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BY THE COMPTROLLER GENERAL
Report To The Chairman, Subcommittee On Energy Research And Protection, Committee On Science And Technology House Of Representatives
OF THE UNITED STATES

New And Better Equipment Being Made Available For International Nuclear Safeguards

Since 1977, the United States, eight other countries, and a multinational organization have voluntarily contributed about $80 million to improve the technical capabilities of the International Atomic Energy Agency (IAEA) in conducting its nuclear safeguards activities These activities are intended to ensure that safeguarded nuclear facilities and materials are not used to further any military or explosive purpose. The U S program, first and largest of these efforts, has resulted in the development of 21 types of safeguards equipment, most of which are currently in use.

With the recent growth in the number and size of specialized support programs, effective coordination is needed to help achieve a fully integrated, multilateral technical assistance program In June 1983, IAEA took a significant step toward this goal by sponsoring the first conference for representatives from each of the 10 formal assistance programs.

Efforts are underway to overcome a number of hindrances to getting equipment into routine use, including the need for more coordination, early testing and use of equipment, and equipment documentation GAO recommends actions to the Secretary of State to further assist in overcoming these and other hindrances

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

B-215047

The Honorable Marilyn Lloyd
Chairman, Subcommittee on Energy
Research and Production
Committee on Science and Technology
House of Representatives

Dear Madam Chairman:

This report responds to your June 23, 1982, request that we evaluate U.S. research and development efforts in connection with equipment for the International Atomic Energy Agency's (IAEA) international nuclear safeguards program. It discusses U.S. equipment programs, other countries' programs and their international coordination, and problems being experienced by the IAEA in getting equipment into use.

As arranged with your office, we are sending copies of this report to the Secretaries of Energy and State; the Director, U.S. Arms Control and Disarmament Agency; and the Commissioner, Nuclear Regulatory Commission. Copies will also be available to other interested parties who request them.

Sincerely yours,

Charles A. Bowsher

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT
TO THE SUBCOMMITTEE ON ENERGY
RESEARCH AND PRODUCTION,
COMMITTEE ON SCIENCE AND
TECHNOLOGY
HOUSE OF REPRESENTATIVES

NEW AND BETTER EQUIPMENT BEING MADE AVAILABLE FOR INTERNATIONAL NUCLEAR SAFEGUARDS

DIGEST

The International Atomic Energy Agency (IAEA) was established as an autonomous U.N. agency to foster the peaceful use of nuclear energy under effective safeguards. IAEA's safeguards system depends upon material accountability complemented by containment and surveillance devices to ensure that safeguarded nuclear materials and facilities are not used to further any military or explosive purpose. The United States supports the IAEA safeguards system through a variety of programs and other efforts. Eight other countries and one multinational organization also have formal programs for providing direct safeguards assistance to IAEA.

In June 1982, the Chairman of the Subcommittee on Energy Research and Production asked GAO to evaluate U.S. research and development efforts regarding equipment for IAEA's international nuclear safeguards program.

U.S. EQUIPMENT PROGRAMS

Foremost among the U.S. efforts is the Program of Technical Assistance to Safeguards (POTAS), a special program initiated in 1976 to supplement other U.S. assistance to international nuclear safeguards. It has evolved into the main vehicle for providing direct technical support to improve international safeguards. POTAS is funded under the Foreign Assistance Act appropriations. The Department of State chairs the interagency groups which provide policy guidance and technical coordination for POTAS.

Through POTAS, the United States has developed 21 types of safeguards equipment for IAEA use, such as scientific instruments for measuring various nuclear materials and seals and cameras for containment and surveillance purposes. GAO found most of this equipment in some degree of use or available for use.

Expenditures through POTAS have totaled over $31 million, about one-half of which has been for equipment related tasks. The remainder has been used to fund such activities as training, systems studies, and information processing/evaluation efforts. (See p. 12.)

Despite its equipment development success, POTAS has not been without problems, some of which are only now beginning to be addressed. These problems range from providing too much equipment too quickly in the program's early years to equipment that does not work adequately or that does not meet IAEA's needs. (See p. 11.)

ADEQUACY OF EQUIPMENT

Neither the United States nor IAEA currently has criteria for determining the adequacy of safeguards equipment. IAEA is formalizing its overall safeguards evaluation process, including assessing the results of equipment measurements. In this way, IAEA's evaluation process will address the quality of instruments.

In the absence of generally accepted criteria and given GAO's lack of audit authority at IAEA, GAO examined the various options currently available for assessing equipment adequacy. GAO determined that there can be differing views of whether a particular type of equipment is adequate. For example, equipment might be adequate on a quantitative or technical basis (sufficiently accurate and precise) but wholly inadequate from a qualitative or usefulness standpoint (too heavy, too fragile, or too complex for field use). (See p. 21.)

Many U.S. officials agree that the ultimate judge of "adequacy" is the user (the IAEA Inspectorate) and the degree to which IAEA integrates a type of equipment into its safeguards efforts. In this regard, 15 (71 percent) of the 21 types of U.S.-furnished equipment are in some degree of use, or are available for use, by IAEA. Two others (about 10 percent) are still being tested and evaluated, while four (about 19 percent) are not now used or expected to be used. (See p. 24.)

ASSISTANCE FROM OTHERS AND THE EVOLVING NEED FOR COORDINATION

Eight other nations and one multinational organization have programs supporting safeguards--Australia, Belgium, Canada, France, Japan, the United Kingdom, the U.S.S.R., West Germany, and the European Atomic Energy Community. Spending under these programs totaled an estimated $50 million through 1983. Also, a number of other nations have contributed in lesser degrees and amounts to IAEA's safeguards program. (See p. 35.)

Greater international participation through formal assistance programs provides IAEA with the opportunity to better plan and control its safeguards development activities. As more than one contributor may be working in the same area, the need for improved multilateral coordination has grown. To this end, IAEA sponsored the first special assistance coordinators' conference in June 1983. The conference was a significant first step in multilateral coordination. Participants agreed that improved coordination was needed and suggested additional meetings to focus on technical assistance matters. Future meetings with a technical focus, or other coordination approaches, are especially important in view of the continuing growth of assistance activities and an IAEA hoped-for increase in the aggregate level of assistance. GAO believes that multilateral coordination with a technical emphasis is necessary and should enable IAEA to (1) better plan and control its safeguards development activities, (2) avoid unnecessary or undesirable duplication of future program activities, and (3) facilitate exchanges of technical information about equipment under development. (See p. 39.)

PROBLEMS IN GETTING EQUIPMENT INTO USE

Getting equipment into use has been recognized as a problem for several years. Both IAEA and POTAS have begun to address a number of hindrances to equipment implementation. Technical problems hindering implementation include whether the current levels of documentation (written instructions or descriptions) for equipment usage, operation, and training are adequate for IAEA's effective and efficient use of the equipment. Another hindrance to equipment implementation is the reluctance of some facility operators to accept new equipment for use on inspections at their facilities. In addition, both IAEA and U.S. officials are concerned about whether IAEA will be able to procure and support its projected equipment needs. These hindrances have begun to be addressed by:

--Testing/training exercises at U.S. nuclear facilities.

--Placing more emphasis on improved equipment documentation.

--Long-range planning and development efforts for equipment and evaluation methods. IAEA's long-range planning has been included in two reports. The later report was completed in 1983 and estimated that the costs of needed equipment and technical support (repairs and maintenance) are $20 million and $13 million, respectively, over the 6-year period ending in 1988.

--Reorganizing IAEA's Safeguards Department to upgrade safeguards evaluation and training activities.

--Using more experts (cost-free to IAEA) to supply special technical and management skills necessary for assisting IAEA in getting equipment into use.

However, some of the hindrances are persistent and not amenable to simple solutions. U.S. officials should work to help complete a number of recent initiatives which will further progress towards effective equipment implementation. (See p. 42.)

RECOMMENDATIONS

The Secretary of State should request IAEA to further develop and implement coordination mechanisms to help achieve a fully integrated, multilateral safeguards support program among countries providing substantial support. (See p. 41.)

The Secretary of State, after consulting with other POTAS member agencies, should direct POTAS to:

--Work with the IAEA Secretariat to follow through on planned equipment testing, to encourage early routine use at facilities in the United States, and to encourage other nations providing voluntary assistance to IAEA safeguards to do the same.

--Assess the IAEA Secretariat's concern that the current documentation on equipment usage, operation, and training is not meeting IAEA's needs and, if necessary, adjust the U.S. assistance efforts to address this problem. (See p. 53.)

The Secretary of State should also monitor IAEA's progress in procuring and supporting its planned equipment needs and, if problems occur, work with the IAEA Secretariat to develop strategies for overcoming them. (See p. 53.)

AGENCY COMMENTS

In commenting on the draft of this report, the Department of State and the Nuclear Regulatory Commission agreed with GAO's conclusions and recommendations. The Department of Energy generally agreed with the findings of the report and believed the report provided a good evaluation of U.S. efforts regarding equipment for IAEA's international nuclear safeguards program. The Arms Control and Disarmament Agency said the report provided a good analysis of a complex subject and addressed the most important questions. It also said that the recommendations will be used in identifying additional useful ideas for improvements. Comments from the four agencies are in appendices V through VIII.

In line with the GAO recommendation on IAEA's need for improved equipment documentation, the Department of State said that this is a major concern which is being given priority attention in the current and upcoming support program plans. (See p. 70.)

The Department of State also commented on the importance of possible constraints to procuring and supporting equipment and said it will continue to give this area priority attention. (See p. 71.)

Contents

ABBREVIATIONS

ACDA	Arms Control and Disarmament Agency
CFE	cost-free expert
C/S	containment/surveillance
DOE	Department of Energy
EURATOM	European Atomic Energy Community
GAO	General Accounting Office
IAEA	International Atomic Energy Agency
ISPO	International Safeguards Project Office
NDA	nondestructive assay
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRC	U.S. Nuclear Regulatory Commission
POTAS	Program of Technical Assistance to Safeguards
TSCC	Technical Support Coordinating Committee

CHAPTER 1

INTRODUCTION

In June 1982, the Chairman, Subcommittee on Energy Research and Production, House Committee on Science and Technology, asked us to evaluate U.S. research and development efforts regarding equipment for the International Atomic Energy Agency's (IAEA) international nuclear safeguards program. Specifically, we were asked to examine the

--adequacy of equipment being used by IAEA;

--scope, cost, and effectiveness of U.S. programs to develop new or improved equipment;

--extent of U.S. coordination with the programs of other nations and need for additional cooperation;

--problems in getting equipment into use by IAEA; and

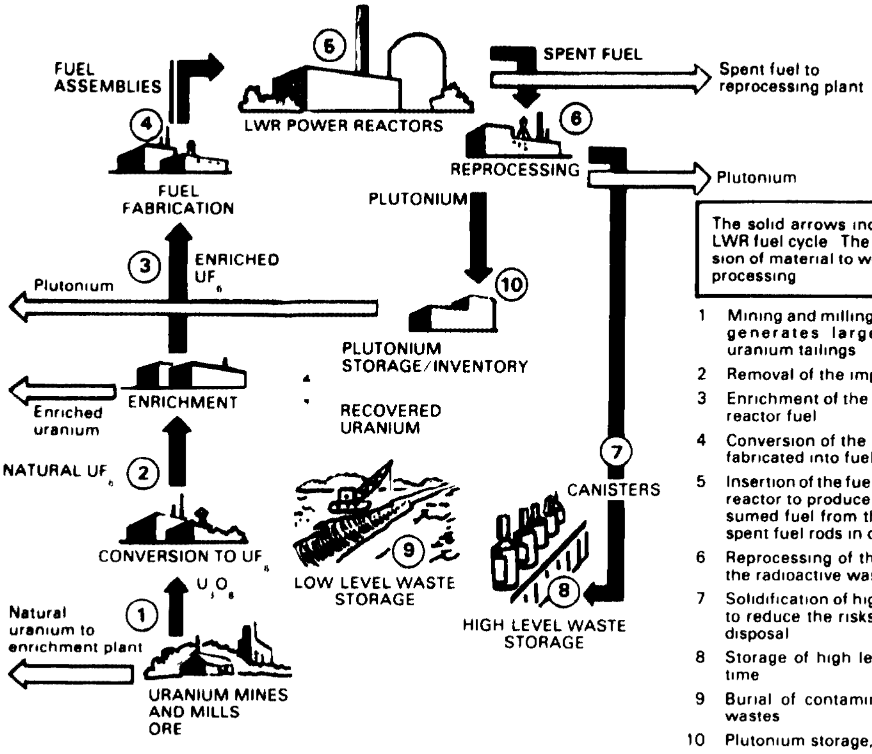
--long-range plans for improving international safeguards equipment.

Underlying this request was a continuing concern about the research and development of technology appropriate to monitor and account for nuclear materials. In addition, committee staff told us they hoped the report would contain sufficient detail in describing safeguards equipment to provide committee members with a basic understanding of the equipments' features and uses.

LINKS BETWEEN NUCLEAR POWER PROGRAMS AND NUCLEAR WEAPONS

Certain processes, materials, and technologies used in civilian nuclear power programs provide potential links to the development of nuclear weapons. This linkage is strongest at those points in the nuclear fuel cycle where weapons-usable materials--highly enriched uranium or plutonium--are easily accessible. The diagram below shows possible diversion paths in one of the most common civilian nuclear energy fuel cycles.

LIGHT-WATER REACTOR FUEL CYCLE



The solid arrows indicate the normal flow of material through an LWR fuel cycle The white arrows indicate potential paths for diversion of material to weapons use, either immediately or after further processing

1 Mining and milling of ore to obtain raw uranium called yellowcake generates large quantities of low-level wastes called uranium tailings
2 Removal of the impurities from the yellowcake and conversion
3 Enrichment of the uranium from step 2 to a level suitable for power reactor fuel
4 Conversion of the uranium from step 3 to leave a powder which is fabricated into fuel elements for the power reactor
5 Insertion of the fuel elements into the power reactor operation of the reactor to produce electricity, removal of the spent or partially consumed fuel from the reactor and storage of the highly radioactive spent fuel rods in cooling tanks at power plants
6 Reprocessing of the spent fuel to separate unconsumed fuel from the radioactive wastes for future recycle
7 Solidification of high level liquid wastes left over after reprocessing to reduce the risks of accidental release and allow for permanent disposal
8 Storage of high level radioactive wastes for indefinite periods of time
9 Burial of contaminated equipment clothing and other low level wastes
10 Plutonium storage, recycling of recovered uranium

SOURCE Office of Technology Assessment

Neither highly enriched uranium nor separated plutonium is commonly used as fuel in civilian nuclear power reactors. As a rule, power reactors use natural uranium with less than 1 percent, or slightly enriched uranium with up to 4 percent, of the uranium isotope needed to power such reactors. In contrast, uranium for reliable nuclear weapons needs to be highly enriched--to about 90 percent or more. Therefore, typical fresh fuel for nuclear power reactors would require further enriching to make it useful as weapons material. On the other hand, most research reactors are currently fueled with highly enriched uranium. According to IAEA, 25 kilograms (about 55 pounds) of highly enriched uranium is a significant quantity, i.e., about the amount needed for a nuclear explosive device. Plutonium is produced as a by-product of uranium-fueled power reactors. If separated from the used fuel by chemical reprocessing, it can be refabricated as either a reactor fuel or a nuclear explosive device. IAEA defines 8 kilograms (about 18 pounds) of plutonium as a significant quantity.

There is no question that nuclear technology and materials which are intended for peaceful purposes can be used, to varying degrees, in making nuclear weapons. The technology and experience accumulated in conducting civilian nuclear energy programs have significantly lowered the technical barriers to nuclear weapons proliferation. The potential for using this link is at the center of the international controversy about nuclear energy. IAEA is seen by many as a key element in detecting and deterring such use.

THE SAFEGUARDS ROLE OF IAEA

IAEA, founded in 1957 as an autonomous agency of the United Nations, is headquartered in Vienna, Austria, and has 112 member nations. It has three principal parts.

1. The General Conference, with representatives from all member nations, meets annually to debate general policy, approve programs and budgets, and elect members to the Board of Governors.

2. The Board of Governors, with representatives from 34 nations, is the Agency's executive body. It meets quarterly and considers policy, recommends budgets, appoints a Director-General, and approves nations for membership.

3. The Secretariat, headed by the Director-General, administers and implements the Agency's programs.

IAEA has a two-part objective--to foster the peaceful use of nuclear energy and to apply international safeguards when requested by member nations. It strives to accomplish the second part of its objective through a system of nuclear safeguards which, for members who have signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), is intended to detect in a timely manner diversions of significant quantities of nuclear material from peaceful nuclear activities and deter such diversions by the risk of early detection.[1] IAEA's safeguards system aims at deterring and/or detecting diversions by nations, but does not extend to physical protection measures (e.g., guards or fences) for deterring theft and/or sabotage by terrorists or sub-national groups. Furthermore, IAEA inspectors do not have unlimited access during their inspections, and IAEA safeguards are not designed or intended to search for undeclared or clandestine facilities. IAEA officials state that the Agency is not a police force, but rather a monitoring group responsible

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[1] Some countries have not signed the NPT, but have agreed to have IAEA safeguard certain facilities within their borders. In these situations, referred to as non-NPT safeguards, IAEA's safeguards are intended to ensure that nuclear materials or facilities subject to these safeguards are not used to further any military or other explosive purpose.

for sounding an alarm. Despite these limitations, IAEA's safeguards system represents an exceptional concession of sovereignty by nations subject to safeguards. It is the only extensive international system that currently allows on-site verification of treaty obligations by an independent third party. According to IAEA's Director-General, the safeguards system is "a unique verification system."

At the conclusion of an inspection, the IAEA inspector reviews inspection results with the facility operator to preclude misunderstandings and subsequently submits a detailed report to IAEA. The report is reviewed within IAEA, and upon completion of the review process, IAEA provides the country with a statement of its inspection results and conclusions. IAEA reports the results of individual inspections to only the country inspected, i.e., the reports are not available to other countries. Aggregated inspection results are reported to the Board of Governors, the General Conference, and the U.N. General Assembly.

