, (2) Europe, (3) North and South America, and (4) Asia and Australia. Countries that are members of the International Atomic Energy Agency (IAEA) and countries that have signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)[12] are identified.

HEU Transfers to Foreign Countries

- ✓ First destination does not mean that the receiving country was the ultimate destination for the U.S.-origin HEU but, in fact, is the first foreign country to receive the material.
- ✓ Retransfers of U.S.-origin HEU from one foreign country to another are not accounted for in this report. The U.S. relies on the IAEA to apply international safeguards on U.S.-origin HEU retransferred from one foreign country to another.

BACKGROUND

The U.S. began exporting HEU in the 1950s as part of President Eisenhower's "Atoms for Peace" program. A series of agreements and treaties between the U.S. and many foreign countries allowed the export of nuclear materials and technology to assist the countries in nuclear research for power and medical purposes. These agreements established guidelines and procedures for the use of the material supplied. For example, material supplied for civil use would not be diverted for military use. The majority of the enriched uranium supplied to foreign countries was for use in experimental and research reactors.

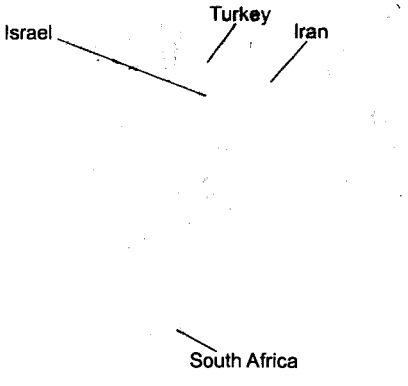
Section 6 of this report provides the quantities of HEU exported to foreign countries of first destination. First destination does not necessarily mean that the receiving country was the ultimate destination for the U.S.-origin HEU, but in fact is the first foreign receipt of the material.

[12] The NPT was a landmark international treaty whose objectives are to prevent the spread of nuclear weapons and weapons technology, to foster the peaceful uses of atomic energy, and to further the goal of achieving general and complete disarmament. The Treaty establishes a safeguards system under the responsibility of the IAEA, which also plays a central role under the Treaty in areas of technology transfer for peaceful purposes.

For example, HEU sent to France for fabrication into reactor fuel for a Swiss reactor is counted as a delivery to France, not to Switzerland. U.S.-origin HEU has been routinely retransferred from a country of first destination to another country. While this type of transaction is not addressed in this report, this information is provided in the report entitled, *The United States Nuclear Regulatory Commission's Report to Congress on the Disposition of Highly Enriched Uranium Previously Exported from the United States (NRC 1993).*

These agreements also called for the return of the nuclear materials when it was spent or no longer required by the recipient country. Section 5 of this report provides the quantities of U.S.-origin HEU returned to the U.S. from foreign countries under agreements for cooperation.

MIDDLE EAST AND SOUTH AFRICA



The U.S. exported 63 kilograms of HEU to South Africa and three countries in the Middle East: Iran, Israel, and Turkey. All of these countries are members of the IAEA. Iran, Turkey, and South Africa are signatories of the NPT.

IRAN

The U.S. shipped 6 kilograms of HEU to Iran in September 1967 as fabricated fuel for a research reactor.

This pool type reactor achieved initial criticality in October 1967 and is used for basic research, isotope production, neutron radiography, and training. In addition, small quantities of HEU as samples and standards were also shipped to Iran.

ISRAEL

A total of 19 kilograms of HEU reactor fuel was shipped from the U.S. to Israel from 1960 to 1975. The majority of the material was fuel for the Israel Research Reactor 1 (IRR-1). This pool type reactor began operation in June 1960 and is used for on-line isotope separation, training, and activation analysis.

TURKEY

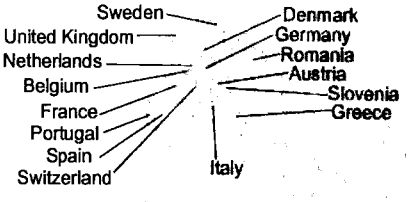
The U.S. shipped 5 kilograms of HEU to Turkey in September 1961 as the initial core load for the Turkish Research Reactor 1 (TR-1). The reactor went critical in January 1962 and operated until September 1977. Turkey has also received U.S.-origin HEU that was fabricated as reactor fuel in France for a second research reactor, TR-2. The TR-2 research reactor began operation in 1981 and was shut down in 1995. Both research reactors are pool-type reactors used for nuclear research, training, and isotope production. In 1986, a total of 5 kilograms of HEU was returned to the Idaho Chemical Processing Plant as spent reactor fuel from the TR-1 reactor.

