BY THE COMPTROLLER GENERAL

Report To The Honorable Gary Hart United States Senate

OF THE UNITED STATES

Obstacles To U.S. Ability To Control And Track Weapons-Grade Uranium Supplied Abroad

The United States has exported over 16,000 kilograms of highly enriched uranium for use in research reactors in over 40 nations.

GAO learned that the central computerized system used for tracking such exports is incomplete and inaccurate. Intended users also consider it inadequate and unreliable. In addition, three other systems gather information on highly enriched uranium. GAO recommends streamlining and consolidating the information maintained on this material in a more accurate, comprehensive, and flexible manner.

GAO believes that reducing the use of highly enriched uranium is a sound non-proliferation objective. A number of obstacles, however, must be overcome if the conversion of research reactors to non-weapons grade fuels is to become a reality in the next few years. In the meantime, U.S. ability to ensure adequate physical protection of highly enriched uranium supplied abroad is limited and international safeguards of nuclear material need further improvement.

GAO/ID-82-21
AUGUST 2, 1982

Request for copies of GAO reports should be sent to:

U.S. General Accounting Office
Document Handling and Information
Services Facility
P.O. Box 6015
Gaithersburg, Md. 20760

Telephone (202) 275-6241

The first five copies of individual reports are free of charge. Additional copies of bound audit reports are $3.25 each. Additional copies of unbound report (i.e., letter reports) and most other publications are $1.00 each. There will be a 25% discount on all orders for 100 or more copies mailed to a single address. Sales orders must be prepaid on a cash, check, or money order basis. Check should be made out to the "Superintendent of Documents".

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-207024

The Honorable Gary W. Hart
United States Senate

Dear Senator Hart:

In response to your July 14, 1981, request we have reviewed the U.S. ability to control and account for highly enriched (weapons-grade) uranium supplied abroad. This report discusses U.S. administrative controls, physical security reviews, international safeguards and the U.S. ability to keep track of exports of highly enriched uranium. This report also addresses the U.S. efforts to develop a non-weapons grade uranium fuel to be used as a substitute for highly enriched uranium.

As arranged with your office, no further distribution of this report will be made for 5 days from the date of issue unless you publicly announce its contents earlier.

Sincerely yours,

Charles A. Bowsher

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE
HONORABLE GARY HART
UNITED STATES SENATE

OBSTACLES TO U.S. ABILITY TO CONTROL AND TRACK WEAPONS-GRADE URANIUM SUPPLIED ABROAD

D I G E S T

Since 1954, the United States has exported more than 16,000 kilograms of highly enriched uranium for use in research and test reactors in 43 countries. Although most of these exports have gone to countries that are not considered proliferation risks, the U.S. Government has been concerned about the large inventories abroad and terrorists' diversion possibilities. About 25 kilograms of highly enriched uranium is generally recognized as sufficient to make a nuclear explosive device.

CENTRAL TRACKING SYSTEM IS INACCURATE AND UNRELIABLE

The Department of Energy's (DOE) central computerized system used for tracking all U.S. highly enriched uranium exported to foreign countries is incomplete and inaccurate. Intended users also consider it inadequate, inflexible, and unreliable. Although DOE has been working to improve the information in the system, it has not used some readily available internal data to help verify the quantities of highly enriched uranium supplied abroad. (See p. 36.)

Although this one system is supposed to provide a central repository for storage and retrieval of information needed to track highly enriched uranium furnished to other countries, DOE and the Nuclear Regulatory Commission have three other information systems to gather data on this material supplied abroad. (See p. 42.) But the need to have four separate systems appears questionable. Considering the costs of the systems and the needs of the users, efforts to streamline and consolidate needed information seem to be warranted. (See p. 44.)

U.S. CONTROLS OVER HIGHLY ENRICHED URANIUM

The United States attempts to regulate and control its exports of highly enriched uranium fuels through three mechanisms--agreements for cooperation, export licenses, and subsequent arrangements made with other countries. The Nuclear Non-Proliferation Act of 1978 expands U.S. criteria for future nuclear cooperation abroad and calls for a U.S. program to renegotiate existing agreements for cooperation.

Although language in the agreements for cooperation negotiated since 1978 helps establish tighter controls over highly enriched uranium, virtually all present exports of such material are transferred under agreements that have not been renegotiated. (See p. 8.)

Procedurally, U.S. agencies follow essentially the same general export license criteria and review process for subsequent arrangements for the weapons-grade highly enriched uranium as they do for non-weapons-grade uranium used in power reactors. However, U.S. agencies take extra care in analyzing the technical and economic justification for the export of highly enriched uranium. (See p. 8.)

To minimize the risks of having weapons-grade material accumulated abroad, DOE (or its predecessors) has had the authority for years to accept returns of spent highly enriched uranium of U.S.-origin from other nations. However, only a small portion has been returned. According to U.S. officials, factors, such as the minimum charge for accepting spent highly enriched uranium and high shipping costs, may be discouraging some nations from returning such fuel. Moreover, the authority to accept spent U.S.-supplied highly enriched uranium expires in 1982 and a decision on extending it must be made if this practice is to continue. Agency officials advised GAO that plans are underway to extend this U.S. offer. (See pp. 15 and 17.)

LIMITED U.S. ABILITY TO ENSURE ADEQUATE PHYSICAL PROTECTION

In recent years, the U.S. Government has become increasingly concerned with the physical security of highly enriched uranium from theft by subnational groups. The United States has a mechanism for conducting physical security reviews within nations receiving U.S. highly enriched uranium, but there are some limitations in determining the adequacy of physical security systems.

--Some foreign governments have been reluctant to participate in the program and U.S. officials expect future reviews may be rejected by some governments as no longer necessary.

--Some countries have limited U.S. access at their nuclear facilities. Some visits had to be made to "representative" facilities rather than those handling or receiving U.S. materials.

--Intervals between visits to some countries have been as long as 5 years. (See p. 19.)

Nevertheless, U.S. officials believe that the levels of physical security have improved as a result of U.S. initiatives. Moreover, the establishment of an international convention for protecting nuclear materials, particularly in transit, represents a growing effort to establish some universally acceptable standards for physical protection. (See p. 27.)

COMMON SAFEGUARDS PROBLEMS

The problems of safeguarding weapons-grade nuclear materials, including highly enriched uranium, can be significant. The State Department said that the application of safeguards by the International Atomic Energy Agency is uneven for a variety of reasons and the Agency often fails to meet its own goals. (See p. 29.)

It has been generally recognized that bulk handling facilities, such as fuel fabrication and enrichment plants, pose significant safeguards difficulties. During the review, GAO learned that the International Atomic Energy Agency has been able to carry out only 50 percent of its estimated routine inspection effort and that a number of research reactors which use highly enriched uranium, including a few with significant quantities of fuel, were not being visited even once a year. According to the Agency, the approximate time to convert highly enriched uranium into usable material for a nuclear explosive device is 7 to 10 days for unirradiated, pure form, material and 1 to 3 months for irradiated material. (See p. 29.)

For research reactors that were inspected, specific information about the Agency's ability to meet its timely detection goals is not made public. U.S. and International Atomic Energy Agency officials, nevertheless, agree in general terms that the effectiveness of safeguards has been adversely influenced by (1) a limited number of inspectors and (2) a lack of suitable techniques and equipment. To secure sufficient numbers of inspectors and equipment, in the long-term, will require broad financial and political support by member nations. (See p. 29.)

U.S. EFFORTS TO REDUCE HIGHLY ENRICHED URANIUM LEVELS ABROAD

Much of the U.S. non-proliferation policy has centered around minimizing the use of highly enriched uranium. The reduced enrichment program is one of the few concrete U.S. non-proliferation initiatives to gain widespread international support. (See p. 47.)

Notwithstanding the progress this program has made, several factors are hindering the implementation of the reduced enrichment effort. They include: (1) financial constraints on the program, (2) the limited market potential of the new fuel to interest U.S. private sector involvement without continued U.S. Government support, (3) lack of involvement by U.S. research reactor operators, (4) the potential requirement that facilities which convert to the new fuel must be relicensed by the host country, (5) foreign concerns about the reprocessing of the new fuel and safe disposal of the waste, and (6) uncertainty about U.S. willingness to accept the return of spent low enriched uranium. (See p. 49.)

GAO believes that reducing the use of highly enriched uranium is a sound non-proliferation objective, but a number of obstacles will have to be overcome if the conversion to low enriched fuels is to become a reality in the next few years. (See p. 54.)

RECOMMENDATIONS TO THE SECRETARY OF ENERGY

The Secretary of Energy, in conjunction with the Chairman of the Nuclear Regulatory Commission, should streamline and consolidate the information maintained on highly enriched uranium supplied abroad in a more accurate, comprehensive, and flexible manner which meets the needs of the intended users, in the most economical and efficient manner. (See p. 45.)

To increase the accuracy and utility of such a system, the Secretary of Energy should direct that information from other readily available sources be used to verify and reconcile the data on highly enriched uranium exports within the system. (See p. 45.)

As part of the review process relating to the extension and possible expansion of the authority to accept spent research reactor fuel, the Secretary of Energy should also determine the principal reasons why only a small percentage of spent highly enriched uranium has been returned in the past and adequately address the disincentives to some countries in returning such spent fuels. (See p. 18.)

AGENCY COMMENTS

In commenting on the draft of this report, the Departments of Energy and State, the Nuclear Regulatory Commission, and the Arms Control and Disarmament Agency were generally supportive of the thrust of GAO's conclusions and recommendations. They did offer suggestions to improve the clarity and technical accuracy or to provide a more balanced presentation. The report has been modified to reflect their comments which are reprinted in appendices VIII through XI.

In line with the GAO recommendation, DOE is initiating a review to examine the increased integration of the various systems gathering information on highly enriched uranium. (See p. 80.)

DOE commented that it has been actively working to extend the authority to accept spent highly enriched uranium. It is also considering expanding the authority to permit the acceptance of the low enriched uranium fuels currently being developed. However, the Department also recognizes several disincentives to countries regarding the return of spent highly enriched uranium. (See p. 75.)

C O N T E N T S

ABBREVIATIONS

ACDA	Arms Control and Disarmament Agency
DOE	Department of Energy
EURATOM	European Atomic Energy Community
GAO	General Accounting Office
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
IPELTS	International Programs Export License Tracking System
LEU	low enriched uranium
NMMSS/INMTS	Nuclear Materials Management Safeguards System/International Nuclear Materials Tracking System
NNPA	Nuclear Non-Proliferation Act
NRC	Nuclear Regulatory Commission
RERTR	Reduced Enrichment for Research and Test Reactors
STAMAS	Special Nuclear Material Tracking and Management System
UNSSOD	United Nations Special Session on Disarmament

CHAPTER 1

INTRODUCTION

On July 14, 1981, Senator Gary Hart requested that we undertake an investigation covering certain issues dealing with the U.S. ability to control and account for the use of the highly enriched uranium (HEU) 1/ fuel it exports. (See app. I.) In response to his request, this report reviews U.S. efforts to minimize the use of HEU, describes the various U.S. controls over this type of nuclear fuel and the physical security and international safeguards related to it, and assesses U.S. efforts to keep track of its exports of HEU.

HISTORICAL OVERVIEW OF U.S.-SUPPLIED HEU

Since 1954, the United States has exported over 16,000 kilograms of HEU for use in research and test reactors in 43 nations. (See app. II.) This highly enriched uranium has many beneficial uses in research reactors, such as producing radioisotopes for agricultural, medical, industrial, and research purposes; materials testing; and basic scientific research. However, this material is also usable in nuclear weapons and, in irresponsible hands, it could threaten international security. About 25 kilograms of HEU is generally recognized as the amount needed to make a nuclear explosive device.

The potential risk that HEU would be used for nuclear weapons has caused a growing concern as the quantities in use worldwide have increased. In 1977, the United States began to more closely scrutinize exports of HEU, according to DOE. The special sensitivity of HEU has long been recognized, but divergent views have existed over its export.

The "Atoms for Peace" program, proposed by President Eisenhower in 1953 and authorized by the Congress with the passage of the Atomic Energy Act of 1954 (42 U.S.C. 2011), provides the foundation for some of the most important political instruments that the United States relies upon to deter nations from developing nuclear weapons and serves as the basis for intergovernmental agreements for U.S. nuclear exports. It was under these early agreements and the "Atoms for Peace" program that the United States began exporting research reactors in the mid-1950s. These first research reactors used fuel elements containing less than 20 percent enriched uranium, the value considered to be the threshold for weapons-usable material.

1/Highly enriched uranium refers to uranium which has been enriched to 20 percent or more in the isotope U-235. However, HEU is typically uranium enriched to 93 percent U-235.

However, the demand for higher specific power created a desire for greater concentrations of U-235 and led to the use of HEU (mostly 93 percent enriched).

In the 1970s, questions were raised about the proliferation aspects of various fuels and fuel cycles. Early in the Carter administration, U.S. officials became concerned over large inventories of 93 percent HEU that had built up overseas. Although most major recipients were not considered proliferation risks, the Carter administration was concerned with terrorists' diversion possibilities, especially at European fabrication plants. As a result, HEU exports were temporarily suspended pending completion of an assessment of U.S. nuclear export and non-proliferation policies aimed at determining appropriate U.S. policy regarding the foreign distribution of HEU.

The Carter administration wanted to limit the amount of HEU around the world but recognized that the United States had certain obligations as the principal supplier of HEU. It also realized that there were economic benefits to the United States in exporting such material and that continuing to supply HEU could further U.S. non-proliferation objectives by persuading other nations to forego the development of their own enrichment facilities capable of producing HEU.

On April 27, 1977, President Carter proposed non-proliferation legislation to the Congress and outlined several initiatives aimed primarily at strengthening controls over U.S. exports of HEU. Specifically, he announced that, in considering whether a nuclear export would be inimical to the common defense and security of the United States, the executive branch would adhere to the following policies:

--Avoid new commitments to export significant quantities of HEU except when the project was of exceptional merit and the use of low enriched uranium (LEU) 1/ or some other less than weapons-usable material was clearly shown to be technically infeasible.

--Require direct Presidential approval for any supply of HEU greater than 15 kilograms.

--Undertake efforts to identify projects and facilities which might be converted to use LEU instead of HEU.

--Take steps to minimize inventories of weapons-usable uranium abroad.

1/LEU refers to uranium which has been enriched to about 20 percent in the isotope U-235 and is generally considered to be non-weapons usable.

The Carter policy held as a centerpiece the conversion of most research reactors from using 93 percent HEU to uranium enriched to 45 percent and, eventually, to 20 percent enrichment in the isotope U-235.

Although most aspects of President Carter's HEU policy remain in effect, beginning in March 1981, export cases involving HEU were no longer routinely referred to the President. On April 7, 1981, the United States informed its major nuclear trading partners of this change, but noted continuation of other export policies and emphasized the continuing importance attached to the programs to convert to LEU.

ASSESSMENT OF RISK

The current and previous administrations have indicated that HEU poses potential proliferation and nuclear terrorist dangers. For example, in April 1976, DOE's predecessor agency (the Energy Research and Development Administration) defined the proliferation risk of HEU as follows:

> "Highly enriched uranium, when it is in its proper form, is suitable for making nuclear explosives. In the usual forms as a chemical compound, a fuel alloy or a fabricated fuel element, HEU is not directly usable in a nuclear explosive device and would require some chemical or metallurgical conversion. Nevertheless, provided the necessary skills and equipment were available, HEU could be converted and fabricated into a form usable in a nuclear explosive device. It is therefore likely to present a target that is considerably more attractive than low enriched uranium. Because it is not highly radiotoxic prior to irradiation,* * * HEU may also be a more attractive target than plutonium for a nuclear explosive application."

In commenting on a draft of this report, agencies said that most HEU abroad is in an irradiated form which is not easily convertible into weapons-usable material and that only a few nations have the reprocessing capability to recover residual HEU from such irradiated fuel. They pointed out that most HEU has been transferred to close allies and/or signatory nations of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and that the remainder is dispersed in small quantities to the other recipients. Considering these factors, they believe that HEU supplied to other countries does not contribute a significant proliferation risk.

Nevertheless, it is commonly accepted that the presence of HEU should be minimized or avoided to the greatest extent practicable. The agencies agree that reducing the use of HEU was a sound non-proliferation objective. President Reagan

has called upon the executive branch "to substitute lower enriched fuels for research reactors at the earliest possible time." The executive branch has had a high priority program for the past several years to reduce the HEU inventories abroad and thus improve the proliferation-resistance of related fuel cycles.

According to the Argonne National Laboratory, current worldwide use and inventory levels create a considerable concern that HEU might be diverted for non-peaceful purposes while in fabrication, transport, or storage and, particularly, while it is still unirradiated.

Concerning the proliferation risks and the need for the reduced enrichment program, State and ACDA officials made the following assessment in 1978. HEU involves weapons-usable material at all points of the fuel cycle. Even irradiated research reactor fuel involving the use of 90 percent enriched uranium in significant quantities can pose a substantial hypothetical risk, in that the enrichment level of the residual material is still typically 80 percent or more. The officials added that the relatively greater ease of reprocessing metal in HEU means that only modest reprocessing capabilities--even large hot cells--could produce enough material for one or more weapons per year.

These officials also stated that a single seizure of a significant quantity of HEU by an irresponsible government or terrorist group could have profound repercussions for the security of all nations and would almost certainly have a highly negative impact on all peaceful nuclear activities to the detriment of all nations. Furthermore, the officials said that the dangers are not limited to material located in irresponsible nations. They said that an irresponsible nation, or a sub-national group, might seize material from the territory of the most responsible nation. Thus, they concluded the problem is no respector of the political orientation, social system, location, alliance relation or even nuclear-weapons-nation status of the nation concerned. The officials indicated that to the extent that LEU can be substituted for HEU, it will eliminate the problem.

OBJECTIVES, SCOPE, AND METHODOLOGY

In line with Senator Hart's request, the thrust of this review was to assess the U.S. ability to control and account for its exports of HEU. As specifically requested, the objectives of this review were to:

(1) Evaluate the mechanisms established in international agreements of cooperation for controlling the use of U.S.-supplied HEU fuel and assuring adequate protection of HEU fuel shipments from terrorists.

(2) Assess the ability of the International Atomic Energy Agency (IAEA) to detect diversions of HEU and fissionable materials produced from this fuel, through material accounting techniques and containment and surveillance devices.

