United States General Accounting Office

GAO



Report to the Chairman, Subcomm
on Oversight and Investigations,
Committee on Energy and Comme
House of Representatives

February 1990

# STRATEGIC DEFEN
# INITIATIVE PROGR

## Extent of Foreign Participation





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GAO

**United States**
**General Accounting Office**
**Washington, D.C. 20548**

**National Security and**
**International Affairs Division**



B-223094

February 7, 1990

The Honorable John D. Dingell
Chairman, Subcommittee on
Oversight and Investigations
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In response to your December 14, 1988, letter, we reviewed the extent of foreign cor in the Strategic Defense Initiative Program. Unless you publicly announce its conten earlier, we plan no further distribution of this report until 15 days after its issue dat that time we will send copies to the Chairmen, House and Senate Committees on Appropriations and on Armed Services; the Secretary of Defense; the Director, Offic Management and Budget; and other interested parties.

Please contact me on (202) 275-4268 if you or your staff have any questions concern report. Other major contributors to this report are listed in appendix II.

Sincerely yours,

Nancy R. Kingsbury

Nancy R. Kingsbury
Director
Air Force Issues

# Executive Summary



## Purpose

The Strategic Defense Initiative Program, announced by Presi gan in 1983, is intended to conduct research on possible ballis defense systems for the United States and its allies. Since 198 allied countries have participated in this program. Because of cerns about the amount of foreign contracts, the Chairman, S tee on Oversight and Investigations, House Committee on Ene Commerce, asked GAO to analyze the level and type of foreign tion in the Strategic Defense Initiative Program.

## Background

The Strategic Defense Initiative Organization manages the Str Defense Initiative Program and allocates annual appropriation program elements. Five of these program elements—Surveilla Acquisition, Tracking, and Kill Assessment; Directed Energy W Kinetic Energy Weapons; Systems Analysis and Battle Manag Survivability, Lethality, and Key Technologies—involve forei tracting. The Strategic Defense Initiative Organization, the Ar Navy, the Air Force, the Defense Nuclear Agency, and the Dep of Energy administer the foreign contracts.

The Secretary of Defense has signed Memorandums of Underst which address broad-ranging government-to-government issu the Federal Republic of Germany, Israel, Italy, Japan, and the Kingdom to facilitate foreign participation in the Strategic De ative Program. In addition, the Strategic Defense Initiative Or has signed two Memorandums of Agreement with Israel and o the Netherlands and one Cooperative Research Arrangement w United Kingdom, which address the implementation of specifi

The flow of classified technology from the United States to fo tries is controlled by legislation and executive regulations, inc Arms Export Control Act, as amended, and the National Disclo icy. These laws and regulations set forth procedures for expor sified information, including obtaining an export license.

## Results in Brief

GAO identified 67 foreign contracts valued at $297.1 million, w resents about 3 percent of total Strategic Defense Initiative co awards, and 86 foreign subcontracts from U.S. companies tota million. The basis of award for the 67 foreign contracts was m competitive than sole source, although sole-source awards are a higher dollar amount. The basis of award by each of the U.S

administering foreign contracts varied. Israel has received the lar dollar value of contracts among foreign recipients.

Department of Defense and foreign embassy officials said that for contracts allow the United States not only to share technology wit other countries but also benefit from technological developments those countries.

## GAO's Analysis

GAO identified 67 foreign contracts in eight countries valued at $2 million. Of this amount, $228.4 million had been obligated by Marc 1989. At least $31.6 million, or about 14 percent of total foreign c obligations, was committed to U.S. subcontractors or other organizations.

In addition, organizations in 11 countries received 86 subcontracts U.S. companies totaling $48.4 million. Of this amount, 64 percent w to British organizations.

Allied participation in the Strategic Defense Initiative Program cen on theater missile defense, which accounts for 69 percent of the to foreign contract amount. Theater missile defense is the defense of allied geographic area against ballistic missile attack.

Israel received the largest dollar amount of Strategic Defense Initi foreign contracts ($141.7 million). One Israeli company was awarde $126.4 million under the largest individual foreign contract. The U Kingdom received the most foreign contracts (36).

About 57 percent of the foreign contracts were awarded on a comp tive basis, but sole-source contracts accounted for 57 percent of to obligations. The basis of award varied by executing agency. For ex ple, the Air Force awarded all of its contracts competitively, where Defense Nuclear Agency contracts were awarded sole source.