If IAEA cannot verify the non-diversion of nuclear material, the country involved is to be given a "reasonable time" to take corrective action before procedures for noncompliance may be initiated. Such procedures may include notifying member countries and the U.N. Security Council and General Assembly. The country's continued failure to rectify the situation may also result in the recall of IAEA-sponsored material and technical assistance, as well as suspension of membership rights and privileges. IAEA has never used any of these procedures.[2]

Growth in IAEA's safeguards responsibilities

The IAEA safeguards system was established initially to cover material provided by or through the IAEA as well as any bilateral, multilateral, or national nuclear activities for which the application of international safeguards had been requested. However, as the world community became increasingly aware of the dangers associated with the rapid worldwide dissemination of nuclear technology, IAEA's safeguards responsibility was substantially broadened in 1968 under the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco) and in 1970 under the NPT.

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[2] In September 1981, the Director-General did notify the Board of Governors of changed circumstances in two countries which precluded IAEA inspectors from fully discharging their verification responsibilities for certain reactors in those two countries. More recently, the Board was notified that negotiations with the countries have defined changes to the safeguards applied such that the inspectors can now provide the "requisite assurances."

Under the NPT, non-nuclear weapon countries agree to accept IAEA safeguards on all source and special nuclear material used in their peaceful nuclear activities. The NPT is the mainstay of the structure of international commitments and agreements to reduce the risk that increasing use of nuclear power may enable more nations to readily acquire nuclear weapons. Under the Treaty of Tlatelolco, Latin American countries are committed to place their present and future nuclear activities under IAEA safeguards to verify compliance with the treaty. At the start of 1983, about 119 non-nuclear weapon countries were full parties to the NPT and/or the Treaty of Tlatelolco.

As the number of nations adhering to such treaties has increased, the challenges to IAEA safeguards have also grown. For example, the number of facilities subject to safeguards has greatly increased--the number of facilities in non-nuclear weapon nations under safeguards or containing safeguarded material increased from 332 in 1976 to 440 in 1982. Moreover, selected facilities in some nuclear weapon nations are also subject to IAEA inspections.

In addition to the increasing number of facilities, IAEA is now or will be responsible for applying safeguards at new types and sizes of facilities which are central to the issue of weapons proliferation because of the nature and/or volume of nuclear material they handle. These facilities include enrichment plants, large reprocessing facilities, and plants for fabricating mixed uranium-plutonium oxide fuel for power reactors and highly enriched uranium fuel for research reactors. Furthermore, IAEA now deals with complete nuclear fuel cycles within single countries or organized groups of countries.

Another area in which IAEA's responsibilities have increased substantially involves the total amount of nuclear material under IAEA safeguards. The increase in safeguarded material between 1976 and 1982 in non-nuclear weapon nations is shown below.

Material	Amount	
	1976	1982
	(metric tons)	
Separated plutonium	3	6
Highly enriched uranium	3	10
Plutonium contained in irradiated fuel	12	83
Low enriched uranium and source material (natural or depleted uranium and thorium)	9,000	42,000

Use of equipment in safeguards

IAEA's safeguards system depends upon material accountability, complemented by containment and surveillance devices. In planning and applying safeguards, IAEA considers (1) the design of the nuclear facility, (2) material records of the facility and reports submitted by the involved country, and (3) inspection and surveillance of the facility.

Reviewing the facility design enables IAEA to verify the character, purpose, capacity, and layout of the facility. IAEA can then select the surveillance techniques and containment devices to be used, such as cameras and seals; select key points for measuring material flows and inventories; and establish requirements for records and reports.

The starting point for an inspection is the inventory data submitted by the country. Changes in the inventory since the last inspection, based on receipt, production, consumption, and transfer notices, are recorded. This inventory then becomes the basis for verification. To verify the inventory, IAEA inspectors may count, weigh, and measure randomly selected portions of the material; take samples for independent analysis; and make comparisons with the accounting records.

U.S. ROLE IN INTERNATIONAL SAFEGUARDS

In the 1950s, the United States inspected facilities in recipient countries to ensure that U.S. nuclear exports were not used for unauthorized purposes. Recognizing a number of advantages in having an international body perform safeguards, the United States played a major role in creating IAEA and in developing its safeguards system. Subsequently, the safeguards functions of U.S. bilateral peaceful cooperative agreements were transferred to IAEA.

Since IAEA was established, the United States has provided substantial technical and policy assistance to IAEA's safeguards program and encouraged IAEA safeguards coverage of all peaceful nuclear activities within a country--often referred to as "full-scope" safeguards. The United States supports the widest possible adherence to the NPT and the Treaty of Tlatelolco, which require non-nuclear weapon parties to accept full-scope safeguards. The Nuclear Non-Proliferation Act of 1978 (22 U.S.C. 3201) requires IAEA safeguards on peaceful nuclear activities as a condition of U.S. supply pursuant to new or amended agreements for nuclear cooperation and for exports pursuant to existing agreements. Additional policy assistance includes efforts to extend the application of IAEA safeguards through the international Nuclear Suppliers Group[3] and to apply IAEA safeguards

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[3] A 15-nation group of major nuclear suppliers which has established and agreed to adhere to a set of limited nuclear export guidelines.

to U.S. nuclear facilities not of direct national security significance.

Recognizing that the IAEA safeguards staff was already heavily burdened by existing requirements, President Ford in 1976 pledged special help to upgrade IAEA safeguards. A special U.S. interagency Program of Technical Assistance to Safeguards (POTAS) was established to assist IAEA in improving its safeguards capability. The Nuclear Non-Proliferation Act of 1978 reaffirmed continuing support by calling for the United States to work with other nations to improve international nuclear safeguards through the contribution of financial, technical, informational, and other resources to assist IAEA in effectively implementing safeguards.

In July 1981, President Reagan re-emphasized the U.S. position that IAEA safeguards are an important element of U.S. nuclear non-proliferation policy. He stated that the United States is committed to "strongly supporting and continuing to work with other nations to strengthen the IAEA to provide for an improved international safeguards regime." In February 1983, following a 5-month reassessment of the entire U.S./IAEA relationship, the U.S. Ambassador to IAEA said that the United States "is prepared to renew its commitment to the IAEA and its important programs."

Therefore, the United States continues to place great importance on the international safeguards system to sound the alarm if nuclear material is diverted for undeclared purposes. Moreover, it has, over the years, helped to persuade other nations that they too should support the IAEA system.

U.S. support to international safeguards

The United States transforms its statements of support for IAEA safeguards into substantive aid through a variety of means. The State Department, through an annual assessed contribution to IAEA's regular budget, provides financial support for the international safeguards operation. To improve IAEA safeguards implementation, the Department of Energy (DOE), the Arms Control and Disarmament Agency (ACDA), and the Nuclear Regulatory Commission (NRC), for years have maintained individual programs, funding studies and technical support activities to develop improved IAEA safeguards approaches, procedures, equipment, and techniques. POTAS was established as a special supplement to these existing programs.

The amounts of U.S. financial support given to international safeguards since the beginning of POTAS are shown on the next page.

U.S. Financial Support To International Safeguards

	1976-77	1978	1979	1980	1981	1982	1983	Total
	(000 omitted)							
U.S. assessed share of IAEA safeguards budget	$4,322	$3,662	$4,637	$6,008	$6,832	$7,033	$8,210	$40,704
Additional Support								
DOE (note a)	$2,400	$3,400	$4,500	$7,135	$6,600	$6,500	$6,500	$37,035
ACDA (note b)	406	1,887	960	1,600	1,250	335	300	6,738
NRC	-	149	88	435	80	162	230	1,144
POTAS	5,420	3,800	5,575	4,100	4,100	4,000	4,500	31,495
Subtotal	$8,226	$9,236	$11,123	$13,270	$12,030	$10,997	$11,530	$76,412
Total	$12,548	$12,898	$15,760	$19,278	$18,862	$18,030	$19,740	$117,116

a. Includes funds for all DOE domestic safeguards research and development and for supporting IAEA inspections at selected U.S. nuclear facilities. Thus, includes more than just IAEA-needed safeguards equipment. In commenting on a draft of this report, DOE stated that the DOE budget figures reflect only program activities carried out under DOE international rather than domestic support. The products of these DOE efforts are largely transferred to IAEA through POTAS. DOE added that its figures include technology research and development and systems analyses for policy assistance to apply IAEA safeguards at U.S. nuclear facilities not of direct national security significance.

b. Includes a project called RECOVER (see ch. 2) which ACDA perceived as having applicability to IAEA safeguards, but which never reached the stage of development required for IAEA use and therefore was never officially accepted for safeguards use.

OBJECTIVES, SCOPE, AND METHODOLOGY

As requested by the Chairman, Subcommittee on Energy Research and Production, the objectives of this review were to:

- --Evaluate the adequacy of the present nondestructive assay equipment and containment and surveillance devices being used by IAEA.
- --Review the scope, effectiveness, and cost of the U.S. programs, such as POTAS, to develop new or improved equipment.
- --Assess the extent to which U.S. programs are coordinated with programs in other nations through existing technology agreements and review the need for additional cooperation.
- --Ascertain the problems, if any, being encountered in getting advanced equipment into routine use by IAEA.
- --Ascertain the long-range plans for improving international safeguards equipment.

This review was made in accordance with generally accepted government audit standards except as noted below. We applied those standards in gathering and analyzing information from a variety of sources, including the U.S. government, U.S. national laboratories, representatives of foreign governments, IAEA officials, U.S. private industry, and various published reports. Audit work was performed from July 1982 through June 1983. Our work was slowed by the 5-month reassessment of the U.S./IAEA relationship (Sept. 1982 to Feb. 1983). Although we visited IAEA headquarters and discussed our review with a number of IAEA officials, we were limited in our ability to fully examine all aspects of the Chairman's request because we do not have audit authority at IAEA. We did not obtain official IAEA comments on this report. Also, we did not visit any intelligence agencies or review any intelligence reports regarding the possibility of nuclear diversions and how any such diversion would relate to IAEA's responsibilities.

U.S. government agencies

We reviewed records and interviewed officials of ACDA, NRC, the Departments of Energy and State, and the U.S. Mission to IAEA.

National laboratories

U.S. national laboratories are government-owned, contractor-operated facilities which conduct extensive research and development in numerous areas, including international safeguards. As part of our effort to assess safeguards research and development efforts and to observe the operation of safeguards equipment and devices, we visited the Los Alamos and Sandia National Laboratories. We also contacted Battelle Pacific Northwest Laboratory officials and visited the Brookhaven National Laboratory's International Safeguards Project Office and Technical Support Organization. The Safeguards Project Office has day-to-day responsibility for administering POTAS.

Foreign governments

We attended the 1983 IAEA conference for safeguards support program coordinators. The meeting was the first of its kind and was attended by representatives of Australia, Belgium, Canada, the European Atomic Energy Community (EURATOM), France, Japan, the Soviet Union, the United Kingdom, the United States, and West Germany. The purpose of the conference was to exchange information about the support programs and to learn how they affect IAEA.

IAEA

We visited IAEA headquarters in Vienna, Austria, and met with IAEA officials, including inspectors, to obtain their views of U.S.-supplied safeguards equipment and the U.S. support program. We discussed efforts to get equipment into use by IAEA and future plans for equipment procurement.

U.S. private industry

We attended the Institute of Nuclear Materials Management's 1983 conference where we heard presentations on safeguards equipment and the role of IAEA. We also discussed these matters with a number of conferees, including former IAEA inspectors.

Reports

We reviewed a number of published reports, including

- --the President's annual report on nuclear nonproliferation;
- --the Brookhaven National Laboratory report, Safeguards Instrumentation--A Computer-Based Catalog;
- --various IAEA reports; and
- --our previous reports on safeguards-related issues.

CHAPTER 2

U.S. EQUIPMENT PROGRAMS

Since 1976, the U.S. government has used the International Safeguards Project Office (ISPO) of the Brookhaven National Laboratory to oversee the technical implementation and coordination of the interagency POTAS program. Established originally to carry out President Ford's pledge of $1 million in special aid to IAEA annually for 5 years, POTAS was to supplement existing U.S. programs. However, its focus has changed and POTAS has evolved from a supplemental effort into the main vehicle for providing direct technical support to improve international safeguards. Through POTAS, the United States has provided about $31 million through fiscal year 1983 in support of international safeguards.

Through POTAS, 21 types of safeguards equipment have been developed for IAEA use. Most of these were in some degree of routine use by June 30, 1983, with four not currently used or planned for use. Despite this success rate in placing equipment into use, POTAS has not been without problems, some of which it is only now overcoming. These problems range from providing too much equipment too quickly in POTAS' early years to equipment that does not work adequately or that does not meet the needs of IAEA.

The United States has also assisted international safeguards through other programs which have had varying degrees of success.

POTAS PROGRAM

Countries accept IAEA safeguards voluntarily as a political indication of their commitment to use civil nuclear material and facilities for peaceful purposes only. In order to give substance to that commitment, IAEA safeguards must be technically capable of meeting their goals of deterrence through early detection of diverted material or use of facilities for other than their stated purposes.

To help IAEA upgrade its safeguards system, President Ford, in 1976, pledged $1 million of special help annually for 5 years. In line with the President's pledge, the Departments of State and Energy, ACDA, and NRC initiated POTAS. The Program was to be of limited life and was principally intended to provide quick reaction to urgent needs identified by IAEA to improve the effectiveness of safeguards where response through the normal IAEA budget process was not fast enough. Technical assistance provided under this Program complements the methods that IAEA would normally use to fill safeguards needs, based on funding from its regular budget.

Moreover, POTAS assistance is directed to areas where IAEA's ability is limited. For example, advanced technical capabilities developed through U.S. research are made available and IAEA personnel are given experience with the type of operating conditions at nuclear facilities they encounter on safeguards inspections.

POTAS consists of specific technical projects requested by IAEA which the United States agrees to undertake. Each project or task is aimed at correcting or improving a particular aspect of IAEA safeguards. The Program started with 98 tasks. As of August 1983, 372 tasks had been accepted and 260, or nearly 70 percent, had been completed. Below is a breakdown of the tasks by category.

Task category	Tasks			
	Current	Completed	Deleted	Total
Measurement technology	25	80	12	117
Training	12	22	0	34
System studies	11	31	11	53
Information processing and evaluation	13	33	5	51
Containment and surveillance	6	46	8	60
Others	7	48	2	57
Total	74	260	38	372

Under POTAS tasks, the United States provided over $31 million in assistance through 1983. Of this amount, about $14.5 million was for equipment-related tasks, which consisted of the following component parts.

$8.4 million	for equipment hardware
$4.5 million	for procedures, manuals, testing, and other technical aspects
$1.6 million	for equipment experts

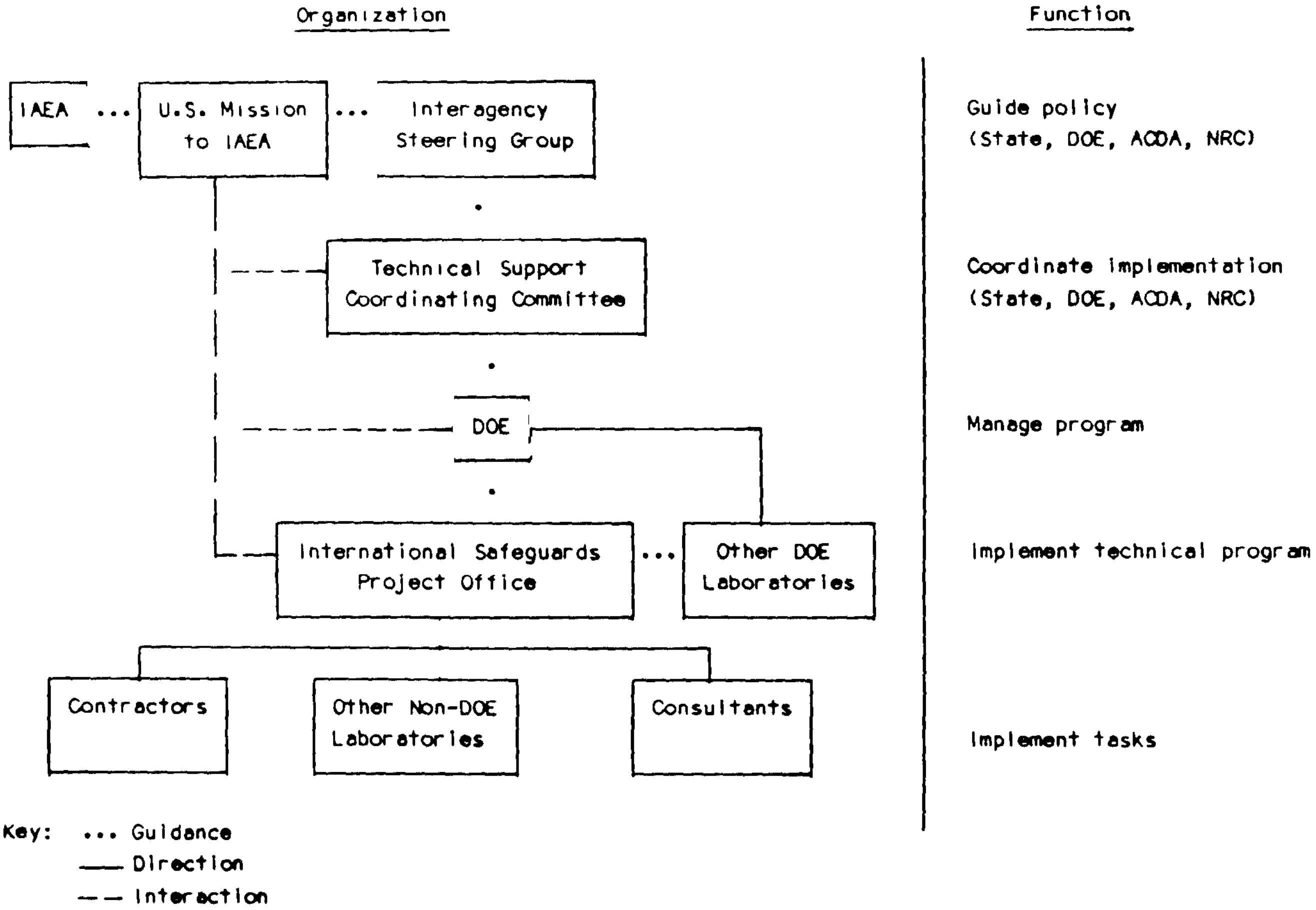
Program management and organization

The Departments of State and Energy, ACDA, and NRC each has roles within POTAS. General policy guidance is provided by an Interagency Steering Group, chaired by State. The Technical

Support Coordinating Committee (TSCC), also chaired by State, with representatives from DOE, ACDA, and NRC is responsible for detailed policy guidance and oversight of the Program. The TSCC meets monthly to discuss program implementation. POTAS is funded under the Foreign Assistance Act appropriation; DOE provides overall program management and distributes program funds, with technical supervision delegated to ISPO at Brookhaven; and ACDA and NRC contribute managerial and technical resources to developing and implementing the POTAS plan. The relationships of these and other organizations involved are illustrated below.