(3) Ascertain the rationale for supplying HEU fuel to foreign countries and the possible nuclear proliferation consequences.

(4) Review the implementation and effects of the U.S. programs announced at the United Nations Special Session on Disarmament in 1978 aimed at limiting the use of HEU fuel in research reactors, as well as any U.S. foreign policy initiatives in this area.

(5) Assess the system used by the United States for keeping track of its exports of HEU fuel and any fissionable materials produced from this fuel.

(6) Determine what controls, if any, the United States has over the use of fissionable materials produced from U.S.-supplied HEU fuel or in U.S.-supplied nuclear facilities.

This review was done in accordance with the "Standards for Audit of Government Organizations, Programs, Activities, and Functions." We applied these standards in gathering information from a variety of sources, including the U.S. Government, national laboratories, private U.S. industry, and embassies of foreign nations.

U.S. Government sources

We reviewed records and interviewed officials at the Departments of State and Energy; the Arms Control and Disarmament Agency (ACDA); and the Nuclear Regulatory Commission (NRC).

We also gathered data about HEU returned to the United States from officials at the U.S.-owned Savannah River plant and the Idaho Fuels Processing Facility. From the Department of Energy's Oak Ridge Operations Office, we received information on the U.S. computerized system designed to track the exports of HEU.

National laboratories

U.S. national laboratories are Government-owned, contractor-operated facilities which conduct extensive research and development. To gain insight into the state-of-the-art of of safeguards, we contacted officials at Brookhaven, Los Alamos,

and Sandia national laboratories. We obtained information on the U.S. program to develop new LEU fuel from officials at the Argonne National Laboratory.

Private U.S. industry

We discussed the U.S. conversion program to LEU with representatives of General Atomics, Atomics International, and Babcock and Wilcox. We also talked with an official at Allied General's Nuclear Fuel Plant in Barnwell, South Carolina, to learn about reprocessing differences between high and low enriched uranium.

Embassies of foreign nations

We met with officials of the French, Japanese, and West German Governments at their respective embassies in Washington, D.C. The purposes of these meetings were to discuss the current status of their programs to convert research reactors to LEU, to learn their views on the U.S. efforts to develop the LEU fuel, and to obtain some perspective on whether such a new fuel would be readily accepted by the world community.

Reports reviewed

In addition, we reviewed a number of other published reports, including the following:

--Annual Presidential Reports on Nuclear Non-Proliferation

--International Nuclear Fuel Cycle Evaluation reports

--1978 U.N. Special Session on Disarmament reports

--Congressional Research Service reports

--Office of Technology Assessment Report on Nuclear Proliferation and Safeguards

--Our previous reports on related issues (See app. III.)

Agency comments

We obtained comments from the Departments of Energy (DOE) and State, NRC, and ACDA on the draft of this report.

We also received technical comments from the Argonne and Lawrence Livermore National Laboratories, as well as DOE's Savannah River Plant and Oak Ridge Operations Office.

The comments offered suggestions to improve the clarity and technical accuracy of the report or to provide a more

balanced presentation and we have modified the report to reflect their comments. We also have included the general comments provided by the four agencies in appendices VIII through XI.

Limitations

In conducting our review, we were confronted by two limitations. We believe, however, these limitations do not significantly detract from our evaluation.

--IAEA does not provide member nations with the results of its inspections in a particular nation or any related documents. Thus, this report does not reflect problems associated with a specific nation or facility, but rather includes a general overview of safeguards implementation. In addition (1) we do not have audit authority at IAEA, (2) IAEA does not make public specific information about safeguards implementation, and (3) some information we had hoped to include in the discussion of safeguards over HEU was classified by the executive branch and therefore was not included in this report. We did not obtain IAEA comments on this report.

--DOE has not yet completed verification of the International Nuclear Materials Tracking System for completeness and accuracy. Although we cite data and statistics from this computer system, we recognize its possible shortcomings. (We discuss the difficulties with this system in ch. 5.)

CHAPTER 2

CONTROLS OVER U.S.-SUPPLIED HEU FUEL

The United States regulates and controls its exports of HEU fuels through three mechanisms--agreements for cooperation, export licenses, and subsequent arrangements. The agreements establish the basic framework for U.S. nuclear cooperation, including the initial supply of nuclear material and any subsequent actions. The export licenses, and review process which justifies them, provide the control mechanism to ensure that the provisions of the agreements and applicable U.S. legal requirements are met before material is supplied. Subsequent arrangements regulate transactions, such as supply contracts, retransfers, reprocessing and return of spent fuel.

Although the special sensitivity of HEU has long been recognized, the terms of the recent agreements for cooperation reflect a greater concern for the control of HEU than those previously negotiated. However, efforts to renegotiate existing agreements for cooperation, as called for in the Nuclear Non-Proliferation Act of 1978 (P.L. 95-242, 92 Stat. 120), have been slow, and, thus, more stringent standards for cooperation, as established by the Act, have not reached fruition on a broad front. Virtually all present HEU exports are transferred under agreements for cooperation that have not been renegotiated.

The specific export licensing review process determines (1) whether the United States will provide HEU to other countries, (2) the amount, and (3) the level of enrichment. The statutory export licensing criteria for HEU are essentially the same as those for slightly enriched uranium. 1/ However, U.S. officials indicated that exports of HEU are given a comprehensive interagency review of far greater intensity, including an in-depth analysis of the technical and economic justification for the export, than normally applied to exports of slightly enriched uranium.

Procedurally, subsequent arrangements for HEU are handled in the same way as those for slightly enriched uranium, with one exception. Unlike spent slightly enriched fuel, the United States routinely accepts the return of spent U.S.-supplied HEU from other nations for reprocessing and storage. The stated reason for this is to minimize the proliferation risk of having such weapons-grade material accumulate abroad. However, DOE records

---

1/Slightly enriched uranium refers to uranium which has been enriched to 3 to 5 percent in the isotope U-235. It is used in power reactors and is non-weapons usable.

show that only about 7 percent of all HEU exported has been returned as spent fuel. 1/ According to U.S. officials, factors, such as the minimum charge for accepting spent HEU and high shipping costs, may be discouraging some nations from returning such fuel.

The authority to accept spent U.S.-supplied research reactor (e.g., HEU) fuel, unless extended, will expire in December 1982. State and DOE officials commented that they are in the process of revising the regulations, but that several disincentives are hampering the return of this fuel.

AGREEMENTS FOR COOPERATION SET CONDITIONS

Agreements for cooperation are a precondition for export of nuclear material, including HEU, to other nations and, generally, do not legally commit the United States to make such exports. Legal commitments exist only with the conclusion of specific supply contracts and the issuance of specific export licenses for such exports. Certain controls in the agreements are designed to assure both the United States and the recipient nation or group of nations that materials and equipment transferred between the parties will be used for authorized purposes only and will be properly safeguarded. As of February 1, 1982, the United States had agreements with 25 individual countries and 2 international organizations.

Agreements for cooperation are not exactly alike, due to provisions tailored to the needs of recipients, changes in U.S. statutory and regulatory requirements, new international treaties, technological developments, and an evolving U.S. non-proliferation policy. They also differ according to the scope of nuclear cooperation involved. Most agreements cover both research and power applications of nuclear energy; a few older agreements cover only research or power. The duration of the agreements also varies. Early agreements for research applications ran for 5 to 10 years, while agreements for power applications ran up to 40 years. Newer agreements have customarily covered both research and power applications and run about 30 years.

Prior to the Nuclear Non-Proliferation Act (NNPA), the Atomic Energy Act of 1954 had specified that each agreement contain guarantees that safeguards would be maintained, U.S. nuclear exports would not be used for atomic weapons, and materials would not be retransferred except as allowed under the agreement. In practice, agreements in effect in 1978 typically contained controls above and beyond those required by

---

1/Minor amounts have been returned in forms other than spent fuels.

the 1954 Act. In 1978 major control provisions common to most U.S. civil agreements included the following:

--Cooperating nations guarantee that (1) material provided under the agreement will not be used for atomic weapons, for research and/or development of atomic weapons, or for any nuclear explosive device; (2) material made available and, in most cases, material produced from supplied material will not be transferred to unauthorized persons or beyond the jurisdiction of the cooperating party except as authorized by DOE; and (3) safeguards will be maintained on such material.

--Enriched uranium may not be supplied in excess of a ceiling specified in the agreement. 1/ A specific technical or economic justification may be required for supplying uranium that is enriched to more than 20 percent because of the suitability of HEU for weapons development as well as for use in reactors.

--The reprocessing of any special nuclear material may be performed in facilities acceptable to both parties upon a joint determination that the safeguards provisions of the agreement may be effectively applied, or with the prior approval of the United States.

The NNPA added six new criteria for agreements to the 1954 Act and expanded three others. (See app. IV.) Some of these changes codify what had been U.S. practice, while others extend controls beyond those in pre-1978 agreements or the new export licensing criteria.

Two of the most important changes involve safeguard requirements and U.S. prior consent rights. A cooperating partner's safeguard requirements regarding U.S. nuclear exports are specified with greater clarity than before, and non-nuclear weapon nation partners must also have IAEA safeguards maintained with respect to all peaceful nuclear activities at the time of the export. U.S. prior consent rights over the reprocessing of spent U.S.-origin fuel are now required in future agreements. (Similar provisions were already part of most existing U.S. agreements.) Furthermore, in future agreements, prior consent rights to be obtained by the United States over reprocessing and retransfers are to be expanded to cover materials used in or produced through the use of U.S. nuclear

---

1/On June 18, 1980, a congressional joint resolution lifted the ceilings for low enriched uranium (less than 20 percent) to nations that are party to the NPT.

exports. Thus, under a new agreement, if a nation were to use non-U.S. fuel in a U.S. supplied reactor, it would have to obtain U.S. permission to reprocess or retransfer the spent fuel. Most of the agreements existing in 1978 did not include prior consent rights involving non-U.S. fuel, nor are such rights required under the export licensing criteria established in the NNPA.

Recent agreements for cooperation have included provisions that are, in certain respects, more restrictive than other agreements or than the law requires. For example, agreements for cooperation concluded since 1978 typically limit the quantity of transferred nuclear material, such as HEU, to amounts sufficient for the loading and continuous, efficient operation of reactors or for use in reactor experiments, or for other purposes as agreed by both parties. In cases where HEU supply is provided for, the new agreements (with such countries as Peru and Indonesia) provide that if excess amounts of HEU are accumulated, the United States has a right to require the return of some HEU. Other new agreements (e.g., with Egypt, Morocco, and Bangladesh) do not provide for the transfer of any special nuclear material other than slightly enriched uranium, except for insignificant quantities for certain specified uses. In addition, DOE officials pointed out that in newer agreements, the cooperating nation authorizes IAEA to provide the United States with nuclear inventory data.

Renegotiation progress is slow

The NNPA attempts to expedite the revision of existing agreements, many of which are not due to expire for several years. The law calls on the President to initiate a program to renegotiate existing agreements, or to otherwise obtain cooperating nations' acceptance of the new criteria, and to "vigorously seek" retroactive application of new criteria to previously exported nuclear material or equipment and to special nuclear material produced in or through their use. However, a deadline for completion of the renegotiation program is not specified, penalties are not prescribed for a nation that refuses to renegotiate its agreement, and the new criteria do not affect the authority to continue cooperation under existing agreements.

The renegotiation progress has been slow and much of the task has not been completed. Since the NNPA was passed, previous agreements with Australia, Canada, Indonesia, and IAEA have been revised or replaced. New agreements have been completed with Egypt, Peru, Morocco, and Colombia; and an agreement with Bangladesh has been forwarded to the Congress for its review. However, previous agreements with 15 nations and EURATOM (European Atomic Energy Community) have yet to be revised. (See app. V.)

Nations have been reluctant to renegotiate for various reasons, including concern over U.S. prior approval rights and perceived U.S. "unilateralism" in revising the ground rules for cooperation. Some nations have deferred renegotiation until the United States has revised other agreements. Others have been unwilling to accept international safeguards on all nuclear facilities.

Some U.S. officials also attribute the slow progress in renegotiating nuclear agreements to the lack of a new, more definitive U.S. policy on non-proliferation. According to one official, foreign countries expect the policy will include a relaxation of restrictions. However, the State Department commented that foreign officials have been given no reason to believe that any changes would affect HEU.

According to ACDA, progress in the renegotiation effort is not that germane to a review of the HEU export question. ACDA commented that although it is helpful to have language in the newer agreements that establishes tighter control over HEU, an effective policy for HEU exports had been implemented prior to the beginning of the renegotiation program; and the the policy continues even though virtually all present HEU exports are transferred under agreements for cooperation that have not been renegotiated.

EXPORT LICENSES CONTROL HEU TRANSFERS

According to U.S. officials, export licensing is the principal controlling mechanism for implementing provisions in the agreements for cooperation. As a condition for future U.S. exports of uranium supplies, other parties must continue to comply with the provisions of the agreements.

The NNPA sets forth the general export licensing criteria. As with slightly enriched uranium exports, the transfer of HEU is generally conditioned upon the proposed license's meeting general conditions. Briefly, these conditions require that the export, and in some cases, special nuclear material used in or produced through the use of such export, be subject to

- --the terms and conditions of the U.S. agreement for cooperation with the receiving nation or group of nations,

- --application of IAEA safeguards (for non-nuclear weapon nations, IAEA safeguards must be maintained on all of their peaceful nuclear activities at the time of export from the United States),

--adequate physical security measures,

--prior U.S. approval for any export retransfers to the jurisdiction of any other nation or group of nations than was initially authorized,

--prior U.S. approval for any reprocessing or other physical alteration of the export,

--prior U.S. approval for any enrichment of the export, and

--a U.S. determination that the proposed export will not be inimical to the national defense of the United States.

Although not set forth in the NNPA as part of the licensing criteria, it is during the export licensing review process that Federal officials

--evaluate the technical and economic justification for any export of 5 or more kilograms of HEU, and

--determine whether a proposed export of HEU has "exceptional merit" before making a new commitment.

Technical and economic justification

In making the required review of proposed HEU exports, U.S. officials 1/ review the operation of the reactor proposed to receive the material, the contemplated use of the HEU, and the recipient country's efforts to convert to LEU fuels. Acquiring its information directly from foreign countries for each case-by-case review, the Argonne National Laboratory calculates how much fuel the facility has on hand, how long it should last, and how much more is needed. Based on such analyses, U.S. officials, in some cases, have reduced requested quantities of nuclear materials, deferred shipments, and split applications for fuel into two separate licenses. The United States usually supplies fuel in 1-year increments.

"Exceptional merit" for new commitments is tightly restricted

Under the Carter policy of April 1977, any "new commitments" of HEU--commitments made for facilities or countries which had not received shipments before April 27, 1977--became subject

---

1/Includes officials from the Departments of State, Energy, Defense, and Commerce, ACDA, and NRC.

to a finding of "exceptional merit." According to U.S. officials, such a determination is to be based on several criteria:

--The level and type or nature of government involvement.

--Fuel alternatives available, i.e., the need for the reactor in question and its design requirements which necessitate HEU fuel usage.

--The country's non-proliferation credentials.

--The nature of a high-powered research reactor.

In assessing whether the project has exceptional merit, the executive branch is to place more emphasis on the project's programmatic aspects--the purpose, importance, and benefits to be derived from the planned research--than on its economic aspects. It also is to consider whether other operating reactors within the country or in other countries could provide a viable alternative for performing any part of the planned research. Cases which might justify a finding of "exceptional merit" include medical research needs or certain kinds of materials testing requiring high-powered research reactors (about 50 megawatts).

According to State Department officials, the application of the exceptional merit criteria has been a deterrent in the requests for new commitments of HEU. The only "new commitment" licensed since passage of the NNPA was in 1978 for HEU shipments to a reactor at Kyoto University in Japan. This was considered justified because the reactor was designed before the Carter policy was initiated. Although one fuel load of HEU was licensed, Japan agreed to work toward converting to LEU fuels. According to a DOE official, the United States would not authorize any further HEU fuel loadings for this reactor.

SUBSEQUENT ARRANGEMENTS EXTEND CONTROLS

Subsequent arrangements refer to the regulatory controls administered by DOE over certain cooperative arrangements regarding the supply, use, or retransfer of U.S. nuclear material and equipment. Such arrangements include contracts for the sale of enrichment services for HEU and arrangements involving the return of spent HEU to the United States.

Before the United States can approve any proposed subsequent arrangement, the NNPA requires DOE to make a national security determination that the arrangement will not be "inimical to the common defense and security" of the United States. The security finding is a common criterion governing all types of subsequent arrangements. Our review showed that the procedures for most subsequent arrangements involving HEU are essentially the same as those employed for non-weapons-grade, slightly enriched fuels, except for the

return of spent HEU fuel. However, U.S. officials assert the nature and intensity of subsequent arrangement reviews are quite different for slightly enriched uranium and HEU.

Pursuant to the Atomic Energy Act of 1954 and Federal regulations, the United States, for years, has routinely accepted the return of limited quantities of spent U.S.-supplied HEU for reprocessing and storage, but not slightly enriched spent fuel. According to DOE records, approximately 1,100 kilograms (about 7 percent of the total U.S.-supplied HEU) have been returned to the United States as shown in the following chart.

Country	Weight in kilograms of returned spent HEU	
	Total element weight	Contained U-235
Austria	3.4	2.3
Belgium	86.6	63.2
Canada	408.2	268.9
Denmark	37.9	25.9
France	408.2	324.6
Germany, West	131.5	93.5
Italy	12.0	9.6
Japan	69.8	61.8
Mexico	.6	.4
Netherlands	105.5	80.4
South Africa	19.0	14.3
Sweden	204.1	153.8
United Kingdom	.4	.3
Total	1,487.2	1,099.0

In commenting on our draft report, the Argonne National Laboratory said that the average fuel burn-up during operations may be nearly 50 percent and the process losses could be nearly 20 percent. Using these figures, the maximum amount that could be expected to be returned is about 4,800 kilograms. Based on such estimates, the 1,100 kilograms returned represent about 23 percent of the total that could be expected to be returned.

DOE is required to recover the full cost for all fuel cycle services rendered to non-DOE customers. As a result, DOE has a minimum charge for accepting and reprocessing spent HEU which reflects an estimate of the cost of providing processing services for small quantities of material. The charge includes process system start-up costs, recovery operations, and plant clean-out for materials accountability. DOE believes it is logical that the per kilogram cost for processing small quantities of fuels is higher than for larger batches because much of the process is insensitive to the quantity of material involved.