SOUTH AFRICA

The U.S. shipped 33 kilograms of HEU to South Africa from 1965 to 1975 for use in the Safari-1 reactor. The Safari-1 reactor is a tank type research reactor that achieved an initial criticality in 1965. The reactor is used for neutron capture reactions, fission reactions, activation analysis, and training. In the 1970s, a total of 34 kilograms of HEU was returned to the Savannah River Site as spent reactor fuel from South Africa.

EUROPE

The U.S. exported over 21 metric tons of HEU to 15 countries in Europe. Most of this material was sent to Euratom countries.



All of the 15 countries identified in the map are members of the IAEA and are signatories of the NPT. All are members of Euratom with the exception of Romania, Slovenia, and Switzerland.

EURATOM

The European Atomic Energy Community (Euratom) was established in 1957. Euratom is responsible for nuclear safety, safeguards, and the peaceful use of nuclear energy within the European Community. As of September 1996, membership included Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom.

Since 1957, the U.S. has shipped a total of 21,101 kilograms of HEU to Euratom countries. Specific quantities by country are shown in Section 6 of this report. The material supplied was for use in research applications, including research materials testing, experimental reactors and reactor experiments. Euratom countries have many reactors that currently use or have used HEU, these reactors include: pool-type reactors, Argonaut-type reactors, critical assembly reactors, TRIGA reactors, heavy water reactors, tank-type reactors, fast flux research reactors, liquid metal fast breeder reactors, and homogeneous reactors. The reactors are used for materials testing, analysis and irradiation, medical applications, astrophysics and propulsion, detector calibration, nuclear fuel cycle experiments, isotope production and separation, neutron radiography and spectroscopy, reactor physics, and training.

Within Euratom countries, large quantities of U.S.-origin HEU have been retransferred. For example, France and the United Kingdom have used U.S.-origin HEU to fabricate fuel for use in Euratom research reactors. In addition, Euratom countries have retransferred HEU to non-Euratom countries.

ROMANIA

The U.S. shipped 39 kilograms of HEU to Romania during the late 1970s. The material was for use in the TRIGA II research reactor. This reactor is a TRIGA II dual core test reactor and is used for fuel testing, neutron spectroscopy, and electronic isolation material.

SLOVENIA

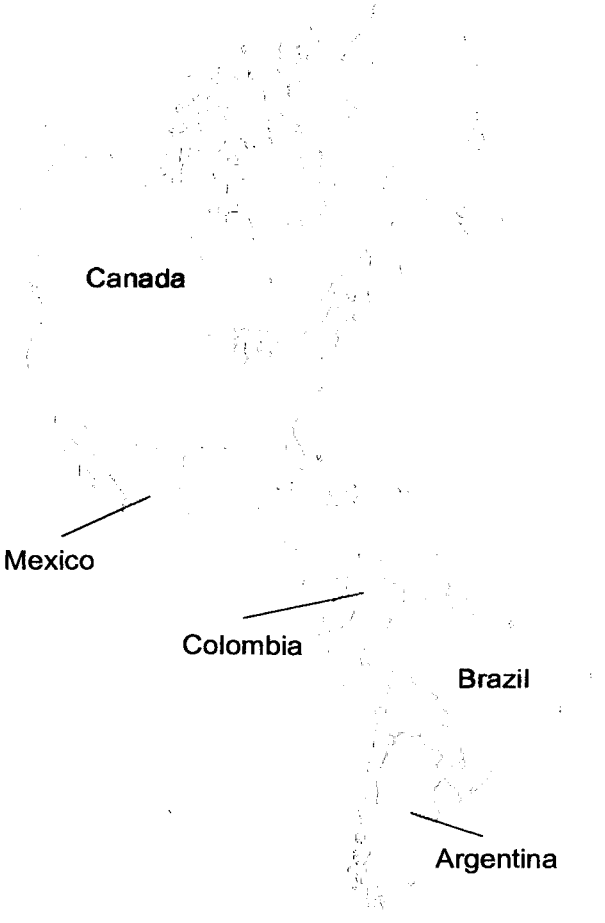
The U.S. shipped 5 kilograms of HEU to Slovenia (formerly Yugoslavia) during the 1970s. The material was for use in the TRIGA Mark II research reactor. This reactor is used for neutron dosimetry, neutron physics, neutron radiography, silicon doping, solid state physics, gamma scanning of nuclear fuel, and training.

SWITZERLAND

The U.S. shipped 9 kilograms of HEU to Switzerland during the 1960s. The material was primarily for use in three reactors: Saphir, Diorit, and AGN 211 P. Saphir is a pool-type research reactor. Diorit is a tank-type research reactor and was shut down in 1977. AGN 211 P is a homogenous training reactor. These reactors are used for radioisotope production, activation analysis, gemstone color enhancement, and training.