The Strategic Defense Initiative Organization maintains a database foreign contracts and subcontracts. The database was overstated b $8.5 million and was frequently in error regarding details on indivi contracts. The organization is attempting to improve the database integrating it with other sources of information in its new managem information system, which was not operational at the time of GAO's review.

Department of Defense and foreign embassy officials said that e
though the United States sends its technology overseas, it also r
technology from foreign countries. For example, the United Stat
providing an Israeli organization working on an electromagnetic
(used for firing projectiles at very high velocities) with barrels, c
tors, and a high-speed camera. In return, the Strategic Defense I
Organization is receiving a demonstration of the research results
procedures for transferring technology in accordance with U.S. l
tion and executive regulations can be time-consuming and, accor
Department of Defense and foreign embassy officials, may limit
participation in the Strategic Defense Initiative Program.

## Recommendations

GAO is not making recommendations in this report.

## Agency Comments

The Department of Defense concurred with the information in th
report. The Department's comments appear in appendix I.

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# Contents

## Abbreviations

| | |
|---|---|
| DOD | Department of Defense |
| GAO | General Accounting Office |
| MOA | Memorandum of Agreement |
| MOU | Memorandum of Understanding |
| NATO | North Atlantic Treaty Organization |
| SDI | Strategic Defense Initiative |
| SDIO | Strategic Defense Initiative Organization |

Chapter 1

# Introduction

When President Reagan announced the Strategic Defense Initiative Program in March 1983, he emphasized that SDI should enhance alli well as national security. To accomplish this, in March 1985 the Sec tary of Defense formally invited 18 countries to participate directly SDI research. The purpose of the SDI Program is to conduct research possible ballistic missile defense systems for the United States and i allies.

The SDI Program is managed by the Strategic Defense Initiative Org zation (SDIO), which allocates its annual appropriation to seven prog elements. Five of the program elements—Surveillance, Acquisition, Tracking, and Kill Assessment; Directed Energy Weapons; Kinetic Energy Weapons; Systems Analysis and Battle Management; and Survivability, Lethality, and Key Technologies—involve foreign con tracting. The other program elements are the Phase I Strategic Defe System, which is expected to receive funds for the first time in fisca year 1990, and Management Headquarters, which provides adminis tive and other support to the SDI Program. Most of the program is ex cuted by organizations other than SDIO, including the Army, the Nav the Air Force, the Defense Nuclear Agency, and the Department of Energy, all of which are involved in foreign contracting.

SDIO has attempted to facilitate foreign participation through the use Memorandums of Understanding (MOU) and Memorandums of Agree ment (MOA), both of which address certain procedures and obligation regarding such issues as the transfer of classified information. MOUs address broad-ranging government-to-government issues, whereas M focus on implementing a particular project. Since the SDI Program's inception, five countries have signed MOUs: the United Kingdom in 1 Israel, Italy, and the Federal Republic of Germany in 1986 and Japa 1987. Three MOAs have been signed to date: one with the Netherland 1987 and two with Israel in 1988 and 1989. A cooperative research arrangement, similar to an MOA, was signed with the United Kingdon 1988.

## SDI Foreign Contracting Database

SDIO's Office of Multinational Programs maintains a database on for contracts and subcontracts. We found that the database was oversta by $8.5 million and was frequently in error regarding details on indi tual contracts. To improve its foreign contracting database, SDIO has recently begun integrating foreign contracting data into its new man ment information system. We did not review this system because it w not operational at the time of our review.

The database we reviewed contained information concerning each contract and subcontract, including effective start date; contract or subcontract number; a brief description; name and country of the contractor and/or the subcontractor; amount obligated by fiscal year; total contract funding; and contract or subcontract status (either ongoing or completed). According to officials of the Office of Multinational Programs, compilation of the database has been a labor-intensive process, depending heavily on the Department of Defense's (DOD) primary contract monitoring system (the DD-350 system) and contacts with DOD contracting officers, embassy officials, and contractors.

The Director of the Office of Multinational Programs said that maintaining such a database is not a requirement. Rather, the office created it for use as a reference source and for those interested in information on allied participation in the SDI Program. No other SDIO office maintains detailed information about foreign subcontracts. The Director added that SDIO is integrating the database into SDIO's management information system, but full integration is not expected until 1990. The Director said the management information system is expected to provide improved information about contract status. The system may also include subcontract information, but the Director said that obtaining this information will continue to be difficult.