According to a Savannah River official, the minimum charge is currently $30,000 plus a charge per kilogram for waste management. He estimated that a country would need to return about 100 kilograms at one time for it to be cost effective. As a result, the minimum charge can act as a disincentive to nations with smaller volumes of spent HEU, according to some U.S. officials. These countries tend to store spent fuel and accumulate it to make the minimum charge economically justifiable. One ACDA official believes it would better serve non-proliferation goals to abolish the minimum charge or adjust it selectively for different countries.

DOE's Federal Register Notice concerning authority to take back and reprocess spent U.S.-supplied HEU expires in December 1982. An ACDA official said it is critical that this authority be extended. He added that it might be desirable to also expand the authority, if possible, to allow for U.S. retrieval of spent foreign-origin HEU fuel. He also said that this would help advance U.S. non-proliferation interests by further preventing spent fuel accumulation in countries' inventories and provide them an alternative to developing their own reprocessing capabilities.

CONCLUSIONS

International agreements for cooperation, export licenses, and regulatory review of subsequent arrangements are the mechanisms by which the United States can control its exports of HEU.

Recent agreements reflect a greater concern for the control of HEU than previous ones. However, efforts to renegotiate existing agreements have been slow and agreements with 15 nations and EURATOM remain to be renegotiated. Virtually all present HEU exports are transferred under agreements that have not been renegotiated.

Procedurally, U.S. officials follow essentially the same general export license criteria and review process for subsequent arrangements for weapons-grade HEU as they

do for non-weapons-grade slightly enriched uranium. However, the additional care taken in analyzing the justifications for proposed exports of HEU have resulted in reduced quantities of material being exported and the deferral of shipments in a few cases.

To minimize the risks of having weapons-grade material accumulated abroad, the United States has had the authority for years to accept the return of HEU of U.S.-origin from other nations. However, only a limited amount of U.S.-supplied HEU has been returned. Moreover, the authority to accept spent U.S.-supplied HEU expires in 1982 and a decision on extending it will need to be made during 1982 if this practice is to continue.

We believe that, in general, the practice of accepting spent U.S.-supplied HEU fuel is beneficial to the overall U.S. non-proliferation strategy and should be continued. In our draft report, we suggested that DOE (1) extend the authority to accept spent U.S.-supplied HEU and (2) consider the concerns expressed by U.S. officials that the minimum standard charge for accepting and reprocessing spent HEU acts as a disincentive to some countries.

AGENCY COMMENTS

DOE commented that it has had active plans underway for several months to extend the U.S. offer to reprocess and store U.S.-origin HEU irradiated in foreign research reactors. DOE indicated that the offer would be extended before the current Federal Register Notice expires at the end of 1982. With regard to the minimum reprocessing charge, DOE believes sufficient flexibility exists in U.S. policy to permit several small users to combine their spent fuel into single batches. DOE added that it has encouraged this type of batching in the past and intends to encourage it to a greater degree in the future. Given its obligation to recover its full costs in such activities, however, DOE does not anticipate that it will be feasible to reduce its charges.

In responding to our draft, those commenting raised other issues about accepting spent research reactor fuel. For example,

--The State Department agreed with our suggestion that the authority to accept spent U.S.-supplied HEU be extended. Additionally, State commented that the authority should be expanded to permit the return of the LEU fuels being developed to replace the currently used HEU. Without such a U.S. commitment in the near future, the State Department believes the implementation of the program to reduce the levels of HEU abroad will be significantly delayed. DOE is now considering the incorporation of provisions in the Federal Register

Notice to accept certain types of new fuels and has a study underway concerning the reprocessing of another new fuel.

--According to the Argonne National Laboratory, the cost of shipping spent HEU from foreign reactors to an assigned DOE reprocessing facility is probably a greater disincentive than the minimum reprocessing charge.

--NRC commented that on at least one occasion a country was reluctant to return HEU because DOE has no authority to reimburse for the value of reclaimed material and U.S. export policies preclude reimbursement through provision of material-in-kind.

RECOMMENDATION TO THE SECRETARY OF ENERGY

As part of the review process relating to the extension and possible expansion of the authority to accept spent research reactor fuel, we recommend that the Secretary of Energy determine the principal reasons why only a small percentage of spent HEU has been returned in the past and adequately address the disincentives to some countries in returning such spent fuel.

CHAPTER 3

U.S. ABILITY TO ENSURE ADEQUATE PHYSICAL PROTECTION IS LIMITED

Due to the rise in terrorism, generally, and the number of specific assaults on nuclear facilities in recent years, the U.S. Government has become increasingly concerned with the physical security of HEU from theft by subnational groups. Although the United States has a mechanism for conducting physical security reviews within nations receiving U.S.-supplied HEU, a number of problems exist which hinder the effectiveness of these reviews.

There is a fundamental need to gain foreign cooperation in ensuring that adequate physical protection standards are applied. However, the United States sometimes finds it difficult to gain access to foreign nuclear facilities or sections of facilities which will be using U.S.-supplied HEU. In addition, due to sensitivities of national sovereignty, intervals between visits have sometimes been lengthy. Nevertheless, U.S. officials have relied on information from the visits for licensing purposes.

Many countries voluntarily adhere to IAEA's guidelines 1/ on physical security and have their own independent reasons for wishing to protect their nuclear installations from dissident or terrorist groups. A group of nuclear supplier nations have also agreed on minimum physical security requirements for exports of HEU. In addition, under a U.S. initiative, an international convention on physical security of nuclear materials has been approved by a number of countries.

CONCERNS OVER NUCLEAR TERRORISM HAVE INCREASED

Terrorists can operate with a variety of purposes which include the theft of nuclear material for use in nuclear explosives, radiological weapons, or resale to finance other operations; sabotage to scare the public and discredit the government or

---

1/IAEA has no statutory basis for conducting physical protection reviews. However, in 1972 and 1975, the IAEA Director General convened a panel of experts which prepared a report containing recommendations on physical protection. The panel report is circulated by IAEA to member nations in connection with their national physical protection responsibilities. U.S. officials indicate that countries do not want IAEA involved in physical security reviews because it would be considered an unacceptable invasion of national sovereignty.

establishment; or extortion to gain concessions such as freeing prisoners. In short, terrorists are interested in those actions that may directly or indirectly cause harm to the public or otherwise undermine government ability to inspire public confidence and to control events.

Since the mid-1960s, the United States and other countries have experienced an upsurge in threats and acts of sabotage or violence directed at nuclear facilities. Although such acts may not involve the efforts of organized terrorist groups specifically to divert nuclear materials for the purpose of making an explosive device, the incidents, whatever the motives, illustrate the need for physical security. Between 1966 and 1979, at least 39 physical security incidents occurred at nuclear facilities. (See app. VI for a listing of the attacks and/or physical security breaches at nuclear facilities.) Nuclear terrorist acts have continued through 1982 with the January 19 assault on the Creys-Malville fast breeder reactor under construction in Lyons, France. Although terrorists firing five Soviet-made antitank rockets caused no injuries and little damage, they scored four direct hits on the plant's concrete outer shell, demonstrating the severity of the challenge to physical protection.

As a 1976 U.S. Government report on nuclear export activities said:

> " * * * any vulnerability in the fuel cycle might conceivably be exploited if it could be used for financial return or in some way cause harm to the public, or at least threaten such harm in a way that concessions would have to be made. * * * The physical security * * * system must be based on an assumption that the possibility of a serious threat exists."

U.S. MEASURES TO ENSURE PHYSICAL SECURITY REQUIRE FOREIGN COOPERATION

Since 1974, the United States has promoted a policy of ensuring the physical security of nuclear facilities on a global basis, and has especially required adequate physical security for U.S. nuclear materials sent abroad. The NNPA made the latter a matter of statute. Thus, DOE/NRC teams assess recipient countries' physical security measures before recommending approval or denial of licenses for exports or retransfers of shipments exceeding certain limits, such as 5 kilograms of HEU. Such teams have visited more than 40 countries receiving U.S. nuclear materials and representatives from a number of countries and EURATOM have visited the United States to observe U.S. methods, discuss individual protection problems, and exchange expertise. In addition, special U.S. training programs involving physical security are being carried out for representatives of foreign countries.

Physical security is a sensitive subject internationally, because it is considered to be a matter within a country's domestic jurisdiction. Consequently, some countries limit U.S. access to their nuclear facilities. Nevertheless, in export licensing, NRC and other Federal agencies have relied on the results of these visits to judge the adequacy of physical security measures in the recipient country.

Physical security standards

Although U.S. agreements for cooperation have not previously contained provisions relating to physical security, the NNPA requires that adequate physical security be maintained for any proposed U.S. export of source material, special nuclear material, production or utilization facilities, or special material used in or produced through the use of such material or facilities. However, it should be noted that neither the NNPA nor the agreements for cooperation require that review visits be conducted on a periodic basis.

In accordance with the NNPA's requirements, NRC established levels of physical security which, in its judgment, would be no less strict than the standards established by any international guidelines to which the United States subscribes. NRC regulations specify levels of physical protection based on the potential hazards of the material to be shipped, its type (i.e., plutonium, uranium, thorium), isotopic composition (i.e., content of fissile isotopes), physical and chemical form, radiation level, and quantity. HEU shipments of 5 kilograms or more are given the highest level of protection.

In addition to these regulations, NRC has noted that in evaluating whether the physical security program of a country meets these physical security standards, the Commission staff considers for the most hazardous materials the following essential elements, or their equivalent:

"(i) Storage of materials in areas which provide penetration resistance and delay;

(ii) Protection of processing and storage areas with intrusion alarm system;

(iii) 24-hour armed security forces (or an unarmed security force if a national or regional emergency plan has been established that will ensure immediate wide scale alert and response by armed police or other government agencies);

(iv) Armed offsite forces capable of response;

(v) Independent duplicated transmission system for two-way voice communication.

(vi) Procedures to control access to and to provide continuing surveillance in material storage and processing areas;

(vii) Protection of transport by escorts or guards to be armed if armed emergency teams are not available for timely response to prevent attempted theft and facilitate recovery;

(viii) Transport in vehicles equipped with communications capable of calling for assistance from the local police or emergency team;

(ix) A program for determining trustworthiness of guards and individuals who have access to nuclear materials.

The Commission also notes that the staff will consider any potential threats to nuclear activities within the recipient country."

Physical protection reviews are limited

Although NRC and DOE officials said that sufficient information is obtained during their visits to determine the adequacy of physical security in a country, there are some limitations and problems with the ability of the United States to determine compliance with U.S. requirements.

NRC and DOE review team officials said that the purpose of the visits is to determine if all elements of an "adequate" physical security system are in place. The review, however, is not intended to determine how effectively the physical security system is working. Moreover, NRC and DOE officials do not consider these visits to be inspections but rather part of an "exchange program" whereby the United States and the recipient country share physical security technology and information with each other.

One limitation confronting the United States is that reviews are not always conducted at each facility handling or using U.S. supplies and materials. Because, at the insistence of the recipient country, visits sometimes are made at "representative" facilities, the United States has approved exports destined for facilities declared to have an adequate physical security system even though U.S. officials had never visited them. NRC commented that, under its regulations, determinations may be based upon a country-wide rather than upon a facility specific analysis.

This situation is exacerbated in some countries by limited U.S. access at the nuclear facility. For example, during one Argentine visit, the U.S. review team was not permitted to see part of the facility it wanted to see. A similar situation

occurred in the United Kingdom, although this was resolved in a later visit. NRC and DOE officials anticipate that this problem might become more severe during future visits because some countries are questioning the need for additional U.S. reviews.

Another limitation is the lack of current physical security information for some countries. As a result, NRC and DOE are limited in their ability to determine if the integrity of the physical security systems has been maintained since the previous visit. Since 1974, the United States has visited 41 countries, including 37 which have received U.S.-supplied HEU and 4 which have received special nuclear materials other than HEU. Visits have not been made to six nations which have received HEU. 1/

As shown by the following chart, the majority of countries and facilities reviewed were visited during the early years of the program. From the first review in December 1974, the physical protection exchange visits peaked at 38 facilities in 20 countries in 1976. In 1981, only five facilities in two countries were visited as part of this program.

Year of visit	Countries visited	Facilities reviewed
1974	1	2
1975	17	28
1976	20	38
1977	9	15
1978	1	2
1979	3	5
1980	7	17
1981	2	5

1/Bangladesh, Bolivia, Czechoslovakia, Iran, Vietnam, and Zaire. With the exception of Iran, which has received 5.2 kilograms, the others have each received no more than a few grams in total shipments. NRC noted that physical security visit are not required for gram quantity amounts and that the shipment to Iran was made before the United States established physical security requirements for exports.

According to DOE, criteria for initiating visits by U.S. physical security teams include:

1. Political unrest or increased terrorist activity in the country since the last visit.

2. New, or expanded, Category I facilities 1/ under consideration or have been put into operation since the last visit.

3. Significant improvements in physical security have occurred since the last visit.

4. Consideration of the time since the last visit.

The following table shows the number of facilities in each country visited since the review program began and the date of these visits.

Date of visit	Country	Number of sites visited
December 1974	France	2
April 1975	Sweden	1
	Netherlands	1
	West Germany	3
	Italy	3
June-July 1975	Japan	2
	Republic of China (Taiwan)	3
	Philippines	1
	South Korea	1
July 1975	Canada	1
August 1975	South Africa	1
September 1975	Romania	2
	Turkey	1
	Pakistan	1
Oct. - Nov. 1975	Denmark	1
	Sweden	2
	United Kingdom	2

1/A designation in IAEA's physical security guidelines which includes a facility containing 5 kilograms or more of unirradiated HEU.

Date of visit	Country	Number of sites visited
November 1975	India	2
	Yugoslavia	1
February 1976	Japan	1
	Philippines	1
	Thailand	2
	Indonesia	2
	Australia	1
April 1976	Austria	3
	Switzerland	2
	Spain	2
	Belgium	2
	France	2
	Italy	6
June 1976	Argentina	3
	Brazil	4
July - August 1976	Portugal	1
	Israel	2
	Greece	1
October 1976	Finland	1
	Norway	1
	Ireland	1
	Luxembourg	1
July 1977	Japan	2
	Thailand	3
	Malaysia	1
September 1977	Colombia	1
	Venezuela	2
December 1977	Argentina	3
	Uruguay	1
	Paraguay	1
	Peru	1
October 1978	Mexico (note a)	2
October 1979	Netherlands	1
	Belgium	3
	Switzerland	1

a/Visit conducted as part of IAEA support program.

Date of visit	Country	Number of sites visited
Feb. - March 1980	United Kingdom	2
	Denmark	1
	France	2
March - April 1980	Switzerland	3
	Spain	2
November 1980	South Korea	2
	Japan	4
September 1981	Italy	2
	West Germany	3

No future visits planned as of December 1981.

Comparing the table above and a DOE listing of HEU transfers shows some of the limitations previously cited. For example, in 1974 six facilities in France received shipments of U.S. HEU; U.S. review teams, however, visited two facilities deemed to be "representative" of them all, including one which received no HEU that year. In 1980, three facilities in the United Kingdom received U.S. HEU shipments while review teams visited two "representative" facilities.

Also, in some cases (West Germany, Korea, and the Philippines) intervals between visits have been as long as 5 years, thus rendering the currency of previously gathered information suspect. During 1974 and 1978, review teams visited only one country, France and Mexico, respectively. Of 41 nations visited, 15 have been visited more than once. NRC commented that although only 11 countries were visited from October 1979 to September 1981, they accounted for approximately 90 percent of the total HEU exported. In addition, the major foreign fabrication plants, which typically are the initial recipients of U.S. exports of HEU, were visited during this time period. It should be noted, however, that a fabrication plant is only an intermediate stop for the HEU before arriving at the ultimate user's facility.

NRC and DOE officials said that as a result of their reviews, NRC has delayed approving licenses on numerous occasions because of problems found with the physical security program of the recipient country or of a country considered to be an intermediate consignee. Although delays of up to 6 months have occurred in the licensing process, these officials advised us that improvements in the recipient country's physical security program were made and U.S. concerns were resolved as a result of the visits.

CONVENTION ON PHYSICAL PROTECTION SETS GLOBAL STANDARDS

Negotiation of an international convention on the physical protection of nuclear material was completed in October 1979. The Convention, which was opened for signature on March 3, 1980, requires nations to take appropriate steps to protect nuclear material used for peaceful purposes during international transport, and not to authorize the import or export of such material unless assured that it will be protected during transport at prescribed levels of physical protection. It also establishes a framework for international cooperation to recover lost or stolen material, and a system for prosecution or extradition for serious offenses.

U.S. officials point out that the Convention successfully completed a United States initiative to establish a regime of international cooperation to improve the physical protection of nuclear material, and that this achievement constitutes a major step in fulfilling the goals expressed in Titles II and IV of the NNPA. The United States signed the Convention on March 3, 1980, and the Senate adopted a resolution providing its advice and consent to ratification on July 30, 1981. (See app. VI for Convention signatories.)

Administration proposals for U.S. legislation to implement the Convention's criminal provisions were submitted to the House of Representatives and Senate on August 22, 1980, and again on April 7, 1981. As of April 1982, hearings have been held by the Senate Judiciary Subcommittee on Criminal Law, and the House Judiciary Subcommittee on Crime.

CONCLUSIONS

We believe that the increasing awareness of the problem of physical protection of nuclear materials, particularly HEU, is appropriate given the increase in incidence of terrorist activities in recent years. Attacks and breaches of security at nuclear facilities demonstrate the persistent danger of diversion of nuclear materials posed by terrorist groups and the continued need for the United States to ensure the physical security of HEU shipped overseas.

The U.S. physical security reviews, however, have uncertain effectiveness for determining adequacy of protection. Visiting "representative" facilities, or parts of facilities, rather than actual recipients of HEU exports might not adequately demonstrate the measures at the facility, or part thereof, which will actually use U.S.-supplied HEU. Thus, applying information gathered during such reviews to approval of export licenses could, in some cases, result in determinations based on inapplicable data. In similar manner, the sometimes lengthy interval between visits to a country throws into question the validity and timeliness of available U.S.

information. In addition, the reported resistance of certain nations to hosting return visits by U.S. teams threatens the continuation of the review program.

The establishment of an international convention for protecting nuclear materials, particularly in transit, represents a growing effort to establish some universally acceptable standards for physical protection.