Laboratories participating in POTAS include Los Alamos National Laboratory, Sandia National Laboratories, Argonne National Laboratory, Battelle Pacific Northwest Laboratory, Brookhaven National Laboratory, Idaho National Engineering Laboratory, Mound Laboratory, Oak Ridge National Laboratory, and Lawrence Livermore National Laboratory. The safeguards programs at these facilities reflect individual areas of specialization. For example, Los Alamos specializes in nondestructive assay measurement equipment, and Sandia in containment and surveillance devices.

POTAS ORGANIZATIONS



Program evolution

Although POTAS was started as a 5-year program of very limited life, its focus has changed and it has evolved into the primary mechanism through which the United States provides direct technical safeguards assistance to IAEA.

Initially, POTAS provided equipment and other assistance to meet IAEA's urgent needs. However, a significant time gap developed between the U.S. completion of a type of equipment and its routine use in inspections by IAEA. (See ch. 4.) As a result, POTAS has begun to emphasize getting equipment into routine use. For example, nearly 13 percent of the new tasks (4 of 31) in the 1983 POTAS plan involve equipment implementation, while as recently as 1980, only 2 of 58 tasks involved equipment implementation.

Another current POTAS emphasis is on cost-free experts (CFEs)[1] provided to IAEA. In the 1983 plan, about 36 percent (11 of 31) of the new tasks involved CFEs. Both U.S. and IAEA officials state that CFEs are vital. They perform a variety of roles at IAEA, though mainly related to equipment needs and uses and to training safeguards inspectors. (See further discussion on greater use of CFEs in ch. 4.)

Equipment developed under POTAS

Since POTAS was initiated, the United States has provided IAEA with 21 different types of safeguards equipment. (See table on pp. 25-28.) These 21 types fall into two general categories: nondestructive assay (NDA) equipment and containment/ surveillance (C/S) devices.

Nondestructive assay equipment

NDA measures the general or specific nuclear material contents of an item without physically affecting the item. This is generally done by measuring the radioactive emissions or externally induced responses from the item and then comparing the measurement with a calibration based on essentially similar items whose contents have been predetermined through chemical analyses. NDA is essential for IAEA to measure, for example, the contents of a facility-owned $250,000 fuel assembly. Since the facility operator is reluctant to allow any handling or movement of the fuel assembly, and disassembly to obtain and destructively test a sample is not feasible, chemical analysis

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[1] Cost-free experts are provided to IAEA by member nations through mutual agreement. They perform work at no direct cost to IAEA.

of a material sample is impossible. NDA might also involve measuring plutonium when removal of a large number of samples for shipment to Vienna for chemical analysis is impractical.

Although IAEA does perform chemical analysis of inspector-acquired nuclear samples, most measurements are obtained by NDA. In 1982, IAEA chemically analyzed 870 samples of plutonium and uranium while more than 60,000 items of nuclear material of widely varying content were subjected to NDA.

Under POTAS, the United States has developed 14 types of NDA equipment for measuring uranium and plutonium in their various chemical forms and within their various containers. A few are described below. Appendix II contains a brief description of each type.

One NDA method involves measuring neutron activity, which is related to the amount of nuclear material present. The Los Alamos National Laboratory, through its basic DOE research program and POTAS, developed and designed a "family" of instruments for neutron measurements. This family-tree concept uses a single electronics package with different measuring instruments and "special heads" (needed to accommodate the various shapes and sizes of nuclear material containers). This approach is intended to simplify the IAEA inspector's job because the operating principles of the unit are basically unchanged. The electronics package (see p. 16) consists of a Hewlett-Packard programmable calculator and a shift-register coincidence counter.[2]

The family tree for neutron assay is shown on page 17. The various boxes represent special heads or different instruments which have been developed for 11 of the 19 measurement applications identified.

Another innovation, brought about by the growth of computer technology, incorporated into POTAS-designed equipment is the concept of "smart" equipment. Los Alamos now designs equipment which can prompt or lead the inspector through the various steps in using the equipment. In the language of today's home computer industry, these instruments are "user friendly." The mini-MCA (Multi-Channel Analyzer) is one of the first types of

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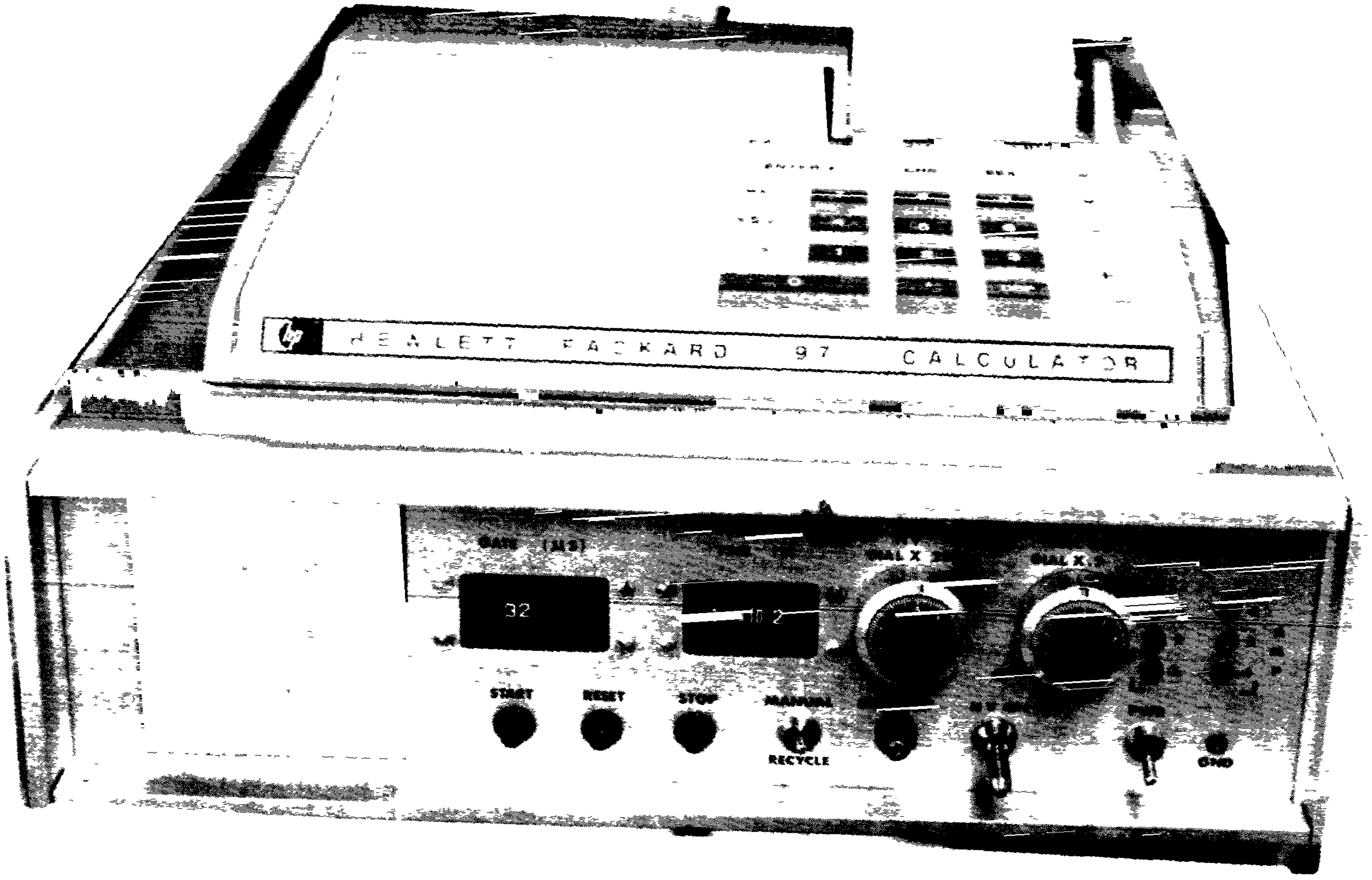
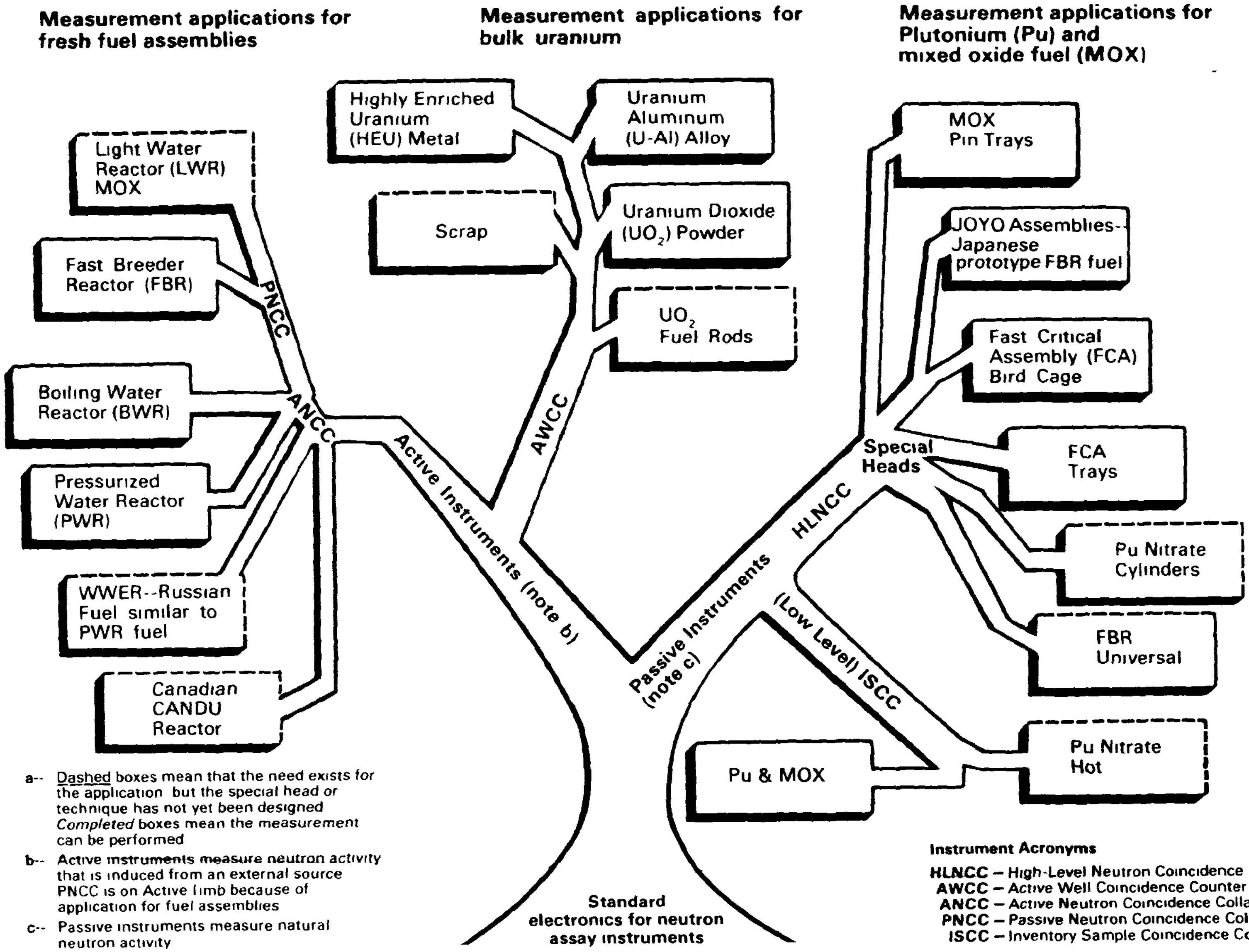
[2] The coincidence counter differentiates neutrons emitted by the uranium and/or plutonium in the sample material from neutrons originating from other sources, such as other materials in the sample container or the room background.



Standard Electronics for "Family" of Neutron Assay Instruments

FAMILY TREE FOR NEUTRON ASSAY (note a)



Notes

a-- Dashed boxes mean that the need exists for the application but the special head or technique has not yet been designed *Completed* boxes mean the measurement can be performed

b-- Active instruments measure neutron activity that is induced from an external source PNCC is on Active limb because of application for fuel assemblies

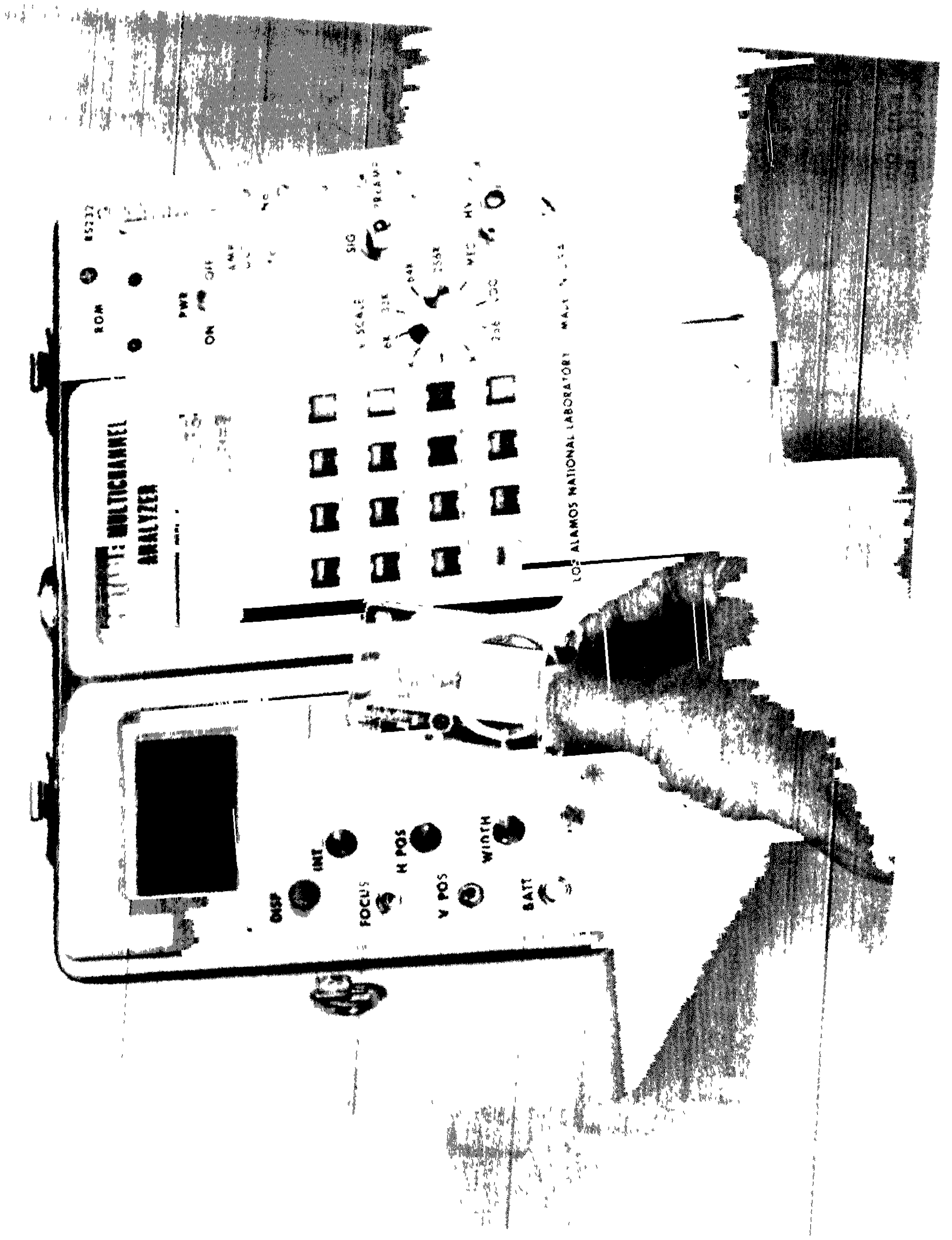
c-- Passive instruments measure natural neutron activity

Instrument Acronyms

HLNCC – High-Level Neutron Coincidence Counter
AWCC – Active Well Coincidence Counter
ANCC – Active Neutron Coincidence Collar
PNCC – Passive Neutron Coincidence Collar
ISCC – Inventory Sample Coincidence Counter

Source Los Alamos National Laboratory

NDA equipment to include the "smart" approach. The mini-MCA is a portable, battery-operated analyzer that records, analyzes, and displays data. It leads the inspector through step-by-step procedures for the specific measurements and calculations needed to determine the nuclear material involved and for diagnosing the equipment for any functional problems. It also monitors and records data on its own internal status. It weighs only 18 pounds and is the size of about two shoe boxes. (See photograph below.)



Mini Multi-Channel Analyzer (Mini MCA)

Containment and/or surveillance devices

IAEA's C/S devices[3] generally fall into two categories: containment seals and surveillance devices. Seven types of C/S devices have been provided to IAEA through POTAS. A few are described below, while appendix III briefly describes each type.

POTAS has developed three types of seals for IAEA use. The improved type-E seal and the type-X seal are in use; the electronic seal is not. (Development of the electronic seal was terminated before completion because it would have been too costly for IAEA to procure.) Seals are used extensively in IAEA's safeguards program. In 1982, IAEA applied and subsequently verified the integrity of more than 6,000 seals.

Pictured on the next page are the two versions of the type-E seal and the type-X seal. The inside of each seal's cap is randomly marked and this characteristic signature is recorded before the seal is used at a nuclear facility. IAEA verifies that the seal has not been tampered with and also verifies that it is indeed the original seal by examining the recorded signature.