North and South America

The U.S. exported over 2 metric tons of HEU to five countries in North and South America: Argentina, Brazil, Canada, Colombia, and Mexico. Most of this material was sent to Canada. All of these countries are members of the IAEA and all are signatories of the NPT .



Argentina

The U.S. shipped 58 kilograms of HEU to Argentina from 1964 through 1973. The material was for use in the RA-3 research reactor. The RA-3 is a pool-type reactor that is used for neutron radiography, isotope production, and training.

Brazil

The U.S. shipped 8 kilograms of HEU to Brazil from 1968 through 1978. The material was for use in the IEA-R1 research reactor. The IEA-R1 is a pool-type reactor that is used for neutron physics, isotope production, and training.

Canada

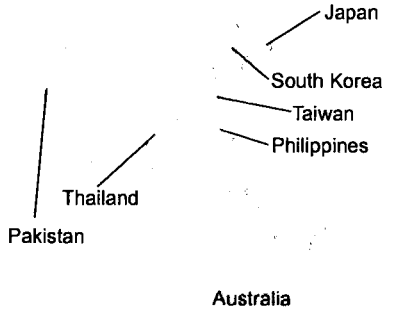
Since the 1950s, the U.S. has shipped a total of 2,187 kilograms of HEU to Canada. Canada has 12 research reactors that use or have used HEU. The types of reactors include heavy water, pool, and Safe Low-Power Kritical Experiment (SLOWPOKE). The reactors are used for neutron transmutation, doping of silicon, gemstone color enhancement, fusion blanket research, neutron activation analysis, training, and loss of coolant accident analysis. Beginning in the 1960s, a total of 702 kilograms of HEU was returned to either the Savannah River Site or the Idaho Chemical Processing Plant as spent reactor fuel from Canada.

COLOMBIA

The U.S. shipped 3 kilograms of HEU to Colombia in 1964 and 1973. The material was for use in the IAN-R1 research reactor. The IAN-R1 was a pool-type reactor that was used for neutron physics, nuclear engineering, material testing, and training.

MEXICO

The U.S. shipped 11 kilograms of HEU to Mexico from 1977 through 1981. The material was for use in the TRIGA Mark III research reactor. The reactor is used for dosimetry, neutron diffraction, neutrography, and training.



ASIA AND AUSTRALIA

The U.S. exported over 2 metric tons of HEU to Australia and six countries in Asia: Japan, Pakistan, the Philippines, South Korea, Taiwan, and Thailand. Most of this material was sent to Japan. All of these countries are members of the IAEA. All are signatories of the NPT with the exception of Pakistan.

AUSTRALIA

The U.S. shipped 10 kilograms of HEU to Australia from 1958 through 1964. The material was for use in the Moata and HIFAR research reactors.

The Moata is an Argonaut-type reactor and the HIFAR is a heavy water-type research reactor. The reactors are used for production of medical radioisotopes, silicon irradiation, and for neutron diffraction research.

JAPAN

The U.S. shipped a total of 2,054 kilograms of HEU to Japan primarily in the 1960s and 1970s. Japan has 14 reactors that use or have used HEU. The types of reactors include, heavy water test, Argonaut training, pool research, tank research, critical assembly, and fast research. The reactors

are used for reactor physics, reactor noise analysis, biological effects of low dose rate, fission tract dating, detector testing, boron neutron capture therapy, doping of silicon, tritium handling, studies on high and low temperature irradiation, thorium cycle, and training. Beginning in the 1970s, a total of 342 kilograms of HEU was returned to either the Savannah River Site or the Idaho Chemical Processing Plant as spent reactor fuel.

Pakistan

The Pakistan Research Reactor-1 (PARR-1) received its initial core load of 6 kilograms of HEU from the U.S. in March 1965. The reactor achieved initial criticality in December 1965.

Philippines

The U.S. shipped a total of 3 kilograms of HEU to the Philippines in 1967. The material was for use in the Philippines Research Reactor (PRR-1), a pool-type reactor, used for basic research.

South Korea

The U.S. shipped 28 kilograms of HEU to South Korea from 1974 through 1978. The material was for use in the TRIGA Mark-III and the TRIGA Mark-II research reactors. The reactors were used for solid state experiments, activation analysis, texture studies, and training.

Taiwan

The U.S. shipped 10 kilograms of HEU to Taiwan from 1967 through 1973. The material was for use in the Thor TRIGA research reactor. The reactor is used for neutron physics, chemistry, reactor engineering, radiation measurement, radiochemistry, and training.

Thailand

The U.S. shipped 5 kilograms of HEU to Thailand in 1962. The material was for use in the TRR-1/M1 TRIGA Mark III research reactor. The reactor is used for neutron activation analysis, and gem stone color enhancements.

This page intentionally left blank