AGENCY COMMENTS

DOE commented that in all of the 41 countries visited one or more times, there has been, in general, excellent cooperation. U.S. physical security teams have visited representative nuclear facilities in each country and all facilities in most countries. However, DOE pointed out that countries view physical security as a national responsibility and not one to be executed by the United States or IAEA. DOE feels this is a reasonable position.

According to DOE, the U.S. team has emphasized to each country that the mutual benefits to be derived by an exchange of information would be improved security systems worldwide. The United States has provided suggestions for improvements, when appropriate, and has held up some exports until systems were upgraded to satisfactory levels. DOE believes the results of this program have been encouraging as evidenced by an international awareness and concern of the risks, a willingness to cooperate, and commitments to upgrade programs where needed.

CHAPTER 4

PROBLEMS WITH INTERNATIONAL SAFEGUARDS

IAEA safeguards are aimed at providing timely detection of diversion of nuclear material from peaceful nuclear activities. However, the adequacy of such safeguards has been increasingly challenged in recent months. In general terms, IAEA and U.S. officials admit that IAEA inspectors have experienced some difficulty in meeting the Agency's timely detection goals at the facilities inspected.

During our review, we learned that IAEA has been able to carry out only about half of its estimated routine inspection effort and that a number of research reactors, including a few with significant quantities of HEU, were not being visited even once a year. If HEU were diverted, it could be converted for use in a nuclear explosive device in as short as 7 to 10 days. Details on IAEA's ability to meet its own timely detection goals for HEU at facilities it has inspected are not available to the public.

Nevertheless, U.S. and IAEA officials agree that the general effectiveness of IAEA safeguards has been adversely influenced by several factors, including (1) a limited number of inspectors and (2) a lack of suitable techniques and equipment. To secure sufficient numbers of inspectors and equipment, in the long-term, will require broad financial and political support by member nations.

IAEA DETECTION ABILITY

The objective of IAEA safeguards is to provide

> " * * * timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection."

To measure its ability to meet this objective, IAEA established detection goals in 1979 in which it defined a significant quantity of nuclear material as the approximate amount needed to construct a nuclear explosive device. For example, IAEA considers 25 kilograms (about 55 pounds) of contained HEU to be enough to make a nuclear explosive device. According to IAEA, timely detection refers to the ability to identify any diversion within the approximate time needed to convert nuclear material into the fissile component of a nuclear explosive device. For certain forms of HEU that time could be as short as 7 to 10 days. For irradiated HEU, the detection time is 1 to 3 months. According to DOE, IAEA determined that detection goals, such as 25 kilograms,

were considered reasonable for a non-nuclear weapon nation because of the difficulties such a nation would have in making efficient use of the material in making a bomb. DOE added that nuclear weapon experts from various nuclear weapon nations, including the United States, advised IAEA on this determination.

In commenting on a draft of this report, ACDA said that IAEA's policy is to inspect every facility at least once a year and that this policy is not dependent on the particular goal being used. According to DOE, research reactors possessing more than a significant quantity of fissile material are inspected with a frequency governed by the size and characteristics of the project, the quantities of unirradiated HEU likely to be involved, as well as the potential for plutonium production. However, our review showed that a number of facilities with HEU, including a few with significant quantities of unirradiated HEU, were not inspected once in a typical year.

The main inspection objective of IAEA safeguards at research reactors is to detect the absence of fuel items (e.g., assemblies, rods, bundles, plates, or pins) containing one or more significant quantities of HEU within the timeliness guideline. However, during any single year, IAEA often does not inspect many research reactors, including some with more than a significant quantity of HEU, because of inspection staff shortages. In addition, IAEA has considered its goals automatically attained when less than a significant quantity of material was reported as being on hand.

STAFFING LIMITATIONS

To fulfill its safeguards responsibilities, IAEA must have the necessary staffing. However, the number of IAEA inspectors has not kept pace with its rapidly growing safeguards responsibilities.

IAEA has been experiencing shortages in its inspectorate staffing for several years. Although there have been major increases in the inspectorate, there has also been a substantial increase in the number of facilities under safeguards. Consequently, IAEA achieves significantly less than its estimated routine inspection effort. This trend has continued, although improving somewhat. According to the State Department, IAEA carried out only about 50 percent of its estimated routine inspection effort in 1981 due to its inspector shortage. The Department indicated that IAEA expects to increase this mark to 60-70 percent by 1983.

Thus, the shortage of inspectors is expected to be a continuing problem. To help offset the lack of regular professional inspectors, the IAEA Secretariat has proposed employing inspection assistants to handle some of the less complex aspects of safeguards.

EQUIPMENT LIMITATIONS

IAEA lacks suitable equipment to adequately make quantitative verifications of nuclear material in many cases. A substantial amount of material, including HEU, is in a form that is currently unmeasurable. According to IAEA officials, further development of methods and equipment for nondestructive measurements of HEU, especially irradiated fuel, at research reactors is still needed.

During a previous review, 1/ IAEA officials indicated that only about 10 percent of all safeguarded material is quantitatively measured. Material inside reactors and irradiated material is not quantitatively measured; for the material that can be measured, IAEA inspectors generally take sample nondestructive assay measurements. U.S. officials advised us that surveillance devices, such as TV monitors and cameras, are seldom used at research facilities fueled with HEU because the nature of the facilities does not lend itself to such devices. However, they noted that IAEA uses seals on HEU, but does not rely solely or indefinitely on them.

Substantial efforts have been made by member nations, particularly the United States, to develop new equipment. However, much of the equipment is considered to be in the prototype stage or under evaluation and testing. For example, only 11 out of the 21 new types of equipment developed by the United States over the last 5 years is in routine field use by IAEA inspectors.

IAEA estimates that the cost of this new safeguards equipment through 1985 will be about $20 million with an additional $10 million for maintenance and consumable supplies (e.g., seals and film). 2/ With inflation, IAEA officials believe the total cost for equipment, maintenance, and supplies would be about $40 million through 1985. ACDA pointed out that most of this amount would be used for safeguarding facilities which do not handle HEU. Even without additional costs, many member nations have already expressed concern about the rising cost of safeguards.

It is generally recognized that new procedures and techniques must also be developed to meet the safeguard challenges presented by the larger and more complex facilities that have come under safeguards in recent years. Large amounts of material in various forms are present in or flow through "bulk handling" facilities. For example, significant amounts of direct use material (e.g., HEU) at

---

1/See our classified report entitled "International Nuclear Safeguards Need Further Improvement" (C-ID-81-4, Feb. 13, 1981).

2/According to IAEA budget projections for 1982, it will spend about $2.1 million on safeguards equipment.

fuel fabrication facilities and enrichment plants, where HEU can be manufactured, have been cited as posing substantial problems for IAEA inspectors.

The task of safeguarding research reactors using HEU, on the other hand, has been characterized by one U.S. official as relatively straightforward--accounting for modest and discrete amounts of fuel. However, according to ACDA, IAEA has been responsible for safeguarding HEU at such facilities for more than two decades, but procedures and techniques for inspecting such facilities have not been standardized to the extent desirable. ACDA pointed out that although further development and standardization are needed, the large number of different types and sizes of research reactors limits how much standardization is possible. A DOE official advised us that DOE expected IAEA to request U.S. assistance in 1982 to develop an inspection methodology for large research reactors which use HEU.

NEED FOR FINANCIAL AND POLITICAL SUPPORT

Effective safeguards depend in large measure on the cooperation and support provided by member nations. For example, IAEA needs financial and political support which, in some cases, it has had difficulty obtaining.

Applying safeguards is only one of IAEA's functions. 1/ About 24 percent of IAEA's total resources are expected to be used for safeguards in 1982. Member nations generally view IAEA safeguards as necessary but many maintain that the financial resources of IAEA should be used primarily for technical assistance to less developed countries and for the promotion of the peaceful uses of nuclear energy.

For several years, the United States has had a special support program to provide technical resources, funds and other support to IAEA when the budget channels of IAEA were not able to respond fast enough to meet IAEA-identified urgent safeguards needs. Under this program, the United States has provided, through 1981, $23 million in assistance in the forms of (1) forty experts to complement IAEA's staff for 1 to 2 years, (2) the development of 21 different types of new safeguards equipment, (3) system studies, (4) training for inspectors, and (5) the development of safeguards techniques, procedures and equipment evaluation. A few other countries have also established special support programs to supply cost-free experts and develop new equipment for IAEA.

1/IAEA was created in 1957 to accelerate and enlarge the contribution of nuclear energy to peace, health, and prosperity throughout the world without furthering any military purpose.

The IAEA Statute provides that IAEA's expenses, including the costs of safeguarding nuclear material, are to be apportioned among all member nations. Our review showed, however, that although the cost of safeguards has increased substantially in recent years, the current IAEA financing formula insulates the majority of member nations from such increases. In 1982, 80 of IAEA's 110 members will provide less than 2 percent (about $424,000) of the safeguards budget. The same 80 countries will provide nearly 8 percent (about $4 million) of the non-safeguards budget. For 1982, 31 members are being assessed about $750 for safeguards--the same as the lowest assessment made in 1971. The following chart helps to illustrate the effects of IAEA's complex financing formula.

Examples of assessed shares for IAEA 1982 regular budget

	Safeguards portion	Non-safeguards portion
Argentina	$ 29,519	$ 408,675
Costa Rica	754	10,346
Ecuador	754	10,346
India	42,563	315,559
South Africa	17,849	222,443
United States	7,033,069	12,932,750

Political obstacles include rejection of whole categories of inspectors. Although every nation has the right to accept or reject a proposed inspector, many countries, including the United States, increasingly reject broad ranges of proposed inspectors on political, linguistic, or nationalistic grounds. The State Department contends that, in practice, the designation of inspectors has not been a serious problem and has not prevented inspections in any country or facility. However, according to IAEA officials, the practice is growing and has diminished safeguards credibility. They indicated that it has led to

--retaliatory discrimination by member nations,

--distortions in the recruiting pattern, forcing IAEA to accept a bias toward designating inspectors from within certain groups of countries, and

--ineffective deployment of inspectors in the field, and less-than-full utilization of inspectors specializing in particular types of facilities.

Continued support to improve safeguards seems appropriate. The cost of safeguards is low compared to the costs of world insecurity and increased military weaponry. However, care must be exercised so that IAEA does not become too dependent on the United States and a few other nations for its support. To retain its character as an international organization, IAEA must receive broader technical, political, and financial support from its members.

EXECUTIVE BRANCH RESPONSE TO OUR PREVIOUS REPORTS

U.S. officials generally agree that the effectiveness of international safeguards has been adversely affected by the problems IAEA has been experiencing and that member nations need to provide greater support to improve safeguards. However, some U.S. officials believe that while a few nations provide support to safeguards, many others either may not be able to help or, in fact, may want to diminish the function of international safeguards.

In previous reports 1/ we recommended that the Secretary of State meet with other world leaders and IAEA officials to discuss the problems impeding the effective application of international safeguards and to develop a multinational plan to overcome these problems. We stressed the need for renewed consideration of how international safeguards should be financed, staffed, and otherwise supported.

The State Department commented that U.S. officials' promotion of continuing attention to these matters in IAEA and other appropriate international forums obviates the requirement for any formal multinational plan. The Department added that an effort to develop or promote such a plan could well detract from the effectiveness of IAEA's safeguards activities and its continuing efforts for safeguards improvement. These activities and efforts were, in the State Department's view, already achieving results.

However, U.S. officials generally believe that the IAEA safeguards system needs substantial improvement. Recently, the State Department concedes that actual in-the-field application of safeguards, although improving, is uneven and often falls short of what should, in principle, be done. Nevertheless, in December 1981 the Under Secretary of State for Management advised a congressional committee that the executive branch planned no new initiatives to help upgrade IAEA safeguards, but rather would continue existing programs. Moreover, the executive branch has proposed to defer payment of most of its fiscal year 1983 IAEA assessment to fiscal year 1984.

1/See our report entitled, "The Nuclear Non-Proliferation Act of 1978 Should Be Selectively Modified" (OCG-81-2, May 21, 1981) and our classified report entitled, "International Nuclear Safeguards Need Further Improvement" (C-ID-81-4, Feb. 13, 1981).

No new forum needs to be established to improve IAEA safeguards. We continue to believe, however, that the United States must work more closely with many member nations in order to develop an approach for providing adequate staffing and financial and technical resources to help IAEA fulfill its substantial safeguards responsibilities.

AGENCY COMMENTS AND OUR ANALYSIS

ACDA agreed with our general thrust that IAEA needs increased resources for inspecting HEU and that IAEA is encountering certain difficulties in applying its safeguards to HEU.

The State Department commented that, except for two large critical assemblies, the HEU safeguarding task for IAEA is fairly straightforward and State has no reason to believe that IAEA is not doing an adequate job. DOE, in its comments, emphasized that IAEA inspections and related safeguards measures can provide reasonable assurances that no HEU has been diverted from a research reactor.

DOE also commented that IAEA is acting prudently in giving its priority safeguards attention to bulk handling facilities such as reprocessing plants or HEU fabrication plants, rather than "squandering" its resources on minor research reactors. IAEA's attention obviously has to be devoted to those cases or situations involving the greatest quantities or production of weapons-usable materials, and DOE believes it would be a misallocation of IAEA resources to shift substantial resources to research reactors possessing less than one significant quantity of material. DOE added that IAEA has reported continual progress in upgrading its safeguards procedures at research reactors.

ACDA in commenting to DOE on the need to continue the reduced enrichment program stated, in October 1981, that the conversion of research reactors from HEU to non-weapons usable LEU would:

--reduce safeguards problems and

--diminish the consequences of a nation's abrogating its safeguards obligations as well as essentially eliminate the risks of nuclear terrorism associated with the current widespread use of HEU.

We agree that as long as the shortage of inspectors exists, IAEA will have to concentrate its efforts on certain important facilities and will not be able to inspect all facilities subject to safeguards. However, we believe the quality of assurances that IAEA safeguards can provide has been adversely affected to the extent that IAEA only carried out 50 percent of its estimated routine inspection effort.

CHAPTER 5

U.S. TRACKING SYSTEM IS WEAK IN PROVIDING INFORMATION ON U.S.-SUPPLIED HEU

DOE has a central computerized system to track all nuclear exports, including HEU. However, our review of this system showed a number of weaknesses:

--Information within the system is often incomplete or inaccurate. A 2-year effort to correct the data is nearly completed but readily available information has not been used to verify and reconcile the data in the tracking system.

--Intended users of the system find it inadequate to meet their needs.

--Although this one DOE system is supposed to provide a central repository for storage and retrieval of information needed to track HEU furnished to other countries, DOE and NRC have developed three other information systems on HEU supplied abroad.

The need to have four separate U.S. systems gathering data on HEU supplied abroad appears questionable. 1/ Considering the costs of the systems and the needs of the users, efforts to streamline and consolidate needed information into one system seem to be warranted. We believe that to be responsive to its intended users, an international nuclear tracking system should provide accurate, up-to-date information in a useful format.

TRACKING SYSTEM CONTAINS UNRELIABLE DATA DESPITE UPDATE EFFORT

The DOE computerized tracking system, implemented in 1968, is called the Nuclear Materials Management and Safeguards System (NMMSS) and contains data on 19 different nuclear materials, including HEU, which have been supplied by the United States both domestically and abroad. In 1977, DOE established a subsystem to NMMSS which contains only international nuclear material information--the International Nuclear Materials Tracking System, NMMSS/INMTS. According to DOE, the mission of INMTS is to record and maintain export, import, and retransfer data for U.S.-origin material.

1/Although not evaluated in this report, it should be noted that IAEA maintains a computerized information system on nuclear material, including HEU, under IAEA safeguards.

Our review showed that the NMMSS/INMTS system is not reliable for tracking HEU supplied overseas for the following reasons:

--Information on HEU exports between 1954 and 1968 was manually recorded and is generally considered incomplete.

--The system shows where the material was originally shipped, but may not identify current location of the exported HEU. Moreover, the system does not show the current physical status of the material (e.g., irradiated, fabricated, or reprocessed).

--Information from the tracking system on the amount of spent HEU returned to the United States did not agree with records at the Federal facilities that actually received the material.

--In trying to upgrade the system, DOE may have been overlooking sources of data which would be useful in verifying/reconciling the amounts shown in the system.

Pre-1968 manual system

In establishing the beginning inventory base for the computerized system, exports prior to 1968 were compiled only as a total figure summarized from manual reports rather than being entered as individual transactions. As part of its upgrade effort, DOE has been working to reconstruct these early export transactions for input into the computerized system. This task is difficult because (1) many documents during that time were maintained as loose pieces of paper containing little information about the transaction, and (2) some documents are missing. DOE officials recognize that these problems create some gaps that will continue to exist in the computerized data base despite the upgrade effort.

System may not identify location or current status

The NMMSS/INMTS international tracking system can provide data on the country and facility to which nuclear exports were initially shipped, certain overseas retransfers of U.S.-supplied nuclear material, and material returned to the United States. Agreements for cooperation do not require prior approval of the United States or subsequent notification to the United States of movements of U.S.-supplied nuclear material within a country, or in the case of EURATOM, within the community of EURATOM nations. Thus, the tracking system cannot assure the current facility location or, in the European Community, even the country location of U.S.-supplied material.

Additionally, information in the international tracking system does not show the current state of the nuclear material exported, i.e., whether it is unirradiated, irradiated, fabricated, burned-up, or reprocessed. When DOE's nuclear material leasing program was in effect (from 1955 to 1974), burn-up information was routinely provided to the United States and and was incorporated into the central system. Although burn-up information is available through other Government systems, adjustments are not being made in NMMSS/INMTS to reflect it. According to an Argonne National Laboratory official, the average burn-up could be as high as 50 percent over the useful life of the fuel.

Although the NMMSS/INMTS system shows HEU supplied to specific facilities, DOE said that this system is not designed to track the movement of U.S.-origin materials within a cooperating nation (or within EURATOM) or the status of the material. DOE added that if the United States moved in that direction, the United States would have to impose an entire series of new reporting requirements on cooperating countries which could be resented by most of them. Also, DOE contends such a requirement is not easily justifiable since all U.S. exports are already subject to IAEA or EURATOM accountability and verification. The United States, DOE commented, looks to these bodies to perform the basic safeguards functions to help determine that no diversions occur.