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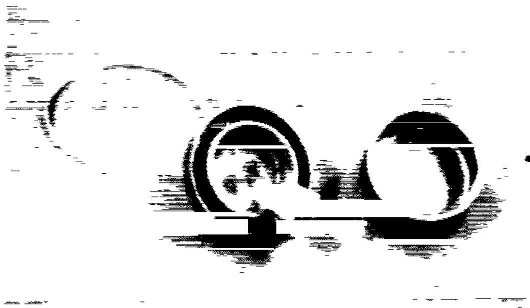
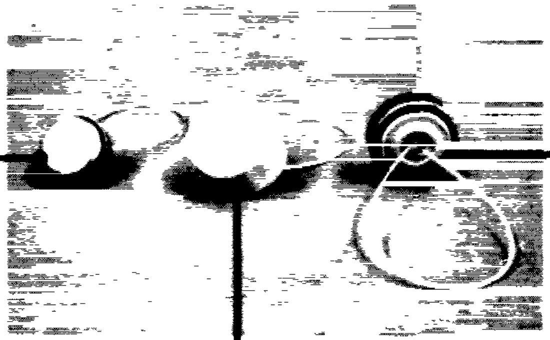
[3] Containment--physical barriers, such as containers and transport flasks, which act to restrict or control the movement of or access to nuclear material, information related to quantities or locations of nuclear material, or IAEA surveillance devices.

Surveillance--the collection of information through devices and/or inspector observation in order to detect undeclared movements of nuclear material, tampering with containment, falsification of information related to locations and quantities of nuclear material, and tampering with IAEA safeguards devices.

SEALS



Type E seal with resin



Double cap type E seal

Type X seal

The principal optical surveillance device (in terms of development cost and eventual procurement) developed under POTAS is the Surveillance Television and Recording (STAR) system. It provides unattended optical surveillance by two closed-circuit television cameras linked to a central control console. The entire unit is tamper resistant (it would register any tamper attempts) and, if necessary, can run on batteries. (See photograph on next page.)

Adequacy of POTAS-developed equipment

The adequacy of NDA equipment and C/S devices can be viewed from a variety of perspectives and can be based on a variety of definitions of the term "adequacy." The combination of the two factors--who is judging and on what basis--can result in different views of adequacy.

DOE officials told us that the United States has no overall criteria for determining the adequacy of equipment. Rather, for each type of equipment, a plan is devised for how it should operate, and the equipment is tested against that plan. In the final analysis, perhaps the ultimate judge of "adequacy" is the user (IAEA) and the degree to which IAEA integrates a type of NDA equipment or a C/S device into its safeguards efforts.

U.S. and IAEA officials generally agree that IAEA can now better safeguard more facilities and more types of facilities than in 1976 when the U.S. support program was initiated. According to IAEA, it had 4 types of safeguards equipment in 1975; today it has over 30. (As discussed in ch. 3, not all equipment is U.S.-supplied.) However, gaps still exist in IAEA's capabilities, and further efforts will be needed to close or narrow them.

Quantitative and qualitative adequacy

The adequacy of U.S.-supplied safeguards equipment can be viewed quantitatively and qualitatively. Quantitative adequacy involves the accuracy and/or precision of measurements.[4] It is generally used in connection with NDA equipment. Qualitative adequacy involves such factors as ease of use and transportability. Both quantitative and qualitative factors, however, must be considered in determining equipment adequacy. For example, poor transportability (too big or too heavy for an inspector to handle) could prevent the use of equipment with outstanding accuracy and precision.

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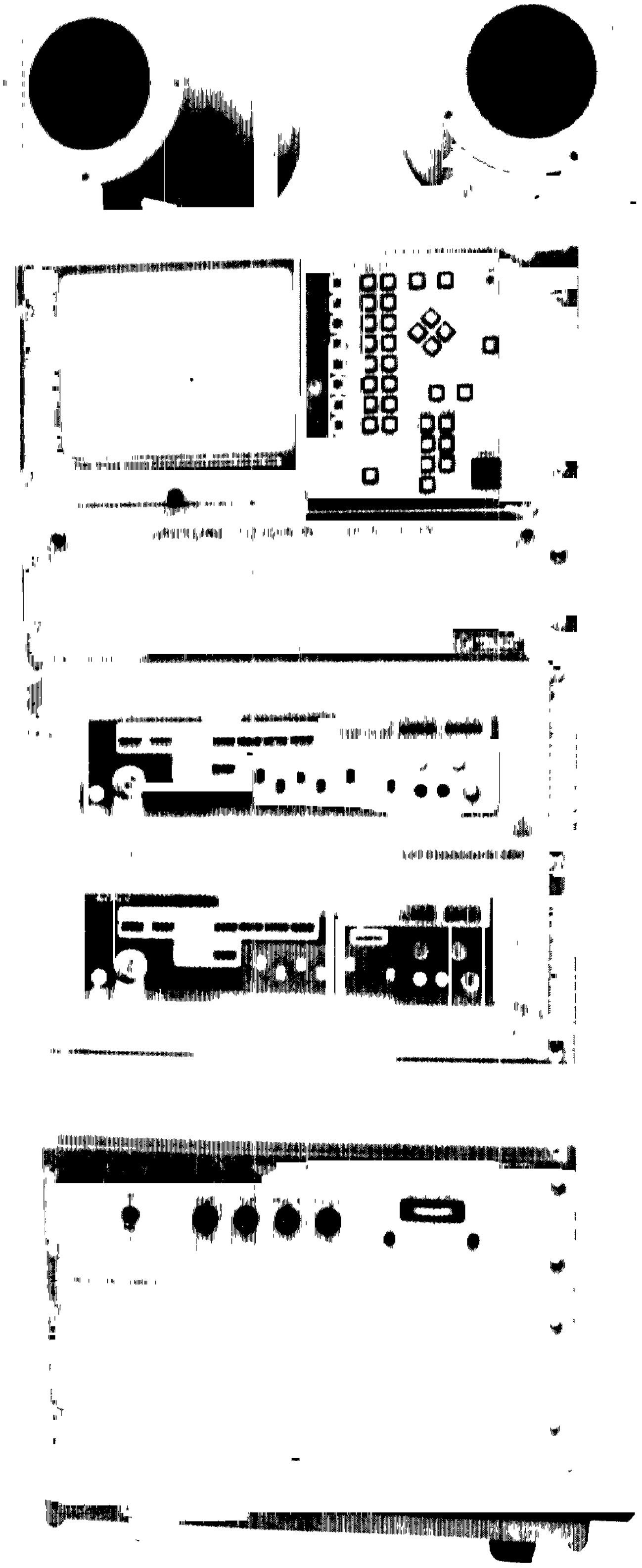
[4] Accuracy is determined by how far one measurement deviates from the true value of what is being measured.

Precision refers to the repeatability of the results of a single measurement over several trials.



Surveillance Television and Recording (STAR) System

In a previous report on international safeguards,[5] we discussed the quantitative adequacy of a number of types of NDA equipment. Based on information developed by Los Alamos National Laboratory, most of the equipment was shown to have high rates of accuracy and precision. For example, the High-Level Neutron Coincidence Counter (HLNCC) was shown to have an accuracy between 0.5 and 3 percent and precision between 0.2 and 1 percent depending on such variables as the size of the sample and the length of the measurement interval. The Active Well Coincidence Counter (AWCC) was shown to have both an accuracy and precision between 0.5 and 4 percent. It is also dependent on the sample size and measurement interval.

Qualitative adequacy is more difficult to define because it involves a number of characteristics, some of which are highly subjective. DOE officials identified the following list with related questions to help define the characteristics.

1. Reliability	What is the failure rate of the equipment? How likely is it to give a false alarm?
2. Maintainability	How difficult is it to maintain or repair? What are its service needs?
3. Operability	How simple is it to operate? How willing is the inspector to use it?
4. Cost	What does it cost? What is its availability?
5. Transportability	How much does the piece of equipment weigh? How rugged is it?
6. Environmental impact	How intrusive is the equipment or measurement application? Does it require plant modifications?
7. Personal bias	Does the IAEA staff involved like and trust the equipment?

There is no generally accepted way to balance these characteristics into an overall judgment of qualitative adequacy.

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[5] International Nuclear Safeguards Need Further Improvement (C-ID-81-4), Feb. 13, 1981.

IAEA acceptance

Since POTAS-furnished equipment is intended to meet IAEA needs, perhaps the best measure of adequacy is the degree to which equipment is accepted by IAEA and integrated into its programs. This view is tempered somewhat by factors, such as budget constraints, which are extraneous to the consideration of equipment adequacy but which can adversely affect getting equipment into use. The table on pages 25-28 summarizes the degree of use (under "Implementation status") of U.S.-supplied equipment and lists its cost, availability, applications, and limitations. In summary, 15, or 71 percent, of the 21 types of POTAS-furnished equipment or devices are in varying degrees of use (or available for use) by IAEA. Another 2, or about 10 percent, are still being tested and evaluated. Four, or about 19 percent, are not now being used or intended for use.

Views on selected POTAS-supplied equipment

Throughout our work, we received comments about several types of equipment that were viewed as especially successful or not-so-successful. Many of the comments related to adequacy, especially qualitative.

Among the identified successes are the following:

--HLNCC and AWCC. These are in the family of neutron assay instruments, which has a common set of electronics. The HLNCC is one of the most sophisticated NDA instruments, yet it was put into use quickly. It subsequently required more work, however, when it was discovered that certain surrounding electrostatic noise could distort the calculations. This problem has been corrected. The AWCC was recently put into use and is described by IAEA inspectors as "working well." The AWCC uses an active neutron source. Its use, therefore, requires permission to bring this source into the country where the material to be measured is located.

--Mini-MCA. An IAEA division director described the mini-MCA as "very useful, especially very portable." It employs the "smart" concept and can help overcome the current lack of well prepared and written handbooks and manuals. (See ch. 4.)

Equipment Provided to IAEA Through POTAS Program

Equipment	Number provided to IAEA	Number purchased by IAEA	Implem. status	Comm. avail- ability	Approx. cost/unit	Application	Limitation	Applicable facilities [a] A	B	C	D	E	F	G	H
NDA EQUIPMENT·															
BSAM (Brookhaven Stabilized Assay Meter)	5	3	Not in use	Yes	$10,000	Unirradiated U and Pu (gamma ray and neutron measurements).	Replaceable with Mini MCA. Commercial units unusable.	X	X		X		X	X	X
Hand-held Ge (Germanium) Detector Probe	2	1	Available for use	Yes	15,000	Unirradiated and irradiated U and Pu (gamma ray measurements).		X	X		X	X	X	X	X
SAMson (Stabilized Assay Meter)	4	7	In use	Yes	8,000	Confirms presence of U and measures its enrichment (gamma ray measurements).	Replaceable with Mini MCA.	X	X		X		X	X	X
Mini MCA (Multi-Channel Analyzer)	3	5	In test and evaluation (T&E)	Yes	10,000	General gamma ray and particle spectrometry. Can measure U-235 enrichment as well as radioactive material in any form.		X	X		X		X	X	X
HLNCC (High Level Neutron Coincidence Counter)	7	11	In use	Yes	50,000	Assay of Pu (neutron measurement) in high content masses. Total Pu content is calculated from Pu 240 isotopic composition. Passive measurement.	Coincidence portion of electronics package needs to be made more rugged for transportation. Sometimes does not work after travel.		X			X		X	X
AWCC (Active Well Coincidence Counter)	3	0	In limited use	Yes	60,000	Measures U-235 content in HEU samples. Active measurement of neutrons. (Neutron source added to induce activity.)	See HLNCC.		X		X				

Equipment	Number provided to IAEA	Number purchased by IAEA	Implem. status	Comm. Avail-ability	Approx. cost/unit	Application	Limitation	Applicable facilities [a] A	B	C	D	E	F	G	H
COLLAR (Coincidence collar)	3	5	In limited use	Yes	$58,000	Measures U-235 content in full LWR fuel assemblies. (Neutron source added to induce activity.)	See HLNCC. Must be calibrated in U.S., which can negate any savings as a result of international competitive bidding.	X			X				
Micro-computer (Portable microprocessor)	2	-	In T&E	No	80,000	Analyzes Pu gamma ray spectra recorded by Silena MCA.	Only usable with Italian-made Silena MCA.		X	X	X				
SGS (Segmented Gamma Scanner)	2	-	In use	Yes	90,000 (1979 $)	Measures the quantity of fissile material in containers of waste (usually cans or bottles). Gamma ray measurements.	Not portable. One unit in use at IAEA's analytical laboratory, but not in IAEA's safeguards program.								
Semiportable cylinder load cell	4	6	In use soon	Yes	40,000	Designed for weighing 2.5 metric ton UF_6 shipping cylinders.									
ION-1	3	-	Avail. for use	No	8-9,000 (Los Alamos)	Measures gross gamma ray and neutron signals of spent fuel contained in spent fuel ponds either at reactor or away from reactor sites.	Detector becomes contaminated in spent fuel pond. Must either leave it in water or go thru decontamination after each use.	X	X			X			
Cerenkov night viewing device	4	12	In use	Yes	6,000	Obtains information about Cerenkov glow from spent fuel assemblies.	Requires dimming or elimination of lighting in spent fuel pond room. This has caused problems with some facility operators. Assures presence of radioactive material--cannot determine exact material or quantity.	X	X			X			

Equipment	Number provided to IAEA	Number purchased by IAEA	Implem. status	Comm. availability	Approx. cost/unit	Application	Limitation	Applicable facilities [a]							
								A	B	C	D	E	F	G	H
Underwater Viewer	1	-	Avail.	Yes	$10,000	Provides means to read serial numbers of fuel assemblies in storage ponds.		X	X			X			X
Calorimeters	3	-	In very limited use	No	80,000 (Argonne)	Assay Pu in solid form by measuring the heat output per unit mass.				X					
C/S DEVICES:															
Semi-automatic Film Scanner	1	-	Not now in use	No	25,000	Automatic video analysis of recorded data from C/S cameras.	Difficult to operate. Noisy.								
Battery-Operated TV	1	-	Not used	No	10,000	Monitoring an activity by a battery-operated closed circuit television system for up to 24 hours.	Only produced prototype. Unit accidentally burned during test and evaluation.	X	X					X	X
STAR (Surveillance Television and Recording System)	6	10 on order	5 in use by 11/83	No	63,000 (Sandia)	Provides unattended optical surveillance via 2 closed circuit television cameras and a central control console.	Since not available commercially, SNL will assume responsibility for production of any additional units. Relatively complex equipment requiring high technical competence for maintenance and repair.	X	X			X	X	X	X

Equipment	Number pro-vided	Number pur-chased	Imple-mentation status	Comm. avail-ability	Approx. cost/unit	Application	Limitation	Applicable facilities [a] A	B	C	D	E	F	G	H
Reactor Power Monitor	1	-	In very limited use	No	$10,000 (Los Alamos)	Provides operator-independent history of power output of a nuclear power reactor.	Has been used in one situation. Questions exist on political acceptability. Are planning test and evaluation in 1984.	X	X						
Electronic Seal	10	-	Not currently planned		Unavailable	Safeguards seal.	Very limited application due to projected high unit cost.								
Type X Seals	500	-	Available for use	Yes	6	Safeguards seal.	Integrity cannot be checked on site.	X	X		X	X	X	X	X
Improved Type E Seals	1,000	25,000	In use	Yes	2	Safeguards seal.	Integrity cannot be checked on site.	X	X		X	X	X	X	X

[a] A Power reactors
B Research reactors and critical facilities
C MOX or HEU fuel fabrication facilities
D LEU fabrication plants
E Reprocessing plants
F Enrichment plants
G Separated storage facilities
H Other facilities

Another IAEA official said that although it was not developed quickly, it was developed steadily and resulted in a quality instrument which reflects what inspectors want. Inspectors told us they are comfortable with the mini-MCA.

--Cerenkov viewing device. This instrument allows the inspector to determine visually that used fuel assemblies do contain radioactive material without the need to have each assembly lifted from the storage pool for individual NDA measurements. It was a major step beyond item counting and number identification. The Cerenkov viewing device was put into use very quickly, but then a problem was discovered. For best results, the lights in the spent fuel pool area must be off. According to some facility operators, this creates a potentially dangerous work environment. Both POTAS and the Canadian support programs have been working to correct the situation. A solution appears likely.

Among the not-so-successful types of equipment identified are the:

--BSAM. According to some IAEA inspectors, the BSAM is unreliable. Others at IAEA feel it was an ill-advised piece of equipment. Even after the BSAM was available for use, inspectors seemed to prefer the lighter, more reliable SAMson, another POTAS-developed item which was an outgrowth of the BSAM. Before the BSAM's problems could be satisfactorily solved, the mini-MCA was introduced and touted as the BSAM's replacement. Instead of encouraging the BSAM's use, IAEA decided to wait for the more technologically sophisticated mini-MCA.

--Semi-automatic film scanner. According to an IAEA official, the scanner did the job it was designed for and was implemented quickly. However, it was not accepted by the inspectors. According to an IAEA official, it was removed from use recently because no inspector had used it in 6 months. One inspector, who had used the scanner and liked what it could do, claimed that the noise level was so high that it would "drive you from the room after a couple of hours."

--Reactor power monitor. This device was never put into routine use. Among the reasons are the need for more technical development and questions about its political acceptability in some countries. Also, some countries felt it would gather information not germane to safeguards but of a proprietary or business sensitive nature. According to IAEA, the monitor is now being put through a test and evaluation process--almost 4 years after the first Class III (test and evaluation model) was delivered to IAEA.

"Closing the gap"

A final view of adequacy judges equipment not on the basis of performance or acceptability to the user but rather on whether it helps fill a "gap" in safeguards. The officials holding this view feel that if a type of equipment helps fill a safeguards need, it is adequate for safeguards purposes. For example, despite its current operating limitation, the Cerenkov viewing device helps close the gap in safeguarding spent fuel. Thus, it is adequate.

A U.S. official said that "closing the gap" is a moving target. As technologies spread (enrichment or reprocessing) and new technologies develop (breeders and heavy water production), IAEA's tasks change and initially it may not be able to safeguard those technologies as well as it can safeguard the more traditional nuclear facilities, such as light water reactors. Viewed in this way, new and improved equipment will likely be needed for the foreseeable future as nuclear technologies continue to evolve. Areas identified as most in need of safeguards improvements involve fuel fabrication, enrichment, and reprocessing plants. These types of plants are difficult for IAEA to safeguard because of the high throughput of nuclear material in bulk quantities.