DOE officials argue that agreements for cooperation do not require the collection of data on fuel fabrication, certain material movements, burn-up, reprocessing losses, and inventories. A State Department official told us, however, that nothing in the agreements either authorizes or precludes collecting this information. DOE officials advised us that collecting data on the physical state of HEU is not routinely done for the centralized computer system because the United States requires this data only if the exported material is retransferred to another foreign agreement entity or is returned to the United States. However, we learned that consent of the United States for reprocessing or otherwise altering transferred material (including HEU) is explicitly required by agreements for cooperation, as well as U.S. export licensing criteria. (The only exception involves EURATOM.) Thus, information on some changes in the physical status of U.S.-supplied HEU should be routinely available from DOE records.

Moreover, the United States requires that each foreign facility operator requesting exports of 5 kilograms or more of HEU submit detailed inventory information on the facility's

stocks of U.S.-supplied HEU on hand and data on the current and planned use of the facility which is to receive the material. We believe such information is readily available and could be routinely reconciled with the information in the international tracking system. In addition, DOE pointed out that in newer agreements for cooperation, the cooperating nation authorizes IAEA to provide the United States with inventory data.

Spent fuel return records did not agree

During our review we compared information on the amount of spent HEU fuel returned to the United States as contained in the NMMSS/INMTS system with similar information from U.S. facilities that actually receive spent HEU fuel. The comparison showed a number of discrepancies which, at the time, DOE officials were unable to explain.

While our draft report was with the agencies for review and comment, we asked officials at the Savannah River Plant and those responsible for the NMMSS/INMTS system at Oak Ridge to reexamine their data on spent HEU returns in light of the discrepancies we had noted. On April 23, 1982, the Savannah River Operations Office notified us that its staff had reviewed over 2,000 individual transactions and had identified the following types of differences.

--Inadvertent inclusion of materials other than HEU with the NMMSS/INMTS data on HEU.

--Transaction quantities inadvertently omitted from NMMSS/INMTS or Savannah River records.

--Quantities in the NMMSS system reflected the original shippers' estimated values not the more accurate Savannah River measured values.

--Some spent HEU fuel had been received by other facilities and not included in Savannah River records.

Savannah River officials advised us that they would be making some adjustments to their records and that their findings would be forwarded to Oak Ridge so that appropriate changes to reconcile the information could be made in the NMMSS/INMTS system.

Data verification has not been completed

In February 1980, DOE began a data verification effort to compare the data in the tracking system to other U.S. data sources in order to verify the accuracy of the NMMSS data base. A staff of eight people is in the process of verifying

the computerized data with other records kept since 1954. The project is targeted for completion in September 1982. DOE officials believe that a thorough review of transaction documents, correspondence, licenses, contracts, and other pertinent records will enable them to correlate and refine the data now in the system.

Among the data which DOE has reviewed in this verification effort are

--contractual information on uranium enrichment contracts with foreign entities, and

--financial records on the sales and leases of nuclear materials by the Atomic Energy Commission.

Although much has been done to verify and locate missing NMMSS/INMTS data, DOE officials said they should also look to foreign governments to help reconcile the records of U.S.-supplied nuclear material shipped abroad. To date, DOE has completely reconciled its records with Australia and has initiated contacts with one other country as part of the requirements in the agreements for cooperation. A DOE official said that similar reconciliation efforts with other nations would take place only if adequate funding is provided.

Although DOE has taken a number of steps to improve the data in the NMMSS/INMTS system, it has not used the information obtained by the Argonne National Laboratory for its efforts to develop new LEU fuel for research reactors. DOE officials told us that they were reluctant to use such information to validate HEU data in NMMSS/INMTS because it was obtained from foreign reactor operators and dealt with current inventories and amounts licensed, not total amounts shipped, and/or because it lacked sufficient detail. 1/ There was no evidence of coordination between the Argonne system and the NMMSS/INMTS system. Officials in each program area indicated they had little knowledge about the other program. A DOE official associated with the Argonne system said he would readily coordinate with NMMSS/INMTS, but he had never been asked for any data. We believe that data from such a readily available source could be helpful in reconciling the information in the central tracking system and should be reviewed before any further attempt is made to obtain information from foreign entities.

1/The information in Argonne's system is used to analyze the technical justification for proposed HEU exports and contains information which should be useful in verifying NMMSS/INMTS records. (See pages 13 and 43.)

TRACKING SYSTEM CONSIDERED INADEQUATE TO MEET USER NEEDS

In recent years, DOE and NRC have received a growing number of requests for information relating to nuclear material from the Congress, the White House, the State Department, other U.S. Government entities, foreign governments, and private research organizations. However, many intended users have complained that DOE's centralized international tracking system has been unable to satisfactorily meet their needs. Officials at the Department of State, ACDA, and NRC have criticized the system.

Some officials said it is not being used in their reviews of export license applications because it contains inaccuracies, is not up-to-date and/or is incomplete, and the printouts are improperly designed for their needs. Some said they had come to rely on information from other sources. In addition, the system was criticized for the time lag required to respond to specifically designed reports, thereby reducing the usefulness of the system.

We requested and received from NMMSS/INMTS--after a time lag of 1 month--information on HEU supplied abroad and identified a number of anomalies which DOE officials were unable to explain. Among these were the following:

--The DOE international tracking system shows that the United States had supplied about 13,000 kilograms of contained HEU (element weight of exports less returns) to non-nuclear weapon nations from 1954 thru 1980. However, according to IAEA, it safeguards only about 11,000 kilograms of HEU in non-nuclear weapon nations from all sources. Because all U.S.-supplied material must be safeguarded and because the United States does not supply all of the world's HEU, the amount of IAEA safeguarded HEU should be greater than the amount supplied by the United States. DOE officials, however, were unable to explain the difference.

--The printout showed shipments to 246 accounts in non-nuclear weapon nations. IAEA safeguards 175 research reactors and a few HEU fuel fabricators. Because all facilities in non-nuclear weapon nations receiving U.S.-supplied HEU must be subject to IAEA safeguards, a basic assumption is that the numbers should be comparable. DOE officials said that an IAEA safeguarded facility might

be assigned more than one NMMSS code number, but they could not identify any examples. They were also unable to report how many facilities were included in the 246 accounts.

--The computer printout contained a number of mathematically incorrect enrichment percentages which the officials could not explain.

--The printout contained many negative numbers which DOE officials said must represent some adjustments, yet they did not know why negative entries would be shown for the amount supplied abroad.

In an effort to improve the international tracking system and to determine the needs and perceptions of the users, DOE distributed approximately 150 questionnaires within DOE headquarters, field organizations, facility contractors, NRC, ACDA, and State. A frequently reported criticism was that reports from the system are insufficiently flexible. NRC noted in a separate criticism that, although material accounting data exists in the interational system, the lack of an integrated data base and the lack of direct access to the data limited the analyses that could be performed.

OTHER U.S. SYSTEMS GATHER HEU DATA

Although the NMMSS/INMTS system, located in Oak Ridge, Tennessee, 1/ is the official central repository for storage and retrieval of information needed to track HEU shipped abroad, it is not the only such information system maintained by the U.S. Government. DOE also maintains information on HEU supplied abroad as part of its Reduced Enrichment in Research and Test Reactors (RERTR) program and the Special Nuclear Materials Tracking and Management System (STAMAS) at its Argonne and Lawrence Livermore National Laboratories, respectively. 2/ NRC maintains its own computerized system with information on HEU supplied abroad--the International Programs Export/Import License Tracking System (IPELTS).

Operating costs for the four systems are projected to be nearly $1.4 million in fiscal year 1982. It is important to note that these are total costs for the systems, not only the costs for gathering and maintaining information on HEU.

1/NMMSS/INMTS is operated by the Union Carbide Corporation under contract to DOE.

2/Argonne National Laboratory is located near Chicago and Lawrence Livermore National Laboratory is near San Francisco.

Fiscal Year 1982 Budget Estimates
for Information Systems Dealing With HEU (note a)

	($000 omitted)
NMMSS/INMTS	$ 525
STAMAS	b/905
RERTR	(c)
IPELTS	18
	$1,448

a/Except for RERTR, each system contains information on a number of nuclear materials, including HEU.

b/According to Lawrence Livermore National Laboratory, about $50,000 of the $905,000 is related to the disposition of HEU.

c/RERTR is a noncomputerized system. Its records are manually maintained and no cost breakdown is available for the information gathering segment.

As discussed in chapter 6, the RERTR program was begun in 1978. An integral part of the program is the accumulation and analysis of information on the current status of research reactors, including general operating data; the current inventory of HEU; spent fuel inventory; and HEU reprocessed. This information serves two purposes--it provides data for the economic and technical justification for an export license (see ch. 2), and determines the feasibility of converting research reactors to LEU fuel. (See ch. 6.)

Lawrence Livermore's STAMAS system is a computerized data system which was developed in 1977 to provide more accurate information on the amount, composition, and location of plutonium in the world. In 1981, STAMAS began developing a computer data base to describe the flow and stockpiles of HEU. Despite the fact that STAMAS and NMMSS/INMTS are both called tracking systems and contain information on HEU, a STAMAS official said the two share only the topical concern for fissile material flow but that the goals, operations, and outputs of the systems are different. One major difference is that NMMSS/INMTS does not focus on proliferation while STAMAS is a substantial component of DOE's efforts to technically analyze the nuclear proliferation threat by monitoring

material which is not of U.S. origin or does not cross U.S. boundaries, as well as U.S.-supplied material. Officials from both programs said there has been very limited coordination and/or information exchange between these two DOE systems. Likewise, coordination between STAMAS and the RERTR program has been very limited even though both contain several similar data elements, including reactor name, location, inventory levels, and general operating data.

The IPELTS system was developed by NRC in 1977 as a computerized method of accumulating information on export licenses. The IPELTS system maintains individual license information such as the name of the applicant; material type with element and isotope weights; enrichment percentage; plant, facility and country; intermediate consignee; ultimate end use; and dates the license was issued and will expire. IPELTS does not record the actual supply or receipt of material, nor track nuclear material abroad. License information from IPELTS is provided to NMMSS/INMTS. In this regard, IPELTS supplements the central international tracking system.

Thus, four separate systems are maintaining information on HEU supplied abroad for different but closely related reasons. The NMMSS/INMTS system tracks HEU actually exported; IPELTS provides information on the amount of HEU licensed for export; the RERTR system gathers data on the current inventory of HEU at foreign facilities; and STAMAS is developing data on international flows of HEU. It can be argued that each system complements the others and each concentrates on a different aspect. However, the need to maintain four separate systems to monitor or track certain aspects of HEU supplied abroad appears questionable. None of the systems, by itself, affords U.S. officials the capability to quickly and coherently see the complete picture.

CONCLUSIONS

The central computerized system to track HEU supplied abroad (NMMSS/INMTS) is incomplete and inaccurate. Intended users also consider it inadequate and unreliable. DOE officials have been working to improve the information in the system, but have not used some readily available information within their own Department to help verify the quantities of HEU supplied abroad.

Furthermore, the U.S. Government is currently maintaining four distinct systems to gather information on HEU supplied to foreign countries--DOE has three systems (NMMSS/INMTS, STAMAS, and RERTR), NRC has one (IPELTS). Individually, however, each system provides only a segment of information (e.g., amounts

exported, amounts licensed for export, or amounts currently on hand at the foreign facility). We believe reconciliation and efforts to consolidate the information into a more accurate and comprehensive system are warranted.

RECOMMENDATIONS TO THE SECRETARY OF ENERGY

We recommend that the Secretary of Energy, in conjunction with the Chairman of the Nuclear Regulatory Commission, streamline and consolidate the information maintained on HEU supplied abroad into a more accurate, comprehensive, and flexible system, which meets the needs of the intended users, in the most economical and efficient manner.

To increase the accuracy and utility of such a system, the Secretary of Energy should direct that information from other readily available sources be used to verify and reconcile the data on HEU exports within the system.

AGENCY COMMENTS

DOE commented that, in accordance with our recommendation, it is initiating a review to see whether a better integration of the different systems can be achieved even though they are designed to serve different purposes. NRC said that it agreed with the recommendation that information on U.S.-supplied nuclear material should be streamlined and consolidated, but it was not clear to NRC that this could be best accomplished through the development of a single information system.

NRC emphasized that no U.S. Government agency currently has been assigned responsibility to track U.S.-origin nuclear material within foreign entities and negotiation of international agreements with export recipients would be required to accomplish this. NRC added that sources have not been developed for collecting transaction data for individual foreign facilities or for transfers between countries in EURATOM. However, DOE pointed out that in newer agreements for cooperation, the cooperating nation authorizes IAEA to provide the United States with inventory data.

Concerning the individual information systems, we received the following comments.

--DOE commented that INMTS was conceived in 1977 to automate a manual system of records dating from 1954 pertaining to the international transfer of U.S.-origin nuclear materials. The automation was completed in 1978, and a subsequent audit was performed to determine the accuracy and completeness of the data base. The data base was found to have serious problems

and a "verification" project was planned to compare the data base with all pertinent available sources of data in the United States and correct the deficiencies to the extent possible. This project will be completed in 1982, and DOE believes the INMTS will then be able to perform, with an acceptable degree of accuracy, those functions it has been delegated.

--The Lawrence Livermore National Laboratory advised us that the STAMAS system does not yet monitor the flow and stockpiles of HEU abroad. The Laboratory described its efforts regarding HEU as being in an embryonic stage with the present focus on obtaining and understanding the data that might be obtained on the operating histories of the most interesting (from a proliferation viewpoint) research reactors. The Laboratory added that about $50,000 of its fiscal year 1982 budget has gone into this evaluation of operating histories and the associated questions of HEU disposition.

DOE commented that discussions have been initiated with the Lawrence Livermore National Laboratory on the desirability and feasibility of addressing research facilities and materials such as HEU under the STAMAS effort. DOE indicated that should HEU data be monitored by STAMAS, this system would use NMMSS/INMTS data as a portion of its input. Nevertheless, DOE emphasized that although STAMAS does address "tracking," it is not an accountability system and cannot provide accountability data.

CHAPTER 6

U.S. EFFORTS TO REDUCE LEVELS OF WEAPONS-GRADE URANIUM ABROAD

Much of the U.S. non-proliferation policy is centered around minimizing the use of HEU. The reduced enrichment program is one of the few concrete U.S. non-proliferation initiatives to gain widespread international support.

Our review showed that progress has been made in developing new LEU fuels and in obtaining foreign support for the program. However, the reduced enrichment program has experienced several limitations which have been hampering completion of the conversion effort. These include financial constraints on the U.S. Government program; the limited market potential to interest U.S. private sector involvement without continued Government support; and various foreign concerns about such issues as the lack of participation by U.S. reactor operators, potential difficulties in getting converted reactors (e.g., using new fuel) relicensed, technical problems associated with reprocessing and waste disposal, and uncertainty of U.S. willingness to continue accepting spent U.S.-origin fuel from foreign research reactors if they convert to the new fuel.

In addition, two U.S. initiatives announced at the 1978 United Nations Special Session on Disarmament were aimed at limiting the spread of HEU exported around the world. We learned during our review, however, that the United States has done little, to date, to carry out these proposals.

We believe that reducing the use of HEU is a sound non-proliferation objective, but further efforts are needed if the conversion to LEU fuels is to become a reality in the next few years.

THE REDUCED ENRICHMENT PROGRAM

In April 1977, the Carter administration adopted a new policy aimed at minimizing the use and distribution of HEU. As a result, in 1978 DOE launched the RERTR program as a multi-year program to provide the technical means to convert research reactors now using uranium enriched to 90-percent or more U-235, to 20-percent U-235 fuel or, where necessary, 45-percent U-235 fuel. The program structure was developed to accommodate the large number of reactors involved (approximately 156 worldwide which use U.S.-origin uranium enriched

to more than 70-percent U-235), their design diversity, their different fuel types, and the various requirements of the more than 35 countries in which they are located.

The RERTR program has both short-term and long-term goals. The short-term goals are to develop and demonstrate the technology for medium enriched uranium (45 percent) and LEU (less than 20 percent) fuels, using current fuel fabrication techniques, which can then be used by most research reactors. The long-term goals are the development, testing, and commercialization of the new fuels, one of which the executive branch believes could be used in all but 3 or 4 research reactors. The State Department commented that full-scale testing of LEU fuels has not yet advanced to a stage where conversion of either foreign or domestic reactors to such fuel is presently feasible--several years of further DOE test work on fuels are needed. According to U.S. officials, the best estimates for converting all of these reactors are as early as 1986 and as late as 1988.

U.S. officials told us that progress is continually being made, primarily through DOE's research and development activities. They cite the following examples:

--Major emphasis has been placed on encouraging and assisting all research reactor fuel manufacturers, both in the United States and abroad, to develop and apply the technology necessary to be able to manufacture reduced enriched uranium. As a result, fuel manufacturers have made substantial efforts in the development and application of that technology.

--To expedite testing of proposed reduced-enriched uranium fuels as they become available from manufacturers, the U.S. Government is providing accelerated irradiation services in the Oak Ridge Research Reactor.

--Joint studies by Argonne National Laboratory and foreign reactor operators are designed to (1) define acceptable fuel element designs using appropriate LEU material, (2) convince the operators of the potential performance and safety of the relevant fuel in their respective reactors, and (3) provide the bases for establishing conversion schedules. Joint reactor-specific studies are in progress for 23 reactors from 14 countries.

--Tacit understanding has been obtained from foreign reactor operators that conversion from HEU to LEU would take place when the appropriate fuels, currently under demonstration, are adequately tested to satisfy licensing requirements within their country.

Apart from, but in consort with, the RERTR program, one U.S. company developed an LEU fuel (referred to as Triga fuel) for its own type of research reactor. However, this particular fuel is not readily usable in research reactors built by other companies which comprise the majority of research reactors worldwide.

LIMITATIONS AFFECT IMPLEMENTATION OF THE REDUCED ENRICHMENT EFFORT

Notwithstanding the progress the RERTR program has made, several factors are hindering the implementation of the reduced enrichment effort. Consequently, many countries have taken a wait-and-see attitude about actual conversion to the new fuels. To date, only one research reactor has been converted through the RERTR program. The Ford Nuclear Reactor in Michigan has been converted and licensed by NRC to use one of the new LEU fuels for "full-core demonstration" purposes.

U.S. funding constraints

According to DOE officials, the most significant problem hindering the RERTR program has been lack of adequate funding. One program official indicated that the program's funding under DOE's authority has fluctuated.

Fiscal year	Funding level (million)
1978	$ .64
1979	3.85
1980	4.95
1981 (note a)	2.56
1982 (estimated)	4.14
1983 (requested by ACDA) (note b)	4.80

a/In fiscal year 1981, only $1 million was specifically authorized for RERTR. Additional funding of approximately $1.6 million was provided from other programs by the Department of State, DOE, and ACDA.

b/In fiscal year 1983, DOE requested no funds for RERTR.

According to the fiscal year 1983 ACDA budget submission, ACDA would assume financial responsibility for the program. RERTR program officials had anticipated that RERTR would be funded outside DOE. These program officials had hoped the funding would come from the State Department or ACDA, either of which, one official felt, would give the program a higher priority than DOE had given it. DOE has taken the position that by the end of fiscal year 1982, 90 percent of the RERTR research and development effort will have been completed. DOE officials said that the next steps--commercialization and deployment of the fuel--are not DOE projects. ACDA commented that, in its opinion, the RERTR research and development will not be 90-percent completed by the end of fiscal year 1982. ACDA added that considerably more research and development efforts are needed.

Several U.S. officials said they believed that if a lack of adequate funding for the U.S. RERTR program occurred, it would, in turn, adversely affect foreign participation in the overall effort to reduce HEU use. This belief was substantiated by one Japanese official who said that without the United States, it was uncertain whether Japan would continue its LEU effort. On the other hand, West German and French officials told us that their conversion programs were independent of the U.S. program and that their countries would probably continue regardless of the future status of the U.S. program. A program official commented that West German and French commercial fuel fabricators of research reactor fuel have made similar statements.

Market limitations

Officials at U.S. companies indicated that, although their companies have the technical capabilities to produce LEU fuels, it is questionable whether they would get into the market without U.S. Government support. They indicated the limited market potential for these fuels poses a significant risk. Furthermore, because of a lack of interest by U.S. vendors in providing fabrication services for the fuel to be used in the RERTR tests, the United States has relied on France and West Germany for such services. According to DOE, there is only one U.S. firm interested in commercially fabricating the new fuels developed under the RERTR program. Officials at that company said they probably would not do the conversion work without Government support because the cost would be too high.

Foreign perceptions and concerns

A number of issues complicate the acceptance of the new LEU fuel by foreign reactor operators. Frequently foreign operators perceive that a double standard may be applied

in deciding the acceptability of using HEU in foreign and U.S. research reactors. For example, the U.S. Government has not indicated whether it will restrict or inhibit the continued use of HEU in U.S. reactors. According to an Argonne National Laboratory official, there have been only limited discussions between U.S. operators and DOE about switching to LEU. The lack of participation by U.S. facilities in converting to the new LEU fuel could undermine foreign acceptance of the new fuel and, thus, negate an important part of the U.S. non-proliferation objective. Of the 156 research reactors worldwide which use U.S.-supplied HEU enriched to between 70 and 94 percent in U-235, 54 (about one-third) are located in the United States.

The State Department commented that, although the use of LEU by U.S. research reactor operators is primarily a domestic policy issue, (1) a consistent approach between domestic and foreign policies would benefit overall non-proliferation goals and (2) recent proposed changes in NRC safeguards requirements would provide an incentive to NRC licensed U.S. research reactor operators to convert to LEU, when it becomes available.

U.S. officials told us that the need to license the new fuels could slow HEU conversion abroad. According to the State Department, each country may have to relicense its facilities, some of which are 20 to 30 years old. Foreign research reactor operators believe that, in addition to limited modifications of their facilities to use the new LEU fuel, they would also have to significantly upgrade their facilities to meet new safety standards and current licensing criteria of their countries.

At the September 1981 IAEA Seminar for Research Reactor Operators, foreign operators voiced concern about the reprocessing of the new LEU fuel. In most countries, the license authority will not allow a reactor to operate unless it can prove that the fuel can be reprocessed or that a safe waste disposal can be ensured.

Because there is no U.S. policy on receiving spent LEU fuel from abroad, countries are concerned as to whether or not the United States, when this fuel is available, will accept it back when it is spent. According to French operators, once the United States guarantees that it will accept this spent LEU fuel, it is conceivable that HEU conversion would become more attractive to research reactor operators. The United States currently does accept spent U.S.-origin HEU fuel from foreign research and test reactors, but generally, not spent slightly enriched fuel from power reactors. (This issue is discussed in ch. 2 under "subsequent arrangements.")

Also, reprocessing plants throughout the world may not be willing to accept the new fuel because significant modifications to the facilities may be required. The relatively small amounts of such fuel, as compared to the larger amounts of other spent fuel normally reprocessed, could make such modifications economically impractical.

IMPLEMENTATION OF INITIATIVES ANNOUNCED AT U.N. HAS BEEN LIMITED

At the 1978 United Nations Special Session on Disarmament (UNSSOD), the U.S. Ambassador announced two initiatives designed to minimize the use of HEU. They were:

--Authorizing $5 million over 5 years to provide 20 percent enriched uranium fuel for research reactors through IAEA, with preference to developing countries party to the NPT.

--Providing up to $1 million annually in fuel cycle services to assist countries in the use of LEU fuel in research reactors. (This program was not linked to NPT adherence.)

The United States, however, has done little, as yet, to carry out these proposals. According to a State Department official, the initiatives are being implemented, at least to some extent. U.S. financial support for the two initiatives has been as follows:

1979 --$75,000 to IAEA to study the feasibility of using 20 percent enriched uranium fuel in research reactors.

1980 --$435,000 to Argonne National Laboratory's RERTR program for training reactor operators and for defraying costs of assistance for reactor conversions in IAEA selected developing countries.

--$75,000 to IAEA for the 20 percent enriched fuel program.

--$50,000 to Malaysia for fuel fabrication costs associated with the purchase of LEU (Triga) fuel for one of its research reactors.

Money to address these initiatives has come from the Foreign Assistance Act--U.S. voluntary contributions. A State Department official informed us that he has requested funding over and above the normal U.S. voluntary contribution each year; but, to date, has not received any additional funding for the UNSSOD initiatives. For example, for fiscal year 1982, State requested $18.5 million for voluntary contributions, of which $4 million was designated for the UNSSOD initiatives. However, the Office of Management and Budget cut the request to $14.1 million by eliminating funding for those initiatives.

It can be argued that the RERTR program addresses the same overall objective of the U.S. initiatives announced at UNSSOD, i.e., minimizing the use of HEU abroad. However, according to U.S. Government officials, the RERTR program was never intended to meet the UNSSOD initiatives.

Nevertheless, the 20 percent enriched fuel is not yet available for routine use and the United States has not yet fulfilled the initiatives announced at the UNSSOD.

CONVERSION PROGRAMS IN OTHER COUNTRIES

Several other countries have also initiated programs in the areas of reduced enrichment fuels for research and test reactors.

In 1975, France started a general program of fuel development and reactor study. The development of the so-called "Caramel" fuel is a result of the program. Caramel fuel is a low enriched fuel containing 7 percent U-235 and, according to the French, is able to fulfill principal reactor requirements of fuel cycle length and performance. To date, only one French research reactor has been converted to Caramel fuel.

According to DOE, West Germany is implementing a 5-year, $30 million Deutschmarks (about $12 million) program on enrichment reduction in research reactors. The main objective is to develop and test fuel and fuel elements essential for converting reactors to LEU fuels. West Germany also offers consulting services to organizations considering enrichment reduction of their research reactors.

Japan has a 5-year program for the conversion to reduced enrichment uranium fuel. The Japan Atomic Energy Research Institute and the Kyoto University Research Reactor Institute research reactors are being used in this program. Japan is using a step-by-step approach to demonstrate the engineering feasibility of medium enriched uranium fuels to satisfy requirements made by its government for changing fuel designs. Full core demonstrations of alternative fuels in both institutes' reactors are expected by mid-1983.

Canada, Argentina, Denmark, the United Kingdom, Spain, and the Soviet Union also have programs dealing with LEU fuels.

A paper delivered by an Argonne Laboratory official at an international meeting in early 1981 described the international scene as one of "excellent agreement and cooperation" between the RERTR program and various foreign national and international organizations. Furthermore, he said that these organizations are conducting "ambitious programs" with the same general goals as the RERTR program.

CONCLUSIONS

Although the executive branch has taken steps to develop new LEU fuels for research reactors, it is difficult at this time to measure the effectiveness that this effort will have in converting research reactors to LEU fuels and in significantly reducing worldwide inventories of HEU. Most countries recognize the need to reduce the use of HEU worldwide, but have taken a wait-and-see attitude in the actual conversion of the research reactors because of a variety of concerns and uncertainties. According to DOE, many countries have deferred their conversion decisions pending demonstrations of the new fuels.

We believe that reducing the use of HEU abroad is a sound non-proliferation objective. However, a number of issues need to be resolved if the conversion to LEU fuels is to become a reality in the next few years.

AGENCY COMMENTS

The Department of State and ACDA agreed that reducing the use of HEU is a sound non-proliferation objective.

DOE commented that it believes that substantially more work is needed to encourage nations to actually shift to lower enrichment. However, DOE stressed that the RERTR program is designed to develop the technology of LEU fuels to the point where they can be put to practical application with the assent of foreign and domestic reactor operators--including foreign licensing and regulatory authorities. DOE added that actual deployment of such fuels to foreign reactor operators is not within its control.

According to ACDA, the issues identified in this report which require resolution before foreign reactors actually convert to LEU are precisely those which the executive branch is giving high priority to resolving. ACDA cited the following examples.

--ACDA, along with some other executive branch agencies, has diligently supported funding the RERTR program in the fiscal year 1983 budget at the level necessary to complete the program as expeditiously as possible.

--The technical and political problems associated with accepting and reprocessing spent LEU research reactor fuel are being addressed, and resolution of these problems is expected within the next year or so.

--Personnel in the RERTR program and executive branch are working with foreign governments and reactor operators to address the technical and licensing problems which must be solved before reactors are actually converted; and a spirit of international cooperation and optimism toward accomplishing the program's objectives continues to be demonstrated at international meetings of program participants.

--RERTR program personnel are working closely with a U.S. fuel vendor to transfer advanced fuel fabricating technology, which could make a U.S. vendor a competitor for research reactor fuel orders.

APPENDIX I

GARY HART
COLORADO

COMMITTEES:
ARMED SERVICES
ENVIRONMENT AND PUBLIC WORKS
BUDGET

United States Senate
WASHINGTON, D.C. 20510

July 14, 1981

Mr. Milton J. Socolar
Acting Comptroller General
United States General Accounting Office
441 G Street, N.W.
Room 7000 A
Washington, D.C. 20548

Dear Mr. Socolar:

Increasing concern over the proliferation of nuclear weapons has raised questions about the United States' ability to account for, and monitor the use of the highly-enriched uranium fuel it exports to foreign countries. For example, Victor Gilinksy, Commissioner of the Nuclear Regulatory Commission, has been quoted as saying, "To my knowledge, nobody keeps track of this material in a serious way."

In light of these questions, I request the General Accounting Office to undertake an investigation that will:

(1) Evaluate the mechanisms established in international agreements of cooperation for controlling the use of U.S.-supplied highly-enriched uranium (HEU) fuel and assuring adequate protection of HEU fuel shipments from terrorists.

(2) Assess the ability of the International Atomic Energy Agency (IAEA) to detect diversions of HEU and fissionable materials produced from this fuel, through use of material accounting techniques and of containment and surveillance devices.

(3) Ascertain the rationale for supplying HEU fuel to foreign countries and the possible nuclear proliferation consequences.

(4) Review the implementation and effects of the United States' programs announced at the United Nations Special Session on Disarmament in 1978 aimed at limiting the use of HEU fuel in research reactors, as well as any United States foreign policy initiatives in this area.

(5) Assess the system used by the United States for keeping track of its exports of HEU fuel and any fissionable materials produced from this fuel.

APPENDIX I

Letter to Milton Socolar
Page Two

(6) Determine what controls, if any, the United States has over the use of fissionable materials produced from U.S.-supplied HEU fuel or in U.S.-supplied nuclear facilities.

My staff has discussed the issues presented in this request with Joseph F. Murray, group director for arms control and nonproliferation, International Division. If you have any questions about the scope or nature of this request, please contact me or my staff.

Thank you for your prompt attention to this matter.

Sincerely,

Gary Hart

Gary Hart

APPENDIX II

U.S. SHIPMENTS OF HEU SINCE 1954

Country	Quantity shipped (kilograms of isotope U-235)
Argentina	59.2
Australia	9.1
Austria	7.5
Bangladesh	(a)
Belgium	148.8
Bolivia	(a)
Brazil	7.1
Canada	1,392.6
Colombia	2.8
Czechoslovakia	(a)
Denmark	23.5
Finland	.8
France	4,550.1
Germany, West	6,206.6
Greece	6.1
India	(a)
Indonesia	2.4
Iran	5.2
Ireland	(a)
Israel	17.0
Italy	344.4
Japan	1,021.9
Korea	18.3
Mexico	5.7
The Netherlands	73.0
Norway	(a)
Pakistan	5.2
Philippines	3.0
Portugal	7.1
Romania	36.6
South Africa	30.2
Spain	12.3
Sweden	133.3
Switzerland	7.9
Taiwan	9.2
Thailand	4.8
Turkey	4.8
United Kingdom	2,140.7
Uruguay	(a)
Venezuela	(a)
Vietnam, South	(a)
Yugoslavia	5.2
Zaire	.3
Total	16,302.7

a/The cumulative quantity shipped is less than .05 kilograms

Source: Department of Energy reports from Nuclear Materials Management and Safeguards System, June and October 1981.

APPENDIX III

LIST OF PREVIOUS GAO REPORTS ON HIGHLY ENRICHED URANIUM AND RELATED ISSUES

Title	Date issued
The Nuclear Non-Proliferation Act of 1978 Should Be Selectively Modified (OCG-81-2)	May 21, 1981
International Nuclear Safeguards Need Further Improvement (C-ID-81-4) (Confidential)	February 13, 1981
Evaluation of Selected Features of U.S. Nuclear Non-Proliferation Law and Policy (EMD-81-9)	November 18, 1980
Evaluation of U.S. Efforts to Promote the Nuclear Non-Proliferation Treaty (ID-80-41)	July 31, 1980
Nuclear Fuel Reprocessing and the Problems of Safeguarding Against the Spread of Nuclear Weapons (EMD-80-38)	March 18, 1980
United Nations Special Session On Disarmament: A Forum For International Participation (ID-79-27)	July 3, 1979
Federal Facilities For Storing Spent Nuclear Fuel--Are They Needed? (EMD-79-82)	June 27, 1979

APPENDIX IV

SUMMARY OF CRITERIA FOR AGREEMENTS FOR COOPERATION

(1) The cooperating party guarantees that safeguards specified in the agreement must be maintained on (1) transferred nuclear materials and equipment, and (2) special nuclear material used in or produced through the use of transferred materials and equipment, so long as the material or equipment remains under its control. The obligation continues whether the agreement itself terminates or is suspended.

(2) As a condition of continued U.S. supply, in the case of non-nuclear weapon nations, the cooperating party must maintain IAEA safeguards on all nuclear materials in all of its peaceful nuclear activities.

(3) The cooperating party must guarantee that no transferred nuclear materials, equipment, or sensitive technology, and no special nuclear material produced through the use of such transfers, will be used for any nuclear explosive device, research and development on such devices, or any military use.

(4) The United States must have the right to require return of transferred material and equipment from a non-nuclear weapon nation that detonates a nuclear explosive device or abrogates an IAEA safeguards agreement.

(5) Transferred material, restricted data,1/ production or utilization facilities, or any special nuclear material produced through the use of such material or facilities must not be transferred from the control of the cooperating party without U.S. consent.

(6) The cooperating party must guarantee the maintenance of adequate physical security on transferred materials and special nuclear material used in or produced through the use of any transferred materials or production or utilization facilities.

(7) No transferred material, or material used in or produced through the use of transferred material or transferred production or utilization facilities, may be reprocessed, enriched, or otherwise altered without prior U.S. approval.

(8) The United States must approve in advance storage facilities for weapons-usable material that is transferred, recovered from transferred source or special nuclear material, or recovered from source or special nuclear material used in a transferred production or utilization facility.

(9) All of the above criteria must apply to any special nuclear material, production facility, or utilization facility produced or built by the cooperating party with transferred sensitive nuclear technology.2/

1/"Restricted data" is any data concerning (1) the design, manufacture, or utilization of atomic weapons, (2) special nuclear material production, or (3) the use of special nuclear material in energy production. Not included is data declassified or otherwise removed from this category. (See 42 U.S.C. 2014 (y).)

2/"Sensitive nuclear technology" is defined in section 4(a) (6) of the NNPA.

Source: "The Nuclear Non-Proliferation Act of 1978 Should Be Selectively Modified" (OCG-81-2, May 21, 1981).

APPENDIX V

STATUS OF U.S. AGREEMENTS FOR COOPERATION

Cooperating partner	Status of U.S. effort
Argentina	Discussions begun October 1978. Limited informal discussions since then. (note a)
Australia	Agreement renegotiated, in force January 1981.
Austria	Discussions held June 1978. Suspended. Referendum voted against nuclear power.
Bangladesh	Agreement completed; signed in Dacca, Congressional review needed.
Brazil	Discussions begun June 1978. Informal discussions since then. (note a)
Canada	Agreement amended, in force July 1980.
Colombia	Agreement completed. Congressional review completed. Colombian Parliamentary ratification needed.
Egypt	Agreement completed, in force December 1981.
EURATOM	Limited discussions begun November 1978.
Finland	Negotiations last held June 1980.
Greece	EURATOM member as of January 1981.
IAEA	Agreement amended, in force May 1980.

a/Discussions are limited to assurances needed to permit continued cooperation under the existing agreement in conformity with Title III's export licensing criteria.

Source: Department of State as of December 1981.

APPENDIX V

India	"Special problems" involved. Nuclear cooperation addressed "in the context of broader discussions."
Indonesia	Agreement renegotiated, in force December 1981.
Japan	Negotiations in progress.
Korea, South	Discussions begun September 1978 and are ongoing.
Morocco	Agreement completed and entered in force May 1981.
Norway	Negotiations completed. Draft initiated May 1979. Under Presidential review.
Peru	Agreement completed. Congressional review completed, Peruvian parliamentary ratification needed.
Philippines	Discussions held May 1978 and May 1979. Further discussions were deferred due to pending litigation on reactor exports.
Portugal	Discussions held September and October 1978; and late 1979-80; not currently active.
South Africa	"Special problems" involved. Nuclear cooperation addressed "in the context of broader discussions."
Spain	Discussions begun March 1978. Limited discussions have been held.
Sweden	Negotiations in progress.
Switzerland	Discussions held May 1979. Limited discussions held subsequently.
Taiwan	Discussions held during 1979 and 1980 (non-governmental).
Thailand	Discussions held October 1978 but no current plans for a Thai nuclear program.