SOME EQUIPMENT ALSO DEVELOPED UNDER OTHER U.S. EFFORTS

POTAS is not the only U.S. program developing safeguards equipment or supporting other IAEA activities. DOE's regular safeguards research and development program, which receives $5 million to $6 million annually, also develops equipment. Many of DOE's projects may have international uses and ultimate IAEA interest; however, they are domestically oriented. For example, Sandia National Laboratories recently developed a passive environmental monitor which can be used in domestic facilities. IAEA has also expressed an interest in this instrument. In commenting on our draft report, DOE stated that a "different, larger DOE program funds research and development and technical support for domestic safeguards by DOE contractors, and the spin-off from that program frequently contributes to international safeguards."

ACDA and NRC sponsor safeguards work which can potentially benefit IAEA, such as the ACDA-sponsored RECOVER project discussed below.

Over the years, the United States has also provided other assistance to IAEA safeguards programs, including

--efforts through groups such as the Nuclear Suppliers Group to extend the application of IAEA safeguards;

--participation in IAEA's Standing Advisory Group on Safeguards Implementation and various consultant and advisory group meetings on safeguards topics;

--development and promotion of multinational, regional fuel cycle centers and international regimes for spent fuel or plutonium storage; and

--implementation of the voluntary agreement for application of IAEA safeguards at all U.S. nuclear facilities, except those of direct national security significance.

In addition, the United States has been involved in three specific multilateral projects designed to help improve IAEA safeguards--RECOVER,[6] TASTEX, and Hexapartite.

RECOVER

ACDA initiated the REmote COntinual VERification program in 1976 to help IAEA make better use of its limited number of inspectors by addressing the problem of C/S device failures. RECOVER was intended to improve IAEA safeguards by remotely

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[6] See our report RECOVER: A Potentially Useful Technology For Nuclear Safeguards, But Greater International Commitment Is Needed (GAO/ID-83-9), Jan. 25, 1983.

monitoring the status of C/S devices and transmitting status data to IAEA headquarters. Although RECOVER had generally not been considered an urgently needed project by U.S. and IAEA officials, ACDA believed that RECOVER could be of long-term benefit for international safeguards. (U.S. officials concluded that RECOVER had little utility for U.S. domestic safeguards.)

As conceived by ACDA, RECOVER would involve the use of a central component at IAEA headquarters. Through the international telephone system, this central unit would automatically contact smaller RECOVER components located at various nuclear facilities around the world. The facility components would have already collected and stored information obtained from monitoring units attached to C/S devices. For example, if a camera monitored by RECOVER were to fail, the monitoring unit would detect the failure and store that data until contacted by the facility component. The monitoring unit would then transmit the data to the facility component which, in turn, would store the data until polled by the central unit. An alert would be flashed on the display screen at IAEA headquarters, and IAEA could then decide how to respond.

ACDA's concept also included a portable verification unit to enable an on-site inspector to tap into the facility component and obtain up-to-date information.

IAEA cooperated with ACDA in testing and evaluating the RECOVER prototype. In November 1980, ACDA, IAEA, and representatives of six other IAEA member countries[7] conducted an international test of RECOVER. Testing continued through 1982, with participants meeting annually in Vienna to discuss the project. According to an IAEA official, RECOVER never reached the stage of development required for IAEA use and therefore was never officially accepted for safeguards use.

Between 1976 and 1982, ACDA funding for RECOVER amounted to about $4.1 million. For fiscal year 1984, ACDA has relinquished the RECOVER project. According to ACDA and DOE officials, RECOVER, as an international system feeding information to Vienna, has been discontinued. Under POTAS, however, the United States is going to look at remote monitoring in a more general sense and focus on local or regional systems. The knowledge gained during RECOVER will be used, but according to laboratory officials, new equipment will have to be developed.

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[7] Australia, Bulgaria, Canada, West Germany, Japan, and the United Kingdom. A facility located in Austria also contributed to the test.

TASTEX

From 1978 to 1981, Japan, the United States, France, and IAEA conducted the Tokai Advanced Safeguards Technology Exercise (TASTEX), aimed at improving the technology for applying international safeguards at reprocessing facilities. The Japanese Tokai Reprocessing Facility was the test facility.

The U.S. participation was coordinated through POTAS, and the ISPO office was responsible for technical supervision and task implementation. U.S. investment in TASTEX was $1.8 million.

IAEA's final TASTEX report, issued in mid-1982, concluded that

--significant progress was made in assessing the technologies involved in each task in terms of their applicability and utility to IAEA safeguards at the Tokai reprocessing plant and

--TASTEX had accomplished its purpose and had been a successful program in international cooperation for the improvement of safeguards technology.

The United States is continuing work begun under TASTEX and is focusing on assisting IAEA in implementing the safeguards equipment developed under it. For example, a 1983 POTAS task has the objective of providing IAEA with a compact K-edge densitometer for measuring plutonium concentrate in plutonium nitrate. The K-edge densitometer was developed during TASTEX.

Hexapartite

In 1980, the Hexapartite Safeguards Project began as a U.S. initiative to develop a safeguards approach for gas centrifuge uranium enrichment plants. Other participants were Japan, Australia, URENCO (a consortium involving the Netherlands, United Kingdom, and West Germany in a uranium enrichment facility), and the inspectorates of IAEA and EURATOM.

One of the principal questions the project addressed was the extent to which access by IAEA inspectors could be permitted within the enrichment area, since enrichment technology is extremely sensitive and, therefore, closely guarded. The participants focused on "limited frequency, unannounced access" as the best approach for accomplishing safeguards effectively and efficiently while also protecting the technology. Actual access within the enrichment area will be "specified" in a formal agreement between IAEA and the facility. The specified access will outline the inspector's route, frequency of visit, and type of inspection activity inside the enrichment cascade area.

The Hexapartite project was completed in 1983 and judged successful by U.S. officials. Agreement was reached on the acceptability of limited frequency, unannounced visits. No new equipment or equipment-dependent concepts were developed as part of the Hexapartite project. However, this is not to say that new equipment may not become necessary to adequately inspect enrichment facilities.

CONCLUSIONS

Through POTAS, the United States has provided IAEA with 21 types of safeguards equipment, most of which are in some degree of use. A few have significant limitations. On the whole, however, the POTAS-furnished equipment should help IAEA improve the efficiency and effectiveness of its safeguards inspections. The United States, together with other equipment developers' support programs, is providing IAEA with more and better tools with which to conduct its safeguards operations. However, with the constant evolution of nuclear technology, the need for new and/or improved techniques and equipment will continue.

The recent change in the focus of POTAS was a logical step evolving from experience showing that IAEA needed assistance in getting equipment into use after it was developed. The problems involved and the efforts to overcome them are discussed in more detail in chapter 4.

CHAPTER 3

THE UNITED STATES IS NOT THE ONLY COUNTRY ASSISTING IAEA SAFEGUARDS EFFORTS

Although the United States has the oldest and largest special safeguards support program, it is not alone in its efforts to provide technical assistance to IAEA. Many IAEA member nations have increased their interest in improving IAEA safeguards. By mid-1983, eight other nations and one multinational organization had formal programs supporting IAEA safeguards. These programs totaled an estimated $50 million through 1983 and were sponsored by Australia, Belgium, Canada, France, Japan, the United Kingdom, U.S.S.R., West Germany, and EURATOM.

In addition, a number of other nations have contributed in lesser degrees and amounts to IAEA's safeguards program. They have (1) provided facilities for demonstrating and/or field testing equipment, (2) provided expertise for various procedural or system development efforts, (3) helped with the development of seals and other devices, or (4) participated in international projects, such as RECOVER, TASTEX, and Hexapartite.

The trend toward formal programs gives IAEA the opportunity to better plan and control its safeguards development activities. To extract the maximum benefit, these programs must be well coordinated to avoid unnecessary duplication and wasted efforts and to facilitate the free exchange of information. This is especially important because in a number of cases, more than one country assists IAEA in the same aspect of safeguards research and development. IAEA began to improve coordination with the 1983 conference for the program coordinators from each of the 10 formalized support programs. Such meetings are especially important because of the recent growth of assistance activities and IAEA's hoped-for increase in the aggregate level of such assistance.

SUPPORT PROGRAMS AND OTHER ASSISTANCE

According to IAEA officials, safeguards would be in great difficulty and IAEA would not be able to fulfill its safeguards obligations without the support programs. Moreover, IAEA officials said further support will be needed in the future.

Contributors have assisted IAEA's safeguards mission in various ways. According to U.S. officials, many other contributors are primarily interested in developing safeguards equipment or techniques for those types of facilities which they operate or export. Each of the 10 formal programs and the activities of 12 other contributing countries[1] are briefly described in the

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[1] These 12 are shown to illustrate the types of support given to IAEA. An IAEA official emphasized that a number of other nations have also assisted IAEA.

tables on the following pages. Appendix IV contains a more detailed description of the principal features of these efforts.

PROGRAM COORDINATION

Historically, coordination among the countries with special support programs has been informal and usually bilateral. Until recently, IAEA held only bilateral discussions with each country assisting its safeguards program. This bilateral approach was supplemented in June 1983 when IAEA conducted a week-long conference for the program coordinators and other representatives of the nine countries and one organization with formal IAEA support programs.

Bilateral coordination

Bilateral coordination occurs in many forms and forums. It has served, and will continue to serve, a number of useful purposes both from the standpoint of the contributing country and of IAEA. However, with the growth of support activities, the potential for unnecessary program duplication increases.

Formal bilateral U.S./IAEA coordination occurs during semiannual POTAS review meetings. These meetings are held to discuss the status of current POTAS tasks and of potential tasks for the following year. IAEA holds similar meetings with other formal support programs. U.S./IAEA coordination also occurs directly between U.S. laboratory personnel and IAEA staff by telephone, through the ISPO officer located at the U.S. Mission to IAEA, and/or at international conferences and conventions.

The United States coordinates with other nations' support programs through formal meetings of program managers and through informal discussions by laboratory staffs. The United States, through ISPO, has established contact with a number of the other support programs and regularly exchanges program plans and other information. These exchanges have furthered cooperation between the United States and other countries and have helped to prevent unnecessary duplication. For example, the United States and Canada are cooperating on the development of a seal and seal reader for Canadian-designed reactor fuel assemblies. Canada is developing the seal and Sandia National Laboratory is developing the seal reader.

In another example, as a result of bilateral coordination, the United States stopped development work on a particular camera because the West German program was making better progress on a similar-type task. Notwithstanding "successful" bilateral coordination, the potential for unnecessary duplication increases as the work burden rises on the IAEA staff responsible for monitoring development efforts by the growing number of support programs. This type of concern led to an initial effort at formal multilateral coordination.

FORMALIZED SPECIAL ASSISTANCE PROGRAMS
ASSISTING IAEA'S SAFEGUARDS MISSION

Country	Year formalized	Budget[a]	Description of program or activity	Cost-free experts to IAEA	System studies	Training
Australia	1980	$600,000 total	Enrichment plant safeguards. One-time contribution to International Plutonium Storage study. RECOVER and Hexapartite participant.	Yes (1 CFE)	Yes	
Belgium	1983	Unavailable	Field tests of U.S.-developed equipment. Tasks to be defined and initiated in 1984.			
Canada	1977	$15.4 million total	Developing, providing, and installing safeguards equipment for all Canadian-designed reactors in operation or under construction worldwide in 1977. Participated in RECOVER demonstration.	Yes (1)	Yes	Yes
EURATOM	1981	$4 million annually	Aims at exchange of technical experiences. Participant in Hexapartite project.			Yes
France	1983	Unavailable	Participated in TASTEX. Specific tasks to be defined and initiated in 1984.			
Japan	1981	$4 million total	Safeguard system designs and safeguard approaches. Data collection, treatment, and evaluation. Measurement methods and techniques. Containment and surveillance devices. Participated in TASTEX, Hexapartite, and RECOVER.	Yes (2)		
United Kingdom	1980	$1 million annually	Safeguards for those parts of the nuclear power program with which U.K. is particularly experienced, i.e., fast breeder reactor and its fuel cycle, enrichment plants, and nuclear fuel storage. RECOVER and Hexapartite participant.	Yes (1)		Yes
United States	1976	More than $31 million total	Developing, testing, and providing prototype safeguards equipment. Elaborating on techniques and procedures for equipment use and evaluation. Software equipment in support of IAEA safeguards information treatment. Has provided more than 20 kinds of equipment (NDA and C/S) for testing, demonstration, and operational use. RECOVER, TASTEX, and Hexapartite participant. First formalized national R & D program in support of IAEA safeguards.	Yes (90 staff years)	Yes	Yes
U.S.S.R.	1982	$1.4 million total	Information processing systems for nuclear material accounting and control. Nondestructive assay equipment and use techniques. Surveillance equipment. Procedures and technical measures for implementing nuclear facility safeguards.	Yes		Yes
West Germany	1978	$12.2 million total	Developing safeguards concepts and approaches for advanced nuclear facilities such as fast breeder reactors, high temperature reactors, and spent fuel reprocessing plants. Participated in RECOVER demonstration. Participant in Hexapartite project.	Yes (3)	Yes	

[a] Values shown for formal programs are in estimated U.S. dollars based on average exchange rates from the year formalized through 1983.

OTHER SPECIAL ASSISTANCE TO IAEA'S SAFEGUARDS MISSION

Country	Description of activity
Argentina	Development and application of C/S devices.
Austria	Site of IAEA. Participated in RECOVER demonstration.
Bulgaria	Field tests of equipment. Participated in RECOVER demonstration.
Czechoslovakia	Has furnished calculations of plutonium and uranium depletion.
East Germany	Inspector training.
Hungary	Safeguards procedures for specific facilities.
Italy	Field tests of equipment.
Netherlands	Participant in Hexapartite project.
Romania	Measurement techniques.
South Africa	Development and application of C/S devices.
Spain	Assistance with improved safeguards procedures.
Sweden	Field tests of equipment.

Coordinators' Conference

The first Coordinators' Conference was held at IAEA headquarters in June 1983 with representatives from each of the 10 formalized support programs attending. According to IAEA, the increasing effort spent on support programs and the increasing number of nations sponsoring these programs led to the conclusion that a meeting of the support program coordinators could significantly benefit program results. IAEA expected the meeting to contribute to improving the flow of information, avoiding duplication of mistakes, improving personal relationships among researchers and administrators working on the programs, and improving communications among the program coordinators and IAEA's Department of Safeguards.

The opening statements by the national representatives expressed a number of themes, including:

1. An appropriate degree of program overlap is acceptable and expected.

2. The second generation of safeguards equipment is approaching.

3. IAEA needs assistance in getting developed equipment into use.

4. Better coordination is needed.

During the conference, we noted that:

1. Discussions appeared to be open and frank.

2. Participants gained new knowledge or had old knowledge updated/reconfirmed. For example, one participant was either unaware or had forgotten that nearly all POTAS reports are generally available. The resulting discussion led to the consensus that most reports from all the programs are available--the few exceptions are due to classification or technological sensitivity.

3. All participants took part in the discussions.

4. Participants generally agreed on the need for additional multilateral meetings which should focus on more technical aspects of the programs.

5. Attendance at each session was nearly 100 percent from beginning to end, indicating that the participants thought the meeting was useful, informative, and important.

After a week of discussions covering the many functions of IAEA's Department of Safeguards, how support programs are used, the general descriptions of the individual programs, and IAEA's needs for future equipment and/or services, the participants unanimously agreed that more coordination is needed and that this type of coordination should continue. IAEA said it would do its part to ensure that periodic, multilateral coordination continues.

Other coordination media

Information exchanges also occur at the annual meetings of two international organizations.

The Institute of Nuclear Materials Management, with members from 13 nations, sponsors an annual summer meeting in the United States. At its conference in July 1982, managers of several support programs met informally and agreed that there was a need for more formal coordination. This effort led to the 1983 Coordinators' Conference described above.

The second organization, the European Safeguards Research and Development Association, consists of eight organizations and is similar to the Institute in its safeguards concerns. It strives for agreement on research and development efforts within its major nuclear establishments. This Association holds an annual spring meeting in Europe at which members and other interested parties, including the United States, present papers on safeguards topics.

CONCLUSIONS

The United States is no longer the sole provider of special safeguards assistance to IAEA. Since POTAS began in 1976, eight other nations and one multinational organization have joined the formal effort to improve IAEA's safeguards capabilities. These 10 formal programs have contributed a total of about $80 million in equipment development, cost-free experts, equipment testing and evaluation, training, and other services to support IAEA.

Coordination has occurred in several forms. The United States and IAEA coordinate both formally (POTAS review meetings) and informally. Coordination between support programs has grown from very little to regular exchanges of program plans, bilateral meetings between program managers or laboratory staffs, and the first formal Coordinators' Conference.

The need for increased bilateral and multilateral coordination has grown as the number of formal support programs has increased from 1 to 10. (Seven have been established since 1980.) Many of the support programs focus on safeguards conditions or potential problems with a country's own type of nuclear reactors, fuel cycle involvement, or other matters of self-interest. Nevertheless, the potential for unnecessary duplication has increased as the number and size of these formal programs have increased.

The 1983 Coordinators' Conference was an excellent first step in multilateral coordination. The meeting was well received and the participants generally agreed that more coordination is needed. However, they also agreed that future meetings should focus more on coordinating technical issues instead of the general programmatic discussions which took place at this first Coordinators' Conference.

The effects of coordination are often intangible, and positive results often cannot be seen in the short term. However, the initial effort seemed successful and set the stage for further exchanges of information. The broad-based sharing of technical information is especially important in view of the continuing growth of assistance activities and an IAEA hoped-for increase in the aggregate level of assistance. We believe that multilateral coordination with a technical emphasis is necessary and should enable IAEA to (1) better plan and control its safeguards development activities, (2) avoid unnecessary or undesirable duplication of future program activities, and (3) facilitate exchange of technical information about equipment under development.

RECOMMENDATION

We recommend that the Secretary of State request IAEA to further develop and implement coordination mechanisms to help achieve a fully integrated, multilateral safeguards support program among countries providing substantial support.

AGENCY COMMENTS

The Department of State agreed on the need for a more closely coordinated and integrated safeguards research and development program on the part of IAEA. State emphasized, however, that the management of each nation's technical support program remains accountable to national authorities, and although decisions regarding the allocation of resources must be made in close coordination with IAEA, such decisions cannot be delegated to IAEA.