APPENDIX V

Turkey	Discussions held and then deferred. Draft provided by the U.S. in October 1980. Current agreement expired.
Venezuela	Current agreement expired. State Department expects discussions to commence soon on renegotiation.

APPENDIX VI

ATTACKS AND/OR PHYSICAL SECURITY BREACHES AT NUCLEAR FACILITIES FROM 1966-1979

Date	Installation	Incident or result
November 18, 1966	U.K.: Bradwell reactor in Essex	Theft of 20 uranium rods; reasons obscure.
May 4, 1969	USA: Illinois Institute of Technology Reactor	A pipe bomb found.
September 1970	USA: Point Beach Reactor Two Creeks, Wisconsin	Dynamite discovered.
March 1971	U.K.: Springfield fuel fabrication plant	5 uranium rods disappeared; stolen perhaps in transit or at the Wylfa reactor in Anglesey.
August 1971	USA: Vermont Yankee reactor	Intruder wounded a night watchman before escaping.
December 7, 1971	USA: Stanford University Linear Accelerator in Calif.	2 bombs caused heavy damage to electronic control equipment.
June 25, 1972	USA: New York University reactor	Building broken into; no damage except door panel broken for access.
March 15, 1973	USA: Oconee, South Carolina	Break-in at fuel storage building; no material taken.
March 25, 1973	Argentina: Atucha I Reactor	Overrun by 15 men who caused light damage with the possible motive of gaining publicity for their group.
February 22, 1974	USA: Nuclear survey tower in Montague, Massachusetts	Tower destroyed by unbolting stays. Perpetrator is known.
August 27, 1974	USA: Plymouth I Reactor in Massachusetts	Fire caused minor damage to reactor. Neither perpetrators nor their motives known.
September 4, 1974	USA: U.S. Nuclear Corp., Oak Ridge, Tenn.	Attempted fence breach.
February 23, 1975	USA: Nuclear Fuel Services Erwin, Tenn.	Fence breach; no theft.
May 3, 1975	France: Fessenheim Reactor near Strasbourg	Casing of reactor extensively damaged by two explosions. Responsibility claimed.

APPENDIX VI

Date	Installation	Incident or result
May 27, 1975	USA: Zion Reactor in Illinois	Unknown assailants apparently fired two shots at security guards. No damage reported.
June 6, 1975	France: Framatone's main computer at Courbevoie	Explosion caused extensive damage to the input terminals at main computer at Courbevoie. Responsibility claimed.
June 1975	West Germany: Biblis reactor	An individual carried a Panzer-faust bazooka into the plant to present it to the Director as part of a security demonstration.
July 1975	USA: Brunswick reactor in North Carolina	Guards failed to check identification badges of personnel entering the plant.
July 1975	USA: Quad Cities reactor in Illinois	NRC inspector entered plant through an open uncontrolled gate.
July 2, 1975	USA: Kerr McGee Nuclear Corp., Oklahoma City	Attempted forced entry.
August 1, 1975	Canada: Pickering reactor in Ontario	A visitor entered the plant carrying a satchel; he was not checked at the gate or during his brief visit.
August 15, 1975	France: Monts d' Aree reactor at Brennelis	Two bombs damaged watercooling tank and radiotelephone room causing reactor to be closed. An anonymous call claimed act was a protest against construction of nuclear facilities in Brittany.
September 25, 1975	USA: Mass. Inst. of Tech.	Attempted forced entry.
January 27, 1976	USA: Three Mile Island Reactor in Pennsylvania	Intruder scaled security fence and entered protected area; he later drove off without being apprehended.
Nov.14-15, 1976	France: Margnac Uranium Mines	Bombs caused damage to the extraction plant and other facilities. Responsible group believed known.

APPENDIX VI

Date	Installation	Incident or result
July 1977	France: French Electric was object of terrorist acts.	On July 8, Paris residence of its Director General was attacked. Responsibility claimed. Days later, explosions occurred at two local offices, apparently the protest of a local group against area construction.
October 10, 1977	USA: Trojan Nuclear Power Plant in Rainier, Oregon	Explosive device detonated outside gates causing minor damage to a visitors center. Responsible group known.
Nov. 19-20, 1977	France: A series of ostensibly nuclear objectives	Group armed with machine guns and explosives struck objectives. On November 21, a group claimed responsibility. Declared objective--terminating nuclear energy development in France.
December 1977	Spain: Lemoniz Nuclear Power Plant	Four persons assaulted the facility. The guards repulsed them, killing one.
March 1, 1978	Spain: Iberduero utility properties	Incendiary bombs used by known group to destroy properties.
March 17, 1978	Spain: Lemoniz	Explosion caused deaths of 2 workmen and injuries to 14. Extensive facility damage.
April 1978	Spain: Lemoniz	Explosions destroyed four electricity pylons of constructor and damaged nearby electrical equipment.
May 31, 1978	Sweden: Goteborg	Municipal building and German church damaged by a bomb apparently placed by an antinuclear group.
February 19, 1979	Switzerland: Kaiseraugst Nuclear Power Plant in Basel; Liebstadt Nuclear Power Plant	Explosion severely damaged information center. Another caused minor damage to Liebstadt storage facility.
April 6, 1979	France: La Seyne-sur-Mer nuclear manufacturing plant	Explosions caused millions of dollars worth of damage, most significantly, to certain Iraqi reactor components. Responsible group anonymously identified.

APPENDIX VI

Date	Installation	Incident or result
April 8, 1979	West Germany: Esensham Nuclear Power Plant at Bremenshaven	Two primitive explosive devices damaged a pylon supporting high tension power lines. Damage was not extensive and the line was not severed.
June 1979	Spain: Lemoniz	Three armed persons breached plant security, subdued three workmen, and placed an explosive device near a turbine. One workman died. A group claimed responsibility.
November 1979	Switzerland: Goesgen Nuclear Plant	Explosion did not damage reactor although it nearly ceased functioning. Blackouts resulted and transformer on the periphery of the plant was damaged.
November 1979	Spain: Maliano	Two explosions during the night severely damaged the nuclear equipment factory. Responsiblity claimed.

Source: Flood, M., "Nuclear Sabotage." Studies in Nuclear Terrorism, Norton and Greenberg (eds.). G. K. Hall and Co., Boston, Mass. 1979.

Pilat, J. F., "Ecological Politics: The Rise of the Green Movement." The Washington Papers, Vol. VIII. The Center for Strategic and International Studies; Georgetown University, Washington, D.C. 1980.

APPENDIX VII

COUNTRIES WHICH HAVE SIGNED AND/OR RATIFIED THE CONVENTION ON THE PHYSICAL PROTECTION OF NUCLEAR MATERIALS AS OF FEBRUARY 1, 1982

State	Date of signing	Date of ratification
Austria	March 3, 1980	
Belgium	June 13, 1980 a/	
Brazil	May 15, 1981	
Bulgaria	June 23, 1981	
Canada	September 23, 1980	
Czechoslovakia	September 14, 1981	
Denmark	June 13, 1980 a/	
Dominican Republic	March 3, 1980	
East Germany	May 21, 1980	February 5, 1981
Finland	June 25, 1981	
France	June 13, 1980 a/	
Greece	March 3, 1980	
Guatemala	March 12, 1980	
Haiti	April 9, 1980	
Hungary	June 17, 1980	
Ireland	June 13, 1980 a/	
Italy	June 13, 1980 a/	
Luxembourg	June 13, 1980 a/	
Morocco	July 25, 1980	
Netherlands	June 13, 1980 a/	
Panama	March 18, 1980	
Paraguay	May 21, 1980	
Philippines	May 19, 1980	September 21, 1981
Poland	August 6, 1980	
Romania	January 15, 1981	
South Africa	May 18, 1981	
Soviet Union	May 22, 1980	
Sweden	July 2, 1980	August 1, 1980
United Kingdom	June 13, 1980 a/	
United States	March 3, 1980	July 30, 1981
West Germany	June 13, 1980 a/	
Yugoslavia	July 15, 1980	

a/Signed as member of EURATOM.

Source: International Atomic Energy Agency Bulletin, June 1981.
Department of State.

APPENDIX VIII

DEPARTMENT OF STATE
Comptroller
Washington, D.C. 20520

1• APR 1982

Mr. Frank C. Conahan
Director
International Division
U.S. General Accounting Office
Washington, D.C.

Dear Frank:

I am replying to your letter of March 10, 1982, which forwarded copies of the draft report: "U.S. Ability to Control and Monitor Weapons-Grade Uranium Supplied Abroad is Limited".

The enclosed comments on this report reflect the views of the Acting Assistant Secretary in the Bureau of Oceans and International Environmental and Scientific Affairs.

We appreciate having had the opportunity to review and comment on the draft report. If I may be of further assistance, I trust you will let me know.

Sincerely,

Roger B. Feldman

Enclosure:

As Stated.

GAO note: We have modified the report to reflect information provided by those commenting on the report.

GAO DRAFT REPORT: "U.S. ABILITY TO CONTROL AND MONITOR WEAPONS-GRADE URANIUM SUPPLIED ABROAD IS LIMITED"

The Department of State has reviewed the above-mentioned draft report, and has the following comments. Additional comments of a technical and factual nature were supplied independently to members of your staff on March 18, 1982. [See GAO note.]

We agree with the report's conclusion on p. 70 that "reducing the use of highly enriched uranium is a sound nonproliferation objective." National Security Decision, Directive Number 6, July 16, 1981 signed by President Reagan, mandates action by the Secretary of State and other agencies "to substitute lower enriched fuels for research reactors at the earliest possible time." With respect to such action, procedures established pursuant to the Nuclear Non-Proliferation Act of 1978 (NNPA), 43 FR 2536 (1978), assign responsibility to the Department of State for coordinating Executive Branch judgment and its submission to the Nuclear Regulatory Commission (NRC), for highly enriched uranium (HEU) license applications. In conjunction with the Reduced Enrichment for Research and Test Reactor (RERTR) program managed by the Department of Energy (DOE), the Department of State is taking steps to limit the export of HEU as soon as it is technically and economically feasible. Attached is a copy of the section of the Report to the Congress, (issued December 31, 1981), as required by section 602 of the NNPA, on this topic, which outlines the steps we are taking and the schedule we hope to meet. With a sustained RERTR program, most foreign research reactors should be convertible to use of low enrichment fuel by 1987/88.

We agree with the recommendation to the Secretary of Energy on p. 17 of the report that "the regulatory authority to accept spent U.S. highly enriched uranium be extended." Not only should it be extended, but it should include authority to accept the new low enrichment uranium (LEU) research reactor fuels that will replace the currently used HEU fuels. Without such a commitment by the United States in the near future, implementation of the RERTR program will be significantly delayed, since major countries will be unlikely to authorize research reactor operators to use LEU fuel, unless the U.S. agrees to take back the fuel for reprocessing (for other disposition), as has been done to date for HEU fuels (33 FR 30 (1968)).

We note the report's concern on p. 50 that there may be a discrepancy between our international policy of reducing use of HEU in research reactors abroad, and the attitude of U.S. domestic research reactor operators. Although the latter

GAO note: The March 18, 1982, comments were provided informally and appropriate changes were made to the report. It should also be noted that page number references in DOE's comments have been changed to reflect page references in the final report.

is primarily an issue of domestic policy, we believe that a consistent approach would benefit our overall non-proliferation goals. Full scale testing of LEU fuels has not yet advanced to the stage where conversion of either foreign or domestic reactors to use of such fuel is presently feasible. Several years of further test work on fuels by DOE are needed. Recent proposed changes in NRC safeguards requirements, 46 FR 46333 (1981), will provide an incentive to NRC licensed U.S. reactor operators to convert to use of LEU fuels, when they become available.

We also note concern in the report on p. 50 about the absence of a viable U.S manufacturer of LEU fuel in the commerical market and the impact this may have on the reduced enrichment program. It is our understanding that the DOE (RERTR program) has entered into contract with a U.S. manufacturer for the transfer of LEU plate-type fuel technology. DOE may be able to furnish more specific information concerning this program for LEU fuel production and whether it is likely to lead to U.S. industrial participation in the commercial market. In addition, rod-type fuel technology has been developed by a U.S. commercial manufacturer and testing of this fuel is partially supported by the RERTR program. In view of these developments, concern for the weakness in the U.S. RERTR program, namely, absence of U.S. LEU fuel manufacturers, both for the U.S. Government and commercially, may be unduly pessimistic.

We note the concern in the report for the capacity of the IAEA adequately to apply safeguards to weapons grade material. Much of this concern, however, appears to be based on misundertanding. Thus, comment on pp. i and ii of the digest and on p. 29 implies that the total amount of HEU exported since 1954 is still abroad and readily available for conversion into nuclear explosive devices. However, most HEU abroad is contained in irradiated fuel elements, not easily convertible into weapons-grade material. This fact and the limited number of reprocessing facilities available have an important bearing on the level of the IAEA inspection effort. Except for two large critical assemblies, the safeguarding task for the IAEA with respect to HEU is fairly straightforward and we have no reason to believe the IAEA is not doing an adequate job. This issue is of prime importance to the Department of State in furtherance of non-proliferation policy, and close interaction with the IAEA is maintained.

We also note, on p. 19, in relation to physical protection, the statement that "the United States receives no information from the IAEA in relation to review trips." The IAEA has no statutory basis for conducting physical protection reviews.

APPENDIX VIII

We believe that certain of the findings do not sufficiently take into account: 1) the significance of the current strict U.S. export controls over HEU supply; 2) the relatively few countries which are deemed eligible to receive kilogram quantity HEU exports; 3) the need to distinguish between exports of significant quantities of HEU for fueling research reactors and gram quantities for industrial and research purposes which are not significant from a proliferation standpoint; and 4) the need to distinguish between the national sovereign responsibility of each nation with a nuclear program to apply appropriate physical security measures and the international responsibility, administered by the IAEA, to apply safeguards.

In summary, the Department of State generally agrees with the recommendations of the draft report, and believes it will make a positive contribution to overall U.S. nuclear nonproliferation policy development.

Charles E. Horner
Acting Assistant Secretary
Bureau of Oceans and International
Environmental and Scientific
Affairs

APPENDIX IX

Department of Energy
Washington, D.C. 20585

APR 15 1982

Mr. J. Dexter Peach
Energy and Minerals Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

This refers to your letter of March 10, 1982, to Secretary Edwards, enclosing, for Department of Energy (DOE) review and comment, the draft GAO report entitled "U.S. Ability to Control and Monitor Weapons - Grade Uranium Supplied Abroad is Limited."

The interested DOE offices have reviewed the subject report and have met with your representatives to provide DOE's comments in the interest of producing a more balanced and accurate picture of the status of the various issues addressed in the report. While we agree, in part, with some of the recommendations, we believe major efforts should be made to give the report greater balance. More specific comments follow:

Overall we do not believe the document presents an entirely fair and accurate picture of the efforts the United States has had underway - both in the current and previous Administrations - to phase out the use of highly enriched uranium (HEU) for use in research reactors where found to be technically and economically feasible. This is most unfortunate since from the very beginning of the U.S. international nuclear program there has been an appreciation that unirradiated HEU merits special caution and attention in export processing, and over recent years, progress has been made in moving to lower enrichments. Also, in some instances, the threats described in the GAO report are overstated, and neither the Executive Branch nor NRC are given fair credit for efforts already underway that are consonant with GAO's recommendations. Further, there is an erroneous implication - that the current Administration is treating this area of concern in a more relaxed manner than the previous one. Accordingly, while we believe that substantially more work needs to be done to encourage nations around the world to actually shift to lower enrichments, in our view, the report should be rewritten to present a more factually accurate and balanced picture of where we stand in the process.

GAO note: We have modified the report to reflect information provided by those commenting on the report.

APPENDIX IX

Criteria for Review

The digest of the report, under the caption "U.S. Controls Over Highly Enriched Uranium" indicates that the relevant agencies follow the same general export license criteria and review process procedures for subsequent arrangements for highly enriched uranium as they do for low enriched uranium. We are concerned that this gives a misleading picture of what occurs, when in fact, all proposed exports of HEU are subject to rigorous inter-agency review (supported by analytical studies by the Argonne National Laboratory) with the view of encouraging cooperating nations to phase out the use of highly enriched uranium as soon as technologically and economically feasible. The fact that reports resulting from such efforts are no longer submitted to the President is a reflection of a desire to simplify the procedures, but the criteria that we are employing in reviewing cases remain the same as those adopted by the previous Administration. Our evaluations have been supported by analytical studies conducted by the DOE Reduced Enrichment Research and Test Reactor (RERTR) Program as well as cooperation by U.S. industry and foreign fuel fabricators and users. For example, as a general rule U.S. manufactured and deployed TRIGA reactors around the world will use 20 percent enriched uranium for all fuel replacements, and we are hopeful that many larger test reactors also will convert to lower enrichments when such replacement fuels become available. To place this matter in perspective it must be understood, however, that the DOE RERTR program is addressed to developing the technology of lower enriched fuels to the point where they can be put to practical application with the assent of foreign and domestic reactor operators - including foreign licensing and regulatory authorities. The actual deployment of such fuels by foreign reactor operators is not within DOE control.

Reprocessing

The GAO report appropriately notes the importance of U.S. acceptance (for reprocessing) of spent highly enriched uranium of U.S. origin from other nations. While the report recommends that this program of acceptance be extended, it implies that DOE has not been sufficiently active in encouraging such returns, that our financial terms for reprocessing are an impediment in this regard, and that this in turn is leading to a less than satisfactory situation given the inventories of U.S. origin HEU still overseas. In our view, the report should be modified to reflect the following points:

- First, it should be stressed that DOE has had active plans underway, for several months, to extend the U.S. offer to reprocess U.S. origin HEU irradiated in research reactors. We intend that the offer will be extended before the current Federal Register Notice expires at the end of 1982.