CHAPTER 4

PROBLEMS IN GETTING EQUIPMENT INTO USE

Equipment implementation, or getting equipment into use, has been recognized as a problem for several years. As long ago as 1978, U.S. program managers noted that the "excessive slowness and limited effectiveness with which the results of research and development are generally assimilated and integrated within the IAEA safeguards system are longstanding, real problems . . . ."

The IAEA Secretariat has begun to take steps--some with POTAS assistance--to overcome a number of hindrances to equipment implementation. The corrective actions include long-range planning and development efforts for equipment and evaluation methods, reorganization of the IAEA Safeguards Department, and greater use of cost-free experts (CFEs). However, some of the hindrances to getting equipment into use are persistent and not amenable to simple solutions. U.S. officials should work to help complete a number of recent initiatives which will further progress towards effective equipment implementation.

EQUIPMENT DEVELOPMENT PROCESS

Understanding the reasons for slow equipment implementation requires an understanding of the equipment development process. According to IAEA officials, this process has five steps and there is no typical or standard development program because each type of equipment has its own unique schedule. The five steps, with IAEA-estimated timeframes, are as follows.

	Step	Time frame (months)	Range
1.	Define need and instrument objectives	2	less than 1-6
2.	Design specifications to meet purpose for support program	6	3-9
3.	Develop and construct prototype	6	3-12
4.	Fabricate field version--test and evaluate	12	6-18
5.	Implementation: --provide documentation, e.g., how to use, safety, training --get it accepted by member nations	4	3-12
		30	16-57

We previously reported that IAEA was experiencing problems in getting the results of POTAS projects into the hands of inspectors for use in the field.[1] At that time, we noted, among other things, that IAEA was having difficulty in getting beyond the test phase and into operational use. The above estimates indicate that most of the time is required to take equipment from concept through test and evaluation. Currently, all but 2 of the 21 types of safeguards equipment furnished to IAEA through POTAS are beyond the test and evaluation step. However, some of them are still not yet in widespread, routine use.

To minimize the overall equipment development timeframe, three important points were emphasized during our discussions with IAEA safeguards personnel: (1) There should be frequent and continuing contact between the developer and IAEA project officer, (2) documentation is needed to aid IAEA's review during development, and (3) field tests with IAEA inspector participation are essential to gain user perspectives.

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[1] See our report International Safeguards Need Further Improvement (C-ID-81-4), February 13, 1981.

At the end of the fifth step, the equipment is technically in "routine use." However, that designation can apply to a single piece of equipment used sporadically for a few years, such as the automatic film scanner, and to many units of a type of equipment used frequently for many years, such as 18 HLNCCs.

Even after the completion of all five steps and the routine use designation, IAEA officials said that the development of a piece of equipment is still not completed. Regardless of the amount of testing and evaluations, neither the developer nor IAEA is sure how well or how reliably an instrument will work in the field. This uncertainty highlights the need for a performance monitoring program to assess routine performance capability and to obtain feedback for improving the field reliability of the instrument. IAEA's Department of Safeguards recognizes this need and is working on a solution.

TECHNICAL ISSUES CONCERNING USING EQUIPMENT

From a technical perspective, IAEA experiences several problems which can hinder implementation of equipment. These problems involve field testing of equipment, sufficient documentation, and inspector input in equipment development. ISPO, through POTAS, and IAEA have recently initiated efforts to begin addressing these problems.

Does it work?

According to U.S. and IAEA officials, no new scientific techniques for measuring nuclear materials have been developed during the last 10 years. The current process is one of packaging known techniques into usable, workable equipment. Therefore, the qualitative equipment factors (see ch. 2) are more important than the quantitative factors in determining usability and workability in field situations. IAEA's equipment implementation process, although slow at times, is IAEA's systematic approach to assuring that equipment will work satisfactorily under field conditions.

Need for documentation

IAEA Secretariat officials and inspectors told us that documentation of procedures for equipment use, general operations, use of measurement results, maintenance/repairs, and training is important as an aid to equipment implementation. They said that U.S. developers provide adequate scientific information about how the equipment works but that more documentation is sometimes needed. U.S. officials concur that documentation is critical to the implementation and effective use of equipment. According to a U.S. official, there is no comprehensive, single description of what constitutes the whole family of documentation needed on individual types of equipment. Thus, the need for additional documentation is a long-standing, persistent problem.

The Technical Support Coordinating Committee had two scientists from the Massachusetts Institute of Technology review certain POTAS-related activities. In September 1983, they reported,[2] among other things, that instrument documentation needed more attention, and that IAEA had only one formal document--the "Instruction Manual for Instrumentation"--which specifies how one class of equipment--nondestructive assay instruments--is to be used by inspectors. They concluded that high-quality equipment documentation is "essential for getting...instruments into routine and effective use," and that such documentation should include inspection procedures manuals to address administrative details, sampling procedures, and reporting requirements; training manuals and materials; and maintenance and technical manuals.

IAEA officials said that normal staff turnover and its resulting loss of "institutional memory" make equipment documentation a vital necessity. To compensate for this situation and the varying levels of English proficiency among inspectors and other IAEA personnel, they also said that the documentation must be in easy-to-understand terminology. It should describe how to handle, operate, and maintain/repair the equipment and how to interpret and use the equipment measurements. Also, easy-to-understand training material is needed to help instruct inspectors and others involved with the equipment in all these areas. They said that these training documentation needs have only recently been recognized and then addressed, in part, by the reorganization within the Safeguards Department.

Need for inspector input

U.S. program and laboratory officials emphasized the need for greater inspector input before and during equipment development. This need was also discussed at the Coordinator's Conference in June 1983.

Inspectors should have a prominent role during meetings between IAEA officials and support programs, according to some inspectors and U.S. officials, in order to discuss their equipment needs and to provide feedback on equipment in use or in testing and evaluation. These inspectors argue that, although they are the prime users of the equipment, inspectors generally

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[2] Norman C. Rasmussen and Marvin M. Miller, "A Review of the Development of Safeguards Equipment by the U.S. Programs for Technical Support to IAEA Safeguards (POTAS)," ISPO-202, Sept. 1983.

are not now adequately involved in equipment development, especially in the early stages when design is considered. The result, they say, can be equipment that is too heavy or bulky for them to use or which poses operating difficulties, such as having calculator keys too close or too small to easily use with the protective gloves they may need to wear.

ISPO/IAEA efforts to correct technical problems

Both the United States and IAEA recognize the technical problems affecting equipment implementation. They are undertaking such steps as testing equipment in field exercises, emphasizing equipment documentation, and getting more inspector input during equipment development.

The problem of field testing equipment is being addressed in 1983-84 through training/testing exercises at U.S. nuclear facilities. These exercises are discussed in more detail later in this chapter.

ISPO, through POTAS, has begun emphasizing the need for better documentation. The 1983 POTAS plan includes tasks for specific activities for some types of equipment documentation, including measurement techniques and equipment training and maintenance.

ISPO and IAEA have also done much more work in getting inspector input. For example, although inspectors were always invited, more of them attended the March 1983 POTAS support program meeting at IAEA headquarters than had attended earlier such meetings. One U.S. official credited the pending reorganization, in part, for the increased attendance. ISPO officials say also that inspectors can and do talk to ISPO's Vienna representative about equipment concerns. One high-level IAEA official said he believes that inspectors have adequate communication channels to provide input about equipment. In addition, the new Procedures Groups within the Divisions of Operations will provide a formal mechanism to influence equipment development. (See safeguards reorganization discussion in this chapter.)

OBTAINING AGREEMENT TO USE EQUIPMENT

Before IAEA can inspect a nuclear facility, a subsidiary arrangement is prepared and agreed to by both IAEA and the country. Part of the subsidiary arrangement is an agreement concerning inspection techniques and instruments to be used. Thus, in many cases, when IAEA wants to introduce a new NDA or C/S instrument, it must get agreement from the facility. Facility operators are sometimes reluctant to agree unless or until the reliability or workability of the instrument is proven. Their concern, according to IAEA officials, is mainly focused on the potential for faulty or ill-conceived equipment giving false alarms which can cause them political embarrassment and additional time/effort to resolve. Thus, IAEA can find itself in a difficult position--nuclear facility operators want IAEA to have good, workable, reliable instruments, but do not want the instruments tested in their facilities. Another concern involves the question of liability for damage to nuclear materials during inspection activities.

In an effort to help overcome the reluctance of facility operators to accept unused or unproven equipment, POTAS is sponsoring, for the first time, three testing/training exercises at U.S. nuclear facilities during 1983-84 which will permit IAEA and its inspectors to plan and implement the operation of equipment, identify uses for it, and document their experiences to support using it on actual inspections. These exercises are scheduled to be conducted at (1) the plutonium facility in Richland, Washington, (2) a highly enriched uranium fuel fabrication facility to be selected, and (3) the Three-Mile Island-1 nuclear power reactor near Harrisburg, Pennsylvania. These testing/training exercises will be done under conditions similar to those usually experienced on inspections, except that the equipment developers will be available to help the inspectors when needed.

In their September 1983 report on POTAS, the scientist-authors noted the need for more in-field testing and demonstrating of instruments in an as realistic as possible inspection environment. They also noted that such testing has important training benefits for inspectors.

PROCURING AND SUPPORTING EQUIPMENT

In January 1983, IAEA's Board of Governors received a report entitled IAEA Safeguards Equipment Requirements for 1983 to 1988 which outlined its equipment status and needs. The report stated that the costs of needed equipment and technical support (i.e., repairs and maintenance) are about $20 million and $13 million, respectively, over the next 6 years. The equipment portion represents a five-fold increase in inventory value by 1988. Technical support is estimated to be at least double (on the average) per year from its current level.

IAEA's Department of Safeguards has had no previous experience with an equipment purchasing effort of the magnitude projected in the 1983 report. Both IAEA and U.S. officials are concerned about this situation. In fact, they are discussing U.S. technical equipment procurement assistance which might be made available to IAEA.

Another concern has been with a constraint placed on IAEA's budget. According to the IAEA Financial Director, the Safeguards Department has not spent all of its safeguards equipment budget in the past few years and may not do so in 1983. Prior to 1983, IAEA's equipment funds were tied to a 12-month budget cycle. Money not spent by December 31 had to be returned and was lost for equipment purchases. Now, monies can be obligated in one fiscal year and then actually spent or disbursed during the subsequent fiscal year. Many U.S. officials said that the 12-month cycle had been an obstacle to equipment purchases.

The other estimate in the 1983 report involved the cost of repairing and maintaining the equipment and its component parts. A vital aspect to keeping equipment in service is a properly equipped and adequately staffed facility. According to the IAEA official in charge of the equipment maintenance facility, a few additional technicians and additional work areas will be needed to handle the expected workload increase.

OTHER IAEA STEPS TO AID IMPLEMENTATION

IAEA has taken other steps during the past few years which should aid in getting equipment into routine use. Major efforts included long-range planning and development efforts for equipment and evaluation methods, reorganization of the IAEA Safeguards Department, and greater use of cost-free experts.

Long-range planning

IAEA has conducted two long-range studies of equipment needs in recent years. In 1981, a U.S. cost-free expert performed a 1-month "quick and dirty" study which resulted in the following estimates: $20 million for equipment during 1981-1985 and about $20 million for supplies and maintenance. These estimates were based on a review of agency documents and on information from IAEA personnel, development laboratories, and commercial manufacturers. This initial effort to identify and quantify equipment needs and costs led to IAEA's second, more definitive evaluation of long-term equipment needs.

The January 1983 report, discussed also under "Procuring and Supporting Equipment," was prepared by a U.S. cost-free expert serving as advisor to IAEA's Deputy Director-General for Safeguards, and was the first comprehensive attempt to look at the long-term equipment issue. It showed "a strong field requirement for reliable, simple-to-operate instrumentation that provides the inspector with direct in situ [on site] measurements and verification results...." Based on the report, the inventory of safeguards equipment will increase from its present $5 million level to about $25 million by 1988. It also showed that the demands on all technical safeguards support functions will increase and require a greater proportion of the total safeguards budget in the future.

In addition to refining the estimated cost of needed equipment, the report included several other considerations.

--Extensive input from the Operations Divisions and inspectors, in particular, on equipment needs.

--Defining and classifying safeguards equipment in use or expected in the near term with a standard identification code. This will aid in computerizing information on equipment.

--Categorizing all nuclear facilities into 14 types for standardization purposes.

--Determining the economics of shared equipment.

--Other factors, such as resource and equipment limitations.

The report's author pointed out that the study is a "living" one that can be updated to recognize changes in equipment needs or other conditions. The first update was scheduled for the fall of 1983. Updates will be important because, as one IAEA official stated, the original report had no impact on the 1983 or 1984 budgets due to the long lead time in budget cycles.

Although it does not focus on equipment, a POTAS task was initiated in 1978 to work on a systematic method of evaluating safeguards inspection data. This effort, referred to as SEAM (Safeguards Effectiveness Assessment Methodology) has five steps, one of which involves describing the safeguards approach for a particular facility or type of facility. The description requires the identification of routine inspection activities, that is, what measurements or C/S evaluations are necessary.

According to a Brookhaven National Laboratory official, SEAM concepts are affecting IAEA thinking. The methodology has been described in at least one international statement and is reflected in safeguards reports on inspection criteria for light water reactors.

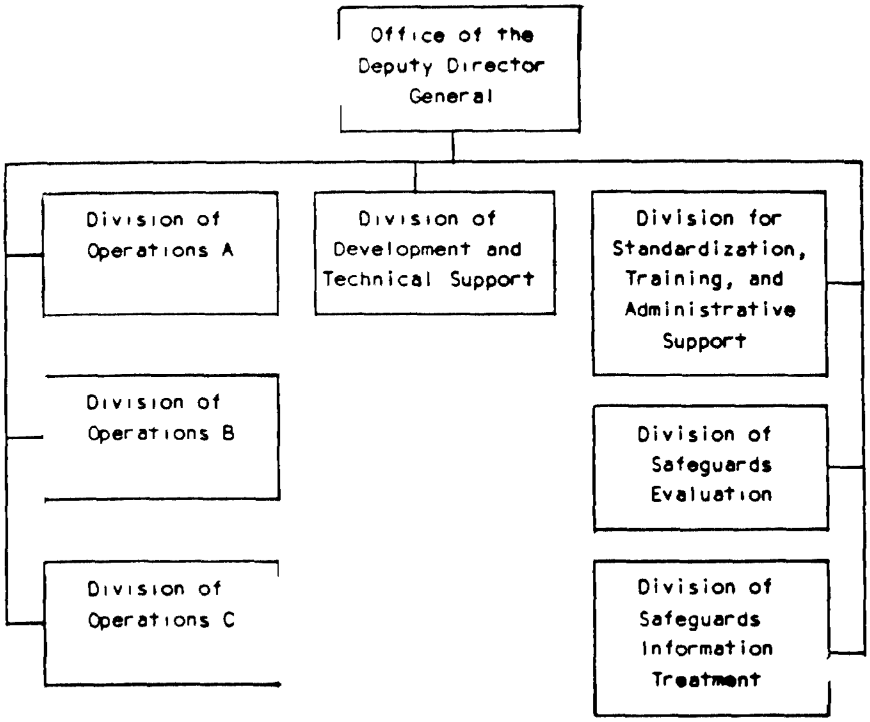
Reorganization of Safeguards Department

Effective July 1, 1983, IAEA's organization responsible for developing and implementing safeguards equipment--the Department of Safeguards--was reorganized by creating some new divisions and combining others. Principal changes were to:

1. Regroup two inspection operations divisions into three.
2. Upgrade safeguards evaluations to division status.

3. Upgrade training, combining it with standardization activities and administrative support to form a new division.

Each of these changes affects equipment to some degree. The new organization for IAEA's Department of Safeguards, down to the division level, is shown below.



Regrouping inspection operations divisions

Each inspection operations division now has a Support and Procedures Section, which among other duties is responsible for obtaining and providing inspector feedback on equipment usefulness and safeguards procedures to other divisions and offices. Inspectors in these groups will concentrate on equipment and procedures as a first priority and inspections as a secondary one. (Inspectors in these sections still routinely perform inspections, both to maintain their firsthand knowledge of inspector problems and needs and to use their experience as inspectors.)

Many U.S. and IAEA officials are hopeful that this new emphasis will permit more and better communications between the IAEA organizational units responsible for developing and using equipment and support program equipment developers. Poor communication among these groups has contributed, at least in part, to the slowness of getting equipment into use--developers do not know or appreciate the needs or problems of the inspectors.

Upgrading safeguards evaluation

By elevating a sub-office through the establishment of a Division of Safeguards Evaluation, IAEA is giving new emphasis to determining the effectiveness of safeguards. The division will conduct four main activities. Although none are directly involved in equipment development, equipment use and results are integral to these activities. For example, the Division is developing a more formal evaluation method to assess the effectiveness of safeguards activities in deterring and/or detecting diversions. (See discussion on SEAM under long-term activities.) In addition, the Division reviews and evaluates inspection reports and statements. Here again, the results of equipment measurements (hence the quality of the instruments) are an essential element of evaluating safeguards.

Upgrading training

Training has also been upgraded by the reorganization. Many U.S. and IAEA officials believe that more and better training and training materials are needed. Training is improving in the sense of course offerings, their contents, and the techniques used, such as video-recordings for individual refresher courses. POTAS, and other support programs, are involved through such projects as inspector on-site training opportunities at various types of facilities and formal equipment training. An IAEA training official said his objective is to make inspectors feel very comfortable in using the equipment--"like it was their hand."

Greater use of cost-free experts

A vital aspect of IAEA efforts to speed up equipment implementation and to improve safeguards in general is the use of CFEs. As shown on the first chart in chapter 3, a number of countries with formalized support programs provide CFEs. As of July 1983, the United States had 14 CFEs assigned to IAEA's Department of Safeguards (there were 2 in 1979), representing about 3 percent of the entire Department and about 60 percent of the CFEs. Their work assignments cover equipment needs, safeguards evaluation, data processing, training, equipment development, system studies, and technical services. Only the inspection staffs do not use CFEs.

U.S. and IAEA officials, as well as the coordinators from other countries providing IAEA with formal support, generally agree that CFEs provide valuable services to IAEA. In fact, many think the use of CFEs should be further increased.