- Second, with reference to the GAO report assertion that only a small fraction of U.S. origin fuel has been returned to the U.S., we believe it is important to note that in most cases the fuel involved is in irradiated form overseas, either in reactors (some of which use a core load for several years before discharge), or in spent fuel storage basins. Irradiation of HEU produces very small amounts of plutonium, and the HEU itself cannot be employed in a nuclear weapon unless a country is able to separate out the highly radioactive fission waste products. Only a few nations have such capabilities.

- Third, with reference to the assertion that our minimum reprocessing charges are serving as a disincentive to some countries to return fuel to the U.S., we believe there is sufficient flexibility in existing U.S. policy to permit several small users to combine their batches. This is a step we have encouraged in the past and intend to encourage to a greater degree in the future. Given our obligation to recover our full costs in such situations, however, we do not anticipate that it will be feasible for us to reduce our charges. The minimum batch charge reflects an estimate of the cost of providing processing services for small quantities of material. It is composed of costs for start-up of process systems, recovery operations, and plant cleanouts for materials accountability. Operations conducted before and after fuel dissolution and uranium purification are for the most part insensitive to the actual quantity of fuel processed; therefore, it is logical that the costs on a per kilogram basis for processing small quantities of fuels will be higher than larger batches.

- Fourth, DOE is now considering the incorporation of provisions in the Federal Register Notice for acceptance of irradiated aluminum-uranium research reactor fuels below the 20 percent range, and a study concerning reprocessing of uranium-silicide fuels is now underway.

Physical Security

The digest caption in the GAO report entitled "Limited U.S. Ability to Assure Adequate Physical Protection" suggests that the U.S. is not receiving timely and sufficient facility specific data on the physical security measures that apply to U.S. origin HEU fuel shipped overseas. The suggestion also is made that cooperating states have not been sufficiently forthcoming in giving us the data or access we need to make timely judgments. We believe that this is a misleading conclusion that overlooks several important factors, including the following: most countries voluntarily adhere to the IAEA's guidelines on physical security and have their own independent reasons for wishing to protect their nuclear installations from dissident or terrorist groups; the London Nuclear Suppliers Group has also agreed on minimum physical security requirements for exports of HEU. Under a U.S. initiative, an international convention on physical security of nuclear materials has been approved by 34 countries.

Although there was some initial resistance in 1974 in one of the first countries that a U.S. team visited for a physical security review, this resistance was rapidly changed to a cooperative attitude.

Criteria for initiating visits by U.S. physical security teams include the following:

1. Political unrest or increased terrorist activity in the country since the last visit, or

2. New, or expanded, Category I facilities under consideration or have been put into operation since the last visit, or

3. Significant improvements in physical security have occurred since the last visit, and

4. Consideration of the time since the last visit.

In all of the 41 countries visited one or more times, there has been, in general, excellent cooperation. U.S. physical security teams have visited representative nuclear facilities in each country and all facilities in most countries. In only one country was there reluctance to allow a U.S. team to visit a specific facility; however, U.S. personnel did later visit this facility. Countries view physical security as a national responsibility and not one to be executed by the U.S. or the IAEA. We feel this is a reasonable position; however, the U.S. team has emphasized to each country the mutual benefits to be derived by

exchange of information which would improve security systems worldwide. The U.S. has provided suggestions for improvements when appropriate and has held up some exports until systems were upgraded to satisfactory levels. The results of this program have been encouraging. There is an international awareness and concern of the risks, a willingness to cooperate, and commitments to generate upgrading programs where needed.

The report should also mention that the U.S. is providing training courses under IAEA sponsorship in physical security systems.

Character of the Material Overseas and its Location

We also believe it is important to make two general comments on the total volume of U.S. exports of HEU. First, of the 16,000 kilograms that has been exported, about 300 kgs of HEU is dispersed in fairly small inventories to a total of 25 countries. Few of these countries have enough material to make a nuclear explosive.

Furthermore, almost all of this material was exported in fabricated fuel element form, and only exported on an as needed basis, e.g., when new fuel was needed or after return to the U.S. of spent fuel. Thus, this material in these 25 countries, in our view, does not constitute a significant proliferation risk. Second, the remainder of the 16,000 kilograms which has been exported has been transferred to nine countries who either are close allies of the U.S., weapons states, and/or NPT signatories. These are Belgium, Canada, France, West Germany, Italy, Japan, The Netherlands, Sweden, and the United Kingdom. The U.S. does not consider these countries to be proliferation risks. However, the U.S. has been concerned about the unauthorized diversion of highly enriched as well as any weapons useable material (Category I material) by a terrorist group. The U.S., particularly in concert with these countries, has placed a premium on ensuring that adequate physical security exists for Category I material. The U.S. took the lead in establishing an international convention on physical security. Before exporting HEU to these nine countries as well as the others, the U.S. must obtain a government-to-government assurance that measures will be maintained to ensure, at a minimum that, the physical security standards set forth in IAEA INFCIRC 225/Rev 1 are maintained. To review physical security measures, the team has visited each of the nine countries within the last two years and has concluded that adequate physical security measures exist in each country for all Category I material, including U.S. origin HEU.

Application of IAEA Safeguards

The section of the report entitled "Common Safeguards Problems Limit Ability to Detect Diversions of Highly Enriched Uranium" argues that the IAEA is not inspecting research reactors that

use HEU with sufficient frequency and states that many such facilities are not being visited even once a year because they are minor and possess less than 25 kilograms of HEU. GAO says that this practice is inadequate. We wish to emphasize that in our view IAEA inspections and related safeguards measures can provide reasonable assurances that no HEU has been diverted from a research reactor. To place this matter in perspective, based on our review of the latest available IAEA evaluation, it is our understanding that at the end of 1980 the IAEA had 175 research reactors and critical assemblies under inspection, and that 131 of these possessed less than one significant quantity (SQ) of material - a quantity the equivalent of 25 kgs of HEU, 75 kgs of uranium with enrichments below 20 percent, or 10 metric tons of natural uranium. Also, our mission in Vienna advises that in a typical 12-month period about three-fourths of the research reactors and critical facilities containing less than one significant quantity of enriched uranium were in fact inspected. Of those not inspected, almost all contained less than one-tenth of a significant quantity. [See GAO note on next page.]

Research reactors possessing more than one significant quantity of fissile material are inspected more often, with the frequency governed by the size and characteristics of the project, the quantities of non-irradiated HEU likely to be involved, as well as the potential opportunities for plutonium production. Most of the material in these facilities typically is in the core or in the form of irradiated spent fuel. The GAO report fails to mention that only a few nations have the capability to recover residual HEU from irradiated spent fuel.

While one cannot discount the diversion scenarios for possible large scale research reactors, we believe that the IAEA is acting prudently in giving its priority safeguards attention to bulk handling facilities such as reprocessing plants or HEU fabrication plants, rather than squandering its resources on minor research reactors. IAEA attention obviously has to be devoted to those cases or situations involving the greatest quantities or production of weapons usable materials, and we believe it would be a misallocation of IAEA resources to shift substantial resources to research reactors possessing less than one significant quantity of material. We are not aware of any diversion of HEU under IAEA safeguards, and the IAEA has reported continual progress in upgrading its safeguards procedures at research reactors.

GAO note: DOE comments do not address the inspection activities at facilities with more than a significant quantity of material or the ability of IAEA to meet its own detection goals at such facilities. It should be noted that the facilities not inspected in 1980 included some with more than a significant quantity of unirradiated HEU. When considering inspections during a one-year period, it should be remembered that (1) the approximate time to convert unirradiated HEU for use in a nuclear explosive device is 7 to 10 days and 1 to 3 months for irradiated HEU and (2) IAEA carried out about 50 percent of its estimated routine inspection effort due to inspector shortages.

Additionally, during conversations subsequent to the issuance of these comments, DOE officials advised us that the "typical 12-month period" was 1980 and that the "three-fourths" should be two-thirds.

APPENDIX IX

- 7 -

Tracking Nuclear Materials

The portion of the digest captioned "Central Tracking System Is Inaccurate and Unreliable" characterizes the Department of Energy's central computerized system used for tracking all U.S. exported highly enriched uranium as incomplete and inaccurate. Unidentified intended users are described as considering the system "inadequate, inflexible and unreliable". The report also suggests that DOE is not effectively using all of the information available to it and has suggested that DOE better integrate the various information systems that it employs for tracking such materials.

As you know, DOE has had a major effort underway to upgrade its tracking system, bearing in mind that for years records were not computerized. We believe useful progress is being made. Also, in accordance with GAO's suggestion, we are initiating a review to see whether a better integration can be achieved of the different systems even though they are designed to serve different purposes. For instance, NRC's IPELTS system is designed to provide only computerized information on export licenses. The NMMSS/INMTS systems are not designed to track the movement of U.S. origin materials within a cooperating nation. If we moved in this direction, we would have to impose an entire series of new reporting requirements on cooperating countries which could be resented by most of them. Also, such a requirement is not easily justifiable since all of our exports are already subject to IAEA or Euratom accountability and verification. We look to these bodies to perform the basic safeguards functions to help determine that no diversions occur. In addition, under our newer agreements for cooperation, the cooperating nation authorizes the IAEA to provide us with inventory data.

To elaborate on the tracking situation, the following additional comments should be made.

The INMTS was conceived in 1977 to automate a manual system of records dating from 1954 pertaining to the international transfer of U.S. origin nuclear materials. The automation was completed in 1978, and a subsequent audit was performed to determine the accuracy and completeness of the data base. The data base was found to have serious problems, and a "verification" project was planned to compare the data base with all pertinent available sources of data in the United States and to correct the deficiencies to the extent possible. This project will be completed in 1982, and we believe the INMTS will then be able to perform those functions it has been delegated with an acceptable degree of accuracy. A recent reconciliation of the "verified" U.S. data with that of Australia supports this opinion.

APPENDIX IX

The mission of the INMTS is to record and maintain export, import, and retransfer data for U.S. origin material. However, the way this issue is treated in the report leads us to believe this is not clearly understood by the GAO.

For example, the report states on page 48, "Our review showed that the NMMSS/INMTS international tracking system is not reliable for monitoring HEU supplied overseas for the following reasons:" and lists as one reason, "...The system shows where the material was originally shipped, but may not identify current location of the exported HEU. Moreover, the system does not show the current physical status of the material (e.g., irradiated, fabricated, or reprocessed)." It should be noted that INMTS was never intended to monitor either the location within the national boundaries of the recipient foreign entity or the physical status of the material.

It should be made clear, however, that INMTS does not track the disposition of HEU within a country. DOE has developed a system designed to address worldwide plutonium generation and utilization. This system, the Special Nuclear Materials Tracking System (STAMAS), is designed to address the generation and utilization of plutonium in the commercial nuclear fuel cycle. Recently, discussions have been initiated on the desirablility and feasibility of addressing research facilities and materials such as highly enriched uranium. Should HEU data be monitored by STAMAS, this system would utilize the NMMSS/INMTS data as a portion of its input. One other point should be made -- although the STAMAS does address "tracking," the system is not an accountability system and cannot provide accountability data.

Terrorist Threats

Finally, the report seems to imply that some, and perhaps a number of, terrorist acts have involved group efforts "to divert special nuclear material for making explosive devices." DOE has no information that indicates such organized efforts on the part of terrorist groups, and barring GAO's possession of some definitive information to this effect the statement seems misleading.

A second concern is the suggestion that all 39 incidents referenced by GAO were "terrorist initiated." While we do not wish to underrate this area of concern, a check of Appendix VI indicates that very few of the 39 incidents were terrorist inspired. With the discussion developed under a section entitled "Concerns Over Nuclear Terrorism..." the lay reader, however, is left with the

APPENDIX IX

impression that more acts of nuclear terrorism have occurred than in fact clearly is the case. Our concerns are that a labeling of almost any criminal act targeted against nuclear facilities as "terrorist" may tend to confuse the analysis and the evaluation of threats. It is recommended that GAO establish a clearer definition in the report of what it means by a terrorist--group or individual--and in particular what is meant by the term nuclear terrorism. Then all reference to the history of acts of nuclear terrorism would meet the report's definition of the phenomenon being analyzed.

We would urge you to factor our comments into the final version of your report. A copy of this letter, as well as an annotated copy of the referenced draft audit report, have been provided directly to your staff.

Sincerely,

William S. Heffelfinger
Assistant Secretary
Management and Administration

APPENDIX X

UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY

Washington, D.C. 20451

April 1, 1982

Dear Mr. Conahan:

Enclosed are ACDA's comments on the U.S. General Accounting Office report "U.S. Ability to Control and Monitor Weapons Grade Uranium Supplied Abroad is Limited."

Sincerely,

Thomas Graham, Jr.
Director, Office of
Congressional and
Public Affairs

Enclosure:

ACDA Comments on GAO Report.

Mr. Frank C. Conahan
Director
International Division
United States General
Accounting Office

GAO note: We have modified the report to reflect the information provided by those commenting on the report.

ACDA General Comments on GAO Report

CHAPTER 1

It is worth noting that the overwhelming majority of HEU exported from the US has been to US allies, and that at present virtually all HEU exports are to such countries. This fact alone tends to reduce significantly the possibility of national diversion of any HEU that continues to be exported from the US, and places the principal risk in the area of theft either by a terrorist group or an outlaw nation.

CHAPTER 3

ACDA agrees with the GAO conclusion that the problem of physical security for nuclear materials warrants increased attention in view of the increase in the number and sophistication of terrorist activities and the increase in the amount of HEU and mixed (plutonium plus uranium) oxide materials being transported within and between national boundaries. ACDA will work with NRC and other Executive Branch agencies to ensure a common understanding of the physical protection problems facing the US and foreign governments so that uniform physical security measures will be applied which will adequately protect nuclear materials in transit, both now and in future circumstances. As more countries expand their involvement in international nuclear fuel cycle commerce, particularly in mixed oxide materials, it will become increasingly important that international norms be established which provide adequate and consistent physical protection of nuclear materials, particularly in transit.

CHAPTER 4

ACDA agrees with the general thrust of GAO comments that there is a need for increased IAEA resources for inspecting HEU and that there are certain difficulties being encountered by the IAEA in applying its safeguards to HEU.

There are, however, a number of points made in the draft report which are general in nature and whose relevance, if any, to safeguarding HEU should be indicated. In addition, the comments in the report on the risks that diversion of HEU might go undetected for long periods of time should be put in the context of the very limited risk, in most countries, that diverted material, i.e., irradiated fuel assemblies, could be reprocessed and the purified uranium recovered. [See GAO note.]

GAO note: Our comments on IAEA safeguards are necessarily general because (1) we do not have audit authority at IAEA, (2) IAEA does not make public specific information about safeguards implementation, and (3) some information we had hoped to include in a discussion of safeguards over HEU was classified by the executive branch and therefore was not included in this report.

CHAPTER 6

ACDA agrees strongly with GAO that reducing the use of HEU abroad is a sound non-proliferation objective. Furthermore, the issues identified by GAO which require resolution before foreign reactors actually convert to LEU fuels are precisely those which the Executive Branch is giving high priority to resolving. For example, ACDA along with other Executive Branch agencies has diligently supported the funding level of the RERTR program in the FY 83 budget necessary to complete the program as expeditiously as possible. The technical and political problems associated with the take-back and reprocessing of foreign research reactor spent fuel are being addressed, and a resolution of these problems is expected within the next year or so. Personnel in the RERTR program and Executive Branch are working with foreign governments and reactor operators to address the technical and licensing problems which must be solved before reactors are actually converted; and a spirit of international cooperation and optimism toward accomplishing the program's objectives continues to be demonstrated at the international meetings of the program participants. Finally, RERTR program personnel are working closely with a U.S. fuel vendor to transfer advanced fuel fabrication technology, which could make a U.S. vendor a competitor for most of the world's research reactor fuel orders.

GAC note: ACDA also suggested clarifying language and editorial changes. These have been deleted here, however appropriate changes were made to the report.

APPENDIX XI

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

APR 12 1982

Mr. J. Dexter Peach, Director
Energy and Minerals Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

This is in response to your letter of March 10, 1982, requesting comments on the draft report to the Congress entitled, "U.S. Ability to Control and Monitor Weapons-Grade Uranium Supplied Abroad is Limited." The draft report has been reviewed by the Nuclear Regulatory Commission staff. In addition to the general comments below, detailed comments are enclosed.

The subject of the report is a complicated one. Although considerable information is presented, the report needs to achieve better balance and perspective and to avoid focusing on events or circumstances in isolation. In addition, the report sometimes generalizes too broadly. These concerns arise particularly in connection with Chapters 3, 4, and 5 which address physical protection, international safeguards and material tracking systems. For example:

-- It should be clearly pointed out that exports of Highly Enriched Uranium are given comprehensive inter-agency review of far greater intensity than that applied to most Low Enriched Uranium exports.

-- The discussion of foreign physical protection reviews needs to be put into better perspective by noting that the great majority of HEU has been exported to a limited number of of countries and that exported HEU has received better coverage by U.S. physical security reviews than implied in the report.

-- The discussion of IAEA safeguards in Chapter 4 should be balanced by noting that the IAEA concentrates its inspections on facilities with significant quantities of material like HEU that can be used directly in explosives rather than on small research reactors.

-- Chapter 5 should clarify that no USG agencies currently have responsibility to track U.S.-origin nuclear material abroad and negotiation of international agreements with export recipients would be required to accomplish this.

GAO note: We have modified the report to reflect the information provided by those commenting on the report.

APPENDIX XI

Should you or your staff wish to discuss the report and our comments in more detail, please let us know.

Sincerely,

William J. Dircks
Executive Director
for Operations

Enclosure:
As stated

GAO note: Although not reprinted here, technical comments and proposed editorial changes provided by NRC have been incorporated, where appropriate, throughout the report. However, we believe it is important to note that in its technical comments NRC agreed with the recommendation that information on U.S.-supplied nuclear material should be streamlined and consolidated. Nevertheless, NRC pointed out that it is not clear whether this could be accomplished through development of a single information system.

Our comments on IAEA safeguards are necessarily general because (1) we do not have audit authority at IAEA, (2) IAEA does not make public specific information about safeguards implementation, and (3) some information we had hoped to include in a discussion of safeguards over HEU was classified by the executive branch and therefore was not included in this report.

(465266)

U.S. GOVERNMENT PRINTING OFFICE: 1982-361-843:2175

22716

AN EQUAL OPPORTUNITY EMPLOYER

UNITED STATES
GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U. S. GENERAL ACCOUNTING OFFICE

U.S.MAIL

SPECIAL FOURTH CLASS RATE
BOOK