U.S. program officials told us that CFEs should not be used in lieu of regular IAEA personnel. Rather, CFEs should be doing specific agreed-upon jobs requiring special technical or management skills which supplement IAEA's regular operations. To obtain the services of U.S.-supplied CFEs under POTAS, IAEA officials must submit and obtain approval of detailed job descriptions and task statements. If IAEA subsequently wants to reassign a CFE to another job area, it must obtain permission. IAEA officials complain that this is too restrictive and prefer to have flexibility in using CFEs. IAEA officials contend that other countries' support programs do not similarly restrict IAEA's use of their CFEs.

CONCLUSIONS

In view of the U.S. commitment to help provide IAEA with effective safeguards equipment and of the cost of its efforts so far, it is in the U.S. interest to follow through after equipment is developed, tested, evaluated, and accepted for use to aid in implementing it throughout IAEA's inspection program. Implementation of safeguards equipment is presently hindered by several obstacles, some of which are persistent and longstanding. Some recent initiatives may help IAEA overcome these obstacles. Among them are equipment testing and training in an inspection environment and efforts to develop additional equipment documentation.

The testing of and training with equipment in an inspection environment has obvious benefits in helping identify and correct field use problems. Not so obvious, but perhaps equally as important, is that such exercises can also help overcome nuclear facility operators' objections to the introduction of such equipment in future inspections. Countries aiding IAEA safeguards equipment development efforts can contribute substantially to help overcome facility operators' reluctance by volunteering to sponsor this type of testing/training exercise. Further use of this approach at nuclear facilities in the United States and expanding its use to nuclear facilities in other countries which support IAEA's efforts provide one means of furthering IAEA's ability to implement equipment.

The POTAS plan emphasis on developing equipment documentation is appropriate. However, in view of the recently expressed concerns about the adequacy of current documentation, U.S. officials should assess whether these concerns are being sufficiently addressed under current U.S. assistance efforts and, if necessary, adjust such efforts.

IAEA is attempting to further promote equipment implementation through such steps as more effective planning and the recent restructuring of the safeguards organization.

However, the impact of all of these efforts will not be known soon. They could have a positive effect in the future provided IAEA purchases equipment in sufficient quantities and is able to persuade inspected countries of the value of using the equipment. In the past, IAEA has not always used its entire equipment and supplies budget because of the current year restriction. This situation has been of concern to IAEA and U.S. officials and was recently corrected. U.S. and IAEA officials remain concerned, however, about the Department of Safeguards' ability to handle an equipment purchasing effort of the magnitude projected in the recent studies of equipment needs since it has had no previous comparable experience. The United States should monitor IAEA's progress and offer whatever assistance is appropriate to help IAEA achieve its procurement goals.

RECOMMMENDATIONS

We recommend that the Secretary of State, after consulting with the other POTAS-member agencies, direct the POTAS program to

--work with the IAEA Secretariat to follow through on planned equipment testing, to encourage early routine use at facilities in the United States, and to encourage other nations providing voluntary assistance to IAEA safeguards to do the same; and

--assess the IAEA Secretariat's concern that the current documentation on equipment usage, operation, and training is not meeting IAEA's needs and, if necessary, adjust the U.S. assistance efforts to address this problem.

We also recommend that the Secretary of State monitor IAEA's progress in procuring and supporting its planned equipment needs and, if problems occur, work with the IAEA Secretariat to develop strategies for overcoming them.

AGENCY COMMENTS

The Department of State concurred in the priority and significance of equipment testing and early routine use. State noted that documentation needs is a major concern of the Technical Support Coordinating Committee and that it is receiving priority attention in the 1983 and 1984 POTAS program plans.

State also agreed with the recommendation on monitoring constraints to providing and supporting equipment and said it would give this area priority attention.

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June 23, 1982

The Honorable Charles A. Bowsher
The Comptroller General of the
  United States
Washington, D.C. 20548

Dear Mr. Bowsher:

Despite efforts by the United States and other nations, there seems to be continuing concerns about the research and development of appropriate technology to monitor and account for nuclear materials internationally. Without adequate equipment and techniques, the International Atomic Energy Agency cannot be expected to fully meet its goals and objectives regarding nuclear material.

In this regard, I request that the General Accounting Office undertake an investigation to:

- Evaluate the adequacy of the present non-destructive assay equipment, and containment and surveillance devices being used by the International Atomic Energy Agency.
- Review the scope, effectiveness, and cost of U.S. programs, such as the program of technical assistance for international safeguards, to develop new or improved equipment.
- Assess the extent to which U.S. programs are coordinated with programs in other nations through existing technology agreements and review the need for additional cooperation.
- Ascertain the problems, if any, being encountered in getting advanced equipment into routine use by the International Atomic Energy Agency.
- Ascertain the long-range plans for improving international safeguards equipment.

The Honorable Charles A. Bowsher
June 23, 1982
Page 2

My staff has discussed this request with Joseph F. Murray of your International Division. If you have any questions about the scope or nature of this request, please contact Dr. Jack Dugan, Subcommittee Staff Director, at 225-8056 or Dr. Harlan Watson, of the Subcommittee staff, at 225-3472.

Best regards.

Sincerely,

Marilyn Bouquard

MARILYN L. BOUQUARD, Chairman
Subcommittee on Energy Research
and Production

MLB:Wjs

DESCRIPTION OF U.S.-SUPPLIED NDA EQUIPMENT

Brookhaven Stabilized Assay Meter (BSAM)

The BSAM was developed to replace the Stabilized Assay Meter (SAM-II) by improving its operational features and adding several new features. One new feature interfaces a built-in pocket calculator to the nuclear electronics. The calculator provides a digital readout and performs calculations needed for the instrument's operation. It can also be used independently for other calculations. Another new feature is a set of internal preset conditions for the more common assay situations. The BSAM also features a reduced sensitivity to ambient temperatures and operates on batteries.

The BSAM design is packaged so that its outer fiberglass case is the normal carrying container. It can be slung over the operator's shoulder, thereby freeing hands for the detector or calculator, or it can be used on a table. The internal rechargeable cells provide enough power for a normal work day.

Hand-Held Germanium Detector Probe

The hand-held Germanium detector (portable gamma spectrometer) is a portable detector which can be used together with a multi-channel analyzer to make semiquantitative measurements of nuclear materials in small quantities. The detector must be cooled with liquid nitrogen, which is generally obtained at the nuclear facility.

SAM-II

The SAM-II is a compact, portable assay meter consisting of a detector, a bias supply, and two single-channel analyzers. The most common use is to measure the U-235 enrichment of thick uranium samples, during which one channel is set to measure the gamma-rays of U-235 and the second at some higher energy level. Data from the second channel is automatically subtracted from the U-235 line to give a number that is proportional to enrichment.

The instrument can also be used to measure gamma-ray emissions of plutonium and other radioactive materials.

Mini-MCA

The mini-MCA is an intelligent, portable, battery-operated multi-channel analyzer that displays measured gamma spectra visually. It provides procedures prompting for specific measurements, internal calculations and diagnostics, and data and instrument status logging on a built-in tape drive. It is used for general gamma-ray and particle spectrometry.

High-Level Neutron Coincidence Counter (HLNCC)

The HLNCC was developed for the assay of plutonium (Pu). The counter was designed to measure the effective Pu-240 mass in Pu samples which may have a high Pu content. The term "high-level" refers to the high neutron count rates produced by large quantities of plutonium. The counter measures coincident fission neutrons in the presence of a random neutron background. Total Pu content is calculated from the Pu isotopic composition.

The detector consists of 18 proportional counters embedded in six polyethylene slabs, which form a hexagonal well. Top and bottom end-plugs can be used to form a closed sample-counting cavity. The detector weighs approximately 35 kilograms and has an efficiency of 12 percent.

A portable electronics package featuring a shift-register coincidence counter, a Hewlett-Packard HP 97 programmable calculator, and standard data communications devices, was designed for use with the detector.

Active Well Coincidence Counter (AWCC)

An AWCC is used to assay uranium fuel material. The AWCC is based on active neutron interrogation and counts the induced fission neutrons with high-efficiency detectors. The unit is useful for the measurement of bulk uranium dioxide samples, HEU metals, light water reactor fuel pellets, and U-233-Thorium fuel materials, which have very high gamma-ray backgrounds. Without its neutron source to induce fission neutron activity, the unit can measure U-238 and Pu. The AWCC is relatively portable and stable. It uses the same electronic system as the HLNCC.

COLLAR

The COLLAR is an active-neutron interrogation system for assaying light water reactor fuel assemblies. A neutron source actively interrogates a fuel assembly for fissile content. A large fraction of the neutrons entering the fuel assembly causes fissions to occur in the fissile material. Coincidence neutron detectors are used to measure the relative fluence of the induced fission neutrons from the fuel assembly. The electronics system is the same as for the HLNCC and AWCC.

Microcomputer

The Microcomputer is a portable microprocessor unit for analyzing Pu gamma-ray spectra recorded by IAEA's portable, Italian built "Silena" multi-channel analyzers. The connection can be direct or through magnetic tape. The unit uses a 20-character vacuum fluorescent display to prompt the user and display error messages. A thermal printer produces a permanent copy of results. A numeric keypad is used for input. The software is included in a 16,000 word memory.

Output from the unit includes plutonium isotopic ratios, U-235 to Pu-239 if it is present, and days since separation. Results are available in 70 to 90 seconds after the data has been taken.

Segmented Gamma Scanner

This equipment is used to measure the quantity of fissile material in containers of waste (usually barrels, bottles, or cans).

With a suitable isotopic gamma-ray source located opposite the detector for transmission corrections, the sample is rotated in a spiraling fashion and gamma rays are accumulated for many discrete segments of the spiral scan. The data are then fed into a minicomputer. The computer relates the measured count rates to fissile material content, computes the absorption correction, and prints out the results about 1 minute after the scanning is completed.

Semi-portable Cylinder Load Cell

Two systems for weighing cylinders are under consideration. The first is a semi-portable load-cell-based system designed for weighing 2.5 metric ton uranium hexafluoride shipping cylinders. The system, which includes a digital display, accurately weighs checkweights to within one-half kilogram. It can be disassembled and assembled in about 20 minutes. The second system is bulkier but involves a load cell under continual stress, thereby improving weighing accuracy. The load cells themselves are commercial devices. It is the specific portable weighing systems that are under development.

ION-1

The ION-1 is a portable spent-fuel gamma-ray and neutron detector. It is used for the verification of spent-fuel assemblies. The detector fits around three sides of the fuel assembly and the gross gamma-ray and neutron signals are measured. The measurement takes place under water and a pipe is used to carry the signal cables to the ION-1 electronics unit above the pool. The measurements give the burn-up and relative cooling time of spent-fuel assemblies.

Cerenkov Night Viewing Device

This device is used to obtain qualitative information based on the Cerenkov glow from spent-fuel assemblies. It intensifies the Cerenkov light image thousands of times to make it visible long after the radioactive decay has made the glow invisible to the naked eye. Information on the uniformity and intensity of the glow, the spatial distribution, and the general appearance of the assemblies can be useful in establishing their authenticity. The method is rapid and the instrument is lightweight and easy to use.

Development is proceeding to combine the night-vision device with either a film camera or a digital readout to give a permanent record of the measurement.

Underwater Viewer

This periscope provides a means for inspectors to read serial numbers of fuel assemblies in storage ponds. The periscope has two components. The first is a basic 2.5 meter long optical telescope designed to penetrate a water surface and having both a 2- and 10-power magnification and a special swivel mount. The second component is a set of optical extenders to be used if water turbidity requires closer viewing. Each part has a special carrying container and weighs 24 kilograms and 80 kilograms, respectively, when packed.

Calorimeters

Calorimeters assay Pu in solid form (metal, oxide, or scrap) by measuring the heat output. They usually are tailored to the mass and shape of the sample and to a given range of specific heat. Three sizes are available: (1) a small sample calorimeter for individual pellets, small numbers of pellets, or small amounts of oxide, (2) a calorimeter for cans or jars of material (a few hundred to a few thousand grams), and (3) a fuel-rod calorimeter, for rods about 1 to 4 meters long. The specific features of a calorimeter system depend on the sample size, the required precision, the data readout, and whether the units are transportable or stationary.

DESCRIPTION OF U.S.-SUPPLIED C/S DEVICES

Semiautomatic Film Scanner

The scanner analyzes an IAEA Minolta camera's 8 mm film, puts a date on each frame, and provides review of the film at 8 frames per second. The scanner transfers onto a video disk any detected movement for review by the inspector.

Battery-Operated TV

The system allows an inspector to monitor an activity at selected time periods between 1 and 15 minutes for up to 24 hours. At each interval, the system controller turns on a tape recorder, records for approximately 1 second, and places the time of recording and the day number into the video picture. The case containing the controller and recorder receives the video signal over a cable from the sealed tamper-indicating camera housing. If the power line (used directly to operate a built-in battery charger) to the camera housing is interrupted, the system will detect the loss of power and automatically record a tamper indication in the video picture. If the video cable is broken, a second tamper indication will appear in the video recording. A third tamper indicator detects an opening of the video recorder case.

Surveillance Television and Recording System (STAR)

This system consists of two cameras and a central control console. The control console includes a support base containing auxiliary batteries; an electronics console containing video tape recorders, control functions and a viewing monitor; and an auxiliary video recorder chassis which can be serviced without allowing access to the electronics console. Signals from the two cameras are combined into a single video signal for recording. Tamper and motion indication and video analysis are included.

Reactor Power Monitor

A microprocessor-based reactor power monitor was developed to provide an independent history of the power output of a nuclear power plant. The monitor is based on a correspondence of neutron flux with reactor thermal power. The sensor is a proportional counter which detects thermal neutrons outside the biological shield. The monitor is placed in a tamper-resistant, tamper-indicating enclosure against the biological-shield wall and records the power level hourly. The system normally operates on facility power, but has a stand-alone capability of approximately 4 days on battery power.

Electronic Seals

Based on fiber-optics, these seals have an internal (battery) power source, continually verify the integrity of the fiber-optic loop, and display their status. A semiconductor light-emitting diode is pulsed repeatedly and these pulses are detected unless the fiber-optic bundle is broken or damaged. The present designs generate a series of random numbers as a function of time so long as the seal remains intact. The random-number series for each seal is programmed into its memory by a programmer-verifier instrument and is recorded. An inspector can verify secure operation by comparing the number on the 3-digit display of the seal with the number from the particular random series for that seal at that time. Though expensive, the units can be reused and could be adapted for remote monitoring.

Type X and Improved Type E Seals

The Type X seal is a stainless steel cup-and-wire design with special spring fingers to hold it together. It is fingerprinted with scribed lines on the inside of the case. Of all non-electronic seal designs tested, the Type X is the most durable and tamper-resistant. Another new design is the Improved Type E seal. This seal has a double-cap which offers improved tamper resistance over its predecessor--the Type E seal.

DESCRIPTIONS OF PROGRAMS AND OTHER ACTIVITIES SUPPORTING IAEA SAFEGUARDS

PROGRAMS

The following is a brief summary of the support activities in the nine formal IAEA safeguards assistance programs, other than the United States'. (The U.S. program is described in chapter 2.)

Australia

The Australian support program was formally introduced in June 1980 as a 3-year program. It was managed by the Department of Foreign Affairs in consultation with the Department of Trade and Resources. Technical advice was given by the Australian Safeguards Office and the Australian Atomic Energy Commission, which were also responsible for the technical implementation of the research projects. Funding for the 3-year effort was about $550,000 Australian (about $600,000 U.S.). This initial program concluded on June 30, 1983. According to a State Department official, resumption will be determined following an Australian Government study of its role in the international nuclear fuel cycle.

The program mainly related to enrichment plant safeguards and consisted of a system analysis, including assessment of available safeguards techniques, and development of measurement equipment for UF_6 (ruggedized assay meter and UF_6 gas phase enrichment meter). In addition, funds were made available for a "once-only" contribution to the IAEA for the International Plutonium Storage study and for IAEA staff travel in connection with the support program. Most recently, an Australian cost-free expert joined IAEA's Department of Safeguards. Australia also took part in the U.S.-sponsored RECOVER project and participated in the Hexapartite project.

Belgium

Belgium formalized its IAEA support program in the spring of 1983. Belgium's first tasks were on safeguards measures in mixed oxide and low enriched fuel fabrication plants. Belgium operates both types of facilities.

Prior to establishing a formal program, Belgium cooperated in several field tests of U.S.-developed safeguards instruments at Belgian nuclear fuel cycle facilities. For example, measurements of the neutron coincidence technique were made at a field test in 1981, with participation by IAEA, a U.S. national laboratory, and Belgian representatives. Results showed that IAEA could use the instruments to determine the relative enrichment of pressurized water reactor fuel assemblies and supported measurements made during a 1979 field test.

Canada

The Canadian program, which was formally set up in 1977, covers the development, provision and installation of safeguards equipment for all 13 Canadian-designed reactors (called CANDU) in operation or under construction worldwide. The program contains about 40 tasks, all concerned with the development of instrument prototypes, followed by the construction of equipment and installation at each of 13 reactor facilities. In the case of the CANDU 600 MW reactors, for the first time in the development of IAEA safeguards schemes, a significant engineering effort has been made to include safeguards as an integral part of a reactor during the design and construction, rather than being a retro-fit requirement.

The Canadian support program is jointly administered and funded by the Atomic Energy Control Board and Atomic Energy of Canada Limited. Over $18 million Canadian have been spent under this program ($15 million U.S.) from 1977 to 1983. Besides the development, delivery, and installation of CANDU safeguards equipment (closed circuit television systems, film cameras, core input monitors, irradiated fuel bundle counters, yes/no monitors, irradiated fuel verifiers and tamper-indicating containers, and seals for spent-fuel bundles), the program has included the provision of five cost-free experts, system analytical studies, and extensive training of IAEA staff members. Canada also participated in the RECOVER project demonstration.

EURATOM

In May 1981, the cooperative safeguards program was formally established within the framework of a 1975 general cooperative program between EURATOM and IAEA. Annual funding is about $4 million U.S. The program, which is managed by the Joint Research Center at Ispra, Italy, aims at an exchange of technical experiences, particularly in the area of safeguards research and development and safeguards implementation in European nuclear facilities. The program is expected to result in technical assistance to IAEA, in agreement on techniques and procedures, and in the evaluation of priorities for research and development as a function of the EURATOM safeguards requirements. A total of 27 tasks have been identified which mainly relate to containment and surveillance, measurement technology, inspector and other safeguards staff training, and information/data treatment and evaluation. Emphasis is placed on standardization and agreement on aspects of measurement techniques, data generation and evaluation, and preparation of reference materials. The EURATOM Inspectorate participated in the Hexapartite project.

France

The French/IAEA support program agreement was signed in June 1983. France plans to include NDA measurement techniques for reprocessing plants, spent fuel, and uranium-holding containers among its research and development efforts. France also plans to provide training courses. According to IAEA, French scientists have expressed interest in sponsoring field tests of U.S.-developed calorimeters, designed for plutonium containing material. France was a participant in TASTEX.

Japan

The Japanese support program for IAEA safeguards (JASPAS) was formally established in 1981. The program is coordinated by the Nuclear Material Control Center in Tokyo under the guidance of the Science and Technology Agency. Nine research and development activities have been identified and are being conducted at the facilities of the Power Reactor and Nuclear Fuel Development Corporation, the Japan Atomic Energy Research Institute, the Nuclear Material Control Center, and other institutions. Total expenditures for JASPAS projects and two cost-free experts, who have been sent to Vienna, amounted to 158 million yen (excluding some personnel costs) in fiscal year 1981. Funding in 1982 was 350 million yen and was expected to exceed 450 million yen in 1983. (We estimate that total Japanese funding to date equals about $4 million U.S.)

Program activities mainly relate to safeguards system designs and safeguards approaches; safeguards data collection, treatment, and evaluation; measurement methods and techniques; and containment and surveillance. The techniques developed under two of the JASPAS tasks have already been implemented at the Tokai-Mura reprocessing plant. An upcoming project is a demonstration program at the Japanese ultracentrifuge uranium enrichment facility.

Prior to initiating JASPAS, Japan was actively involved in a four-party project called Tokai Advanced Safeguards Technology Exercise (TASTEX). TASTEX began in 1977 when Japan and the United States agreed to cooperate in developing and testing safeguards equipment and techniques at the Tokai-Mura reprocessing plant. France also offered to participate in this cooperative project because of interests in safeguards techniques and because the Tokai-Mura facility was of French design. In 1978, IAEA accepted an invitation to join the effort.

Japan also participated in the Hexapartite project and in the RECOVER program where special emphasis was on applying remote communication systems for IAEA monitoring of fast reactor facilities.

United Kingdom

In July 1980 the United Kingdom offered to assist IAEA with a safeguards research and development program at an annual cost of about 500,000 pounds (about $1 million U.S.). The program, which was formally implemented in July 1981, concentrates on safeguards for those parts of the nuclear power program with which the United Kingdom is particularly experienced, such as the fast breeder reactor and its fuel cycle, uranium enrichment plants, and nuclear material storage.

In addition, service elements, such as training, chemical analysis, and manual writing, are included in the program, and facilities for in-plant testing of newly developed safeguards equipment have been provided. One cost-free expert has also been provided to work at IAEA headquarters.

Independently of the support program, British Nuclear Fuels Limited (a U.K. government-owned company) has run 2-week training courses for IAEA inspectors and carried out a 3-month safeguards demonstration program on the safeguarding of centrifuge enrichment plants at its own facility.

The United Kingdom also participated in the Hexapartite project and was active in the RECOVER demonstrations.

U.S.S.R.

In June 1982, the U.S.S.R. formally offered to implement a program of technical support to IAEA safegards. The offer was accepted by IAEA. The program currently consists of 14 tasks related to information processing systems for nuclear material accounting and control; development and improvement of methods and instruments for nondestructive and destructive assay methods; surveillance equipment, procedures, and technical measures for implementing nuclear facility safeguards; organization of scientific visits, training courses, seminars, and schools in the U.S.S.R.; and provision of experts. One million roubles (about $1.4 million U.S. at the official exchange rate) has been allotted to this program so far. The program is coordinated by the State Committee on the Utilization of Atomic Energy, and the I.V. Kurchatov Atomic Energy Institute in Moscow has been designated as the technical organization responsible for the program.

In addition to this formal program, cooperative assistance was provided in sponsoring IAEA training courses in the U.S.S.R. (in 1978 and 1981) on the basic IAEA requirements for state systems of accounting for and control of nuclear materials. The U.S.S.R. also sponsored the IAEA Introductory Course on Agency Safeguards at one of its nuclear power plants. The course included instructing IAEA inspectors on spent fuel measurement techniques with U.S.-developed equipment.

West Germany

The West German program was initiated in 1978 and, like the U.S. program, covers a broad spectrum of safeguards activities. The West German program, coordinated by the Ministry for

Research and Technology, is conducted in close cooperation with the German nuclear research establishments, the German nuclear industry, and EURATOM. About 25 million German marks ($12.2 million U.S.) have been spent on this program.

Individual tasks concentrate on the development of safeguards concepts and approaches for advanced nuclear facilities, such as fast breeder reactors, high temperature reactors, and spent fuel reprocessing plants which are being developed for future operations in West Germany, and other system analytical studies; collection, treatment, and evaluation of safeguards data; development and testing of measurement techniques for nuclear materials; and development of C/S equipment. In addition, three cost-free experts have been sent to assist the IAEA Department of Safeguards. Funds were also made available to procure a data base management system and NDA and C/S prototype equipment and to provide for IAEA staff travel.

West Germany participated in the RECOVER project and was a member of the Hexapartite project.

OTHER ACTIVITIES

Twelve other nations which do not have formal programs with IAEA are also assisting, or have assisted, IAEA's safeguards program. Brief descriptions of these nations' efforts follow.

Argentina

Argentina has provided assistance in the development and application of seals and surveillance devices. According to IAEA, the nuclear facilities and technical personnel in Argentina may be used for future field tests of equipment and procedures developed by the United States.

Austria

Austria has supported demonstrations of U.S.-developed equipment by making available suitable nuclear material at a small research reactor. Other support included a November 1980 demonstration of prototype equipment for spent fuel measurements at the Vienna Technical University. The University also tested a hand-held monitor to measure uranium enrichment in 1981 and has participated in the RECOVER project. During RECOVER, a remote terminal unit was installed at the University and was interrogated by the control unit at IAEA headquarters. A senior staff member provided technical assistance in evaluating the remote communication considerations of the RECOVER system.

Bulgaria

Equipment has been field tested in Bulgaria for measuring the fissile material content of power reactor spent-fuel elements. In addition, a modified commercial underwater periscope for IAEA verification of reactor fuel assembly identity, furnished by the U.S.-support program, was demonstrated twice in Bulgaria in 1981. Bulgaria also participated in the RECOVER demonstration project.

Czechoslovakia

Czechoslovakia has assisted IAEA by furnishing calculations of plutonium production and uranium depletion for certain types of reactors. According to IAEA, this is a possible area for future coordination with efforts in the United States to improve IAEA safeguards approaches for reactors.

East Germany

IAEA inspection training exercises have been held at three operating nuclear facilities (a power reactor, a research reactor, and a critical assembly facility) in East Germany. Training included exercises with equipment developed for IAEA nuclear material measurement. East German representatives indicated in September 1981 that they would continue assisting IAEA in the future by making available nuclear facilities for the basic training of new IAEA inspectors.

Hungary

Hungary has provided assistance in developing safeguards procedures for specific nuclear fuel cycle facilities. According to ISPO, depending on continuing commitments from Hungary, coordination with related U.S. efforts should be considered.

Italy

Several items of U.S.-developed safeguards equipment were installed at a pilot-scale reprocessing facility in 1977. Demonstrations of advanced techniques for plutonium concentration and solution volume measurement for enhancing international safeguards were also conducted at the facility.

Netherlands

The Netherlands was a participant in the Hexapartite project to improve international safeguards at ultracentrifuge uranium enrichment plants. EURATOM research is carried out at a facility in the Netherlands. This research involves cooperative efforts with the United States.

Romania

Romania has supported work on the development of measurement techniques needed by IAEA. Evaluation of new measurement procedures using U.S.-developed equipment may involve cooperative efforts with Romania, according to IAEA.

South Africa

South Africa has provided assistance to IAEA in the development and application of C/S devices.

Spain

Spain has provided assistance to IAEA with respect to improved safeguards procedures.

Sweden

Sweden has had agreements with IAEA for the testing and evaluation of measurement and control procedures under plant conditions. Field tests of a U.S.-designed neutron coincidence collar measurement of fissionable material in boiling water reactor fuel assemblies were performed at a Swedish fabrication facility in 1981. IAEA foresees further field tests of U.S.-developed safeguards equipment in Swedish nuclear facilities.

DEPARTMENT OF STATE
Comptroller
Washington, D.C. 20520

20 DEC 1983

Dear Frank:

I am replying to your letter of November 18, 1983, which forwarded copies of the draft report: "New and Better Equipment is Being Made Available for International Nuclear Safeguards."

The enclosed comments on this report were prepared 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

Roger B. Feldman

Enclosure:
As stated.

Mr. Frank C. Conahan,
Director,
National Security and
International Affairs Division,
U.S. General Accounting Office,
Washington, D.C. 20548

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

GAO DRAFT REPORT: New and Better Equipment is Being Made Available for International Safeguards.

We appreciate this opportunity to review and comment on the draft General Accounting Office report "New and Better Equipment is Being Made Available for International Safeguards." Overall, we find this report to be a balanced and accurate description of the successes and difficulties experienced to date in the course of implementing the U.S. Program of Technical Support to IAEA Safeguards (POTAS).

With respect to the report's first recommendation, that "the Secretary of State should request IAEA to develop and implement coordination mechanisms to help achieve a fully integrated, multilateral safeguards support program among countries providing substantial support," we agree on the need for a more closely coordinated and integrated safeguards research and development program on the part of the IAEA. At the same time, it must be recognized that the management of POTAS, and of each of the other national technical support programs, remains accountable for its decisions to national authorities. Decisions regarding the allocation of resources must be made in close coordination with the IAEA, but cannot be delegated to the IAEA.

The second recommendation of the report is that "The Secretary of State, after consulting with other POTAS member agencies, should direct POTAS to:

-- Work with the IAEA Secretariat to arrange further equipment testing and early routine use at facilities in the United States and early routine use at facilities in the United States and to encourage other nations providing voluntary assistance to IAEA safeguards to do the same.

-- Evaluate the IAEA Secretariat's concern that the current documentation on equipment usage, operations, and training is not meeting IAEA's needs and, if necessary, adjust the U.S. assistance efforts to address this problem."

As the report notes, frequent use has been made of U.S. nuclear facilities for the testing of safeguards equipment being developed by POTAS, and a number of other countries have cooperated in the use of their nuclear facilities for this purpose. We appreciate and concur in the priority and significance which the GAO assigns to this activity. The recommendation concerning documentation identifies one of the major issues of concern to the Technical Support Coordinating Committee. This question is receiving priority attention in the 1983 and 1984 POTAS program plans.

The final recommendation is that "the Secretary of State should also monitor the constraints to providing and supporting equipment and, if problems occur, work with the IAEA Secretariat to develop strategies for overcoming them." We agree fully with the GAO regarding the importance of this issue, and will continue to give this area the high priority attention which the GAO indicates to be warranted.

In addition, a number of minor editorial and technical comments on this report have been conveyed directly to the GAO staff for their consideration.

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

UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY
WASHINGTON

OFFICE OF
THE DIRECTOR

December 16, 1983

Dear Mr. Conahan:

I appreciate the opportunity for ACDA to review and comment on the draft report, New and Better Equipment is Being Made Available for International Nuclear Safeguards. The report provides a good analysis of the development and deployment of new equipment in support of IAEA safeguards.

This is a complex subject and the report addresses the most important questions. Moreover, the interviews cover the spectrum of the participants involved in the equipment development process. The summary descriptions of equipment and the development/implementation procedures are, in general terms, comprehensive and accurate.

The report's analysis complements on-going activities within the Executive Branch to improve the development and implementation of equipment for use in international nuclear safeguards. We shall make use of its recommendations in identifying additional useful ideas for improvements.

Sincerely,

Kenneth L. Adelman

Kenneth L. Adelman

Mr. Frank C. Conahan
Director,
National Security and
International Affairs Division,
United States General Accounting Office.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D C 20555

DEC 20 1983

Mr. J. Dexter Peach, Director
Resources, Community, and Economic
Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

In response to your letter of November 23, 1983, to Chairman Palladino, we have reviewed the draft GAO report titled, "New and Better Equipment is Being Made Available for International Safeguards." We are in general agreement with the conclusions and recommendations of the draft report. To the best of our knowledge, the draft's recommendations concern areas which the United States Government is currently attempting to address. However, this report should serve to reinforce the ongoing activities of the United States. Some specific technical and editorial comments are enclosed for your consideration.

We appreciate having the opportunity to review the report. We plan to continue our support to the interagency efforts to strengthen IAEA safeguards, including the development of new and improved equipment through the Program of Technical Assistance to IAEA Safeguards (POTAS).

If you have any questions, please let us know.

Sincerely,

William J. Dircks
Executive Director for Operations

Enclosure:
Comments on Draft GAO Report

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

Department of Energy
Washington, D.C. 20585

DEC 28 1983

Mr. J. Dexter Peach
Director, Resources, Community, and
Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

The Department of Energy (DOE) appreciates the opportunity to comment on the draft of the proposed report, "New and Better Equipment Is Being Made Available for International Nuclear Safeguards." We are in general agreement with the findings of the report and believe you have provided a good evaluation of "U.S. research and development efforts regarding equipment for the International Atomic Energy Agency's (IAEA) international nuclear safeguards program" (Digest). In order to reinforce our general agreement with the findings, we are limiting DOE comments to items which we believe largely involve errors of fact.

The DOE budget figures in the table "U.S. Support to International Safeguards" reflect only program activities carried out under DOE international rather than domestic support (page 9a). The products of these DOE efforts are largely transferred to IAEA through the U.S. Program of Technical Assistance. The DOE figures include technology research and development and systems analyses for policy assistance to apply IAEA safeguards to U.S. nuclear facilities not of direct national security significance (page 8), in this instance the DOE gas centrifuge enrichment plant at Portsmouth. However, a different, larger DOE program funds research and development and technical support for domestic safeguards by DOE contractors, and the spin-off from that program frequently contributes to international safeguards. As a result, our judgment is that the DOE international support program gets an extremely good return on its investment with commensurate benefit to IAEA safeguards. [See GAO NOTE 1 on p. 76.]

With respect to the question of IAEA equipment utilization, we believe the GAO evaluation suffers from lack of authoritative information from the IAEA on specific decisions and actions regarding equipment use. This is because there has been no firm authorization system within the IAEA Department of Safeguards for deciding that development and preparations for use of equipment are complete and equipment is ready for routine use. As a result, individual members of IAEA staff provided opinions, quoted in the report, but they are sometimes demonstrably wrong, as discussed below:

- "According to some inspectors, the BSAM is unreliable" (page 29)--"not in use" (page 27a).

The BSAM (Brookhaven Survey Assay Meter), though introduced in 1978-79, has not been used because the IAEA chose to await development of the Mini-Multichannel Analyzer. BSAM, nonetheless, is designated for routine use now.

- Reactor power monitor: "never put into use"; "required alterations to the reactor containment vessel" (page 29). Both assertions are factually incorrect. IAEA is currently requesting more such monitors for use at a number of power reactors.

- Battery Operated TV: "not used" (page 27c). IAEA is currently requesting a number of functionally similar Mini-STAR battery augmented television systems after favorable experience with the previous model, which failed only due to improper operational use. [See GAO NOTE 2 on p. 76.]

Throughout the Introduction, undue stress is placed upon the "risks" and "dangers" associated with the development and use of civilian nuclear power technology. Reprocessing technology has been well known and readily available for some thirty years. While use of this technology may be of proliferation concern in the case of a few countries, it is through the continued development of nuclear power technology and its cooperative international deployment, including appropriately integrated safeguards, that we may make progress in the achievement of our nuclear non-proliferation goals. [See GAO NOTE 3 on p. 76.]

Finally, the draft notes that separated plutonium is not commonly used as fuel in civilian nuclear power reactors (page 2). That is largely true; however, some non-nuclear weapon states have begun using plutonium on an experimental basis in a number of their light water power reactors and have obtained several tons of separated plutonium from their reprocessed fuel. Our safeguards R&D in this area is consequently very important if we are to assist in the development of internationally acceptable plutonium storage safeguards.

Again, we appreciate the opportunity to comment on this proposed report, with which we are in general agreement. We offer these comments, and we stand ready to discuss the report as well as our comments at your convenience. [See GAO NOTE 4 below.]

Sincerely,

for: Martha O. Hesse
Assistant Secretary
Management and Administration

GAO NOTE 1: We have added these comments to the reports.

GAO NOTE 2: Since we do not have audit authority at IAEA, we accepted the "Implementation Status" of each U.S.-supplied type of equipment. Regardless of whether IAEA has a firm authorization system or not, we feel that the IAEA officials with whom we spoke were the best qualified officials to assess the use of the equipment.

--In the case of the BSAM, which we describe as "not in use", DOE agrees with its "has not been used." Since our chart was to show the implementation status and not potential, the fact that the BSAM is "designated for routine use" seems to be less relevant than IAEA's and DOE's "not in use" designation.

--We have modified our implementation status on the Reactor Power Monitor to "very limited use" since it has been used at one facility in one country.

--The one Battery Operated TV provided to IAEA is "not used." As we pointed out, the system was accidentally burned during test and evaluation. DOE correctly points out that the Mini-STAR system is functionally similar. However, the Mini-STAR POTAS task was scheduled to be started in May 1983, as our audit was being completed, and therefore it was not included in our review.

GAO NOTE 3: We agree with DOE that the use of reprocessing technology may be of proliferation concern in the case of only a few countries and that appropriately integrated safeguards are an important aspect of achieving U.S. nuclear non-proliferation goals. However, we do not believe that the less than two page discussion in this report on the links between nuclear power programs and nuclear weapons to be placing "undue stress" on the subject. We also believe that it is essential to appreciate that a link can exist in order to understand and to place in perspective the importance of IAEA's international nuclear safeguards role.

GAO NOTE 4: Page references in this appendix refer to our draft report and may not correspond to the pages in this final report.

(465275)

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