To verify the accuracy of the database, we examined all contracts listed in the March 31, 1989, version of the database that were valued at over $1 million and located at various DOD agencies in the Washington, D.C., area or at the Army Strategic Defense Command in Huntsville, Alabama. These contracts amounted to 85 percent of the foreign contracting total. We found that the two most common inaccuracies involved the contract date and the contract amount. For example, contract amounts were frequently incorrect either because they did not reflect contract modifications that had recently been made or they were allocated to the wrong fiscal years. The database total of $321.5 million was close to the total we calculated of $313.0 million partly due to offsetting errors. (Both amounts excluded obligations to U.S. subcontractors.) For example, the database erroneously showed that over $24.2 million had been obligated to U.S. subcontractors, but we found that over $12.5 million in foreign contracts and subcontracts had not been listed in SDIO's database.

The Director of the Office of Multinational Programs said that his office monitors foreign contracts to answer questions regarding foreign participation in the SDI Program. The Director added that contract information changes are not systematically reported to his office, and thus the

database is likely to contain some errors, especially for information regarding subcontracts.

## Objectives, Scope, and Methodology

Because of his concern about the amount of foreign contracts awarded under the SDI Program, the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, asked us to analyze the level and type of foreign participation in the program.

We interviewed officials from SDIO; the Air Force Systems Command's Aeronautical Systems Division, Electronic Systems Division, Rome Air Development Center, Space Systems Division, Air Force Weapons Laboratory, and Wright Aeronautical Laboratories; the Air Force Office of Scientific Research; the Army Strategic Defense Command; the Office of Naval Research; the Naval Research Laboratories; the Naval Surface Warfare Center; the Naval Weapons Center; the Defense Nuclear Agency; the Department of Energy; two U.S. universities; and the embassies of Canada, the Federal Republic of Germany, Japan, and the United Kingdom. In addition, we reviewed contract files and other agency records. We conducted our review between January and August 1989 in accordance with generally accepted government auditing standards.

DOD concurred with our report. Its comments appear in appendix I.

Chapter 2

# Analysis of SDI Foreign Contracts

As of March 31, 1989, the executing agencies of the SDI Progr awarded 67 contracts to foreign contractors in 8 countries. T tracts are valued at $297.1 million, $228.4 million of which h obligated. The contract value represents about 3 percent of t tract awards.

## Foreign Contractor Awards

The 67 foreign contracts awarded to foreign governments, co and universities ranged from a $10,000 contract with an Ital pany for chemicals to a $126.4 million contract with an Israe an experimental missile defense system. These contracts wer both competitively and sole source. At least $31.6 million, or percent, was obligated to U.S. companies and universities as tracts and procurement orders.

Israel was the largest recipient of SDI contracts in terms of do receiving $141.7 million. In terms of the number of contracts Kingdom was the largest recipient, receiving 36 contracts, as table 2.1.

**Table 2.1: Foreign Contracts by Country**

Dollars in millions

| Country | No. of contracts | Award total | Amount obligat FY 85-86 | FY 87 | FY 88 |
|---|---|---|---|---|---|
| **Countries with MOUs** | | | | | |
| Israel | 8 | **$141.7** | $0 6 | $7 6 | $22 8 |
| West Germany | 9 | **64.8** | 6 4 | 19 7 | 30 4 |
| The United Kingdom | 36 | **56.7** | 3 9 | 17 8 | 15 4 |
| Italy | 6 | **15.3** | 0 0 | 4 4 | 7 9 |
| Japan | 1 | **3.0** | 0 0 | 0 0 | 1 2 |
| **Subtotal** | **60** | **281.5** | **11.0** | **49.4** | **77.7** |
| **Countries without MOUs** | | | | | |
| France | 2 | **8.5** | 0 1 | 2 6 | 4 4 |
| The Netherlands | 1 | **5.0** | 0 0 | 4 0 | 1 0 |
| Canada | 4 | **2.2** | 0 2 | 0 6 | 0 5 |
| **Subtotal** | **7** | **15.6** | **0.3** | **7.2** | **6.0** |
| **Total** | **67** | **$297.1** | **$11.3** | **$56.6** | **$83.7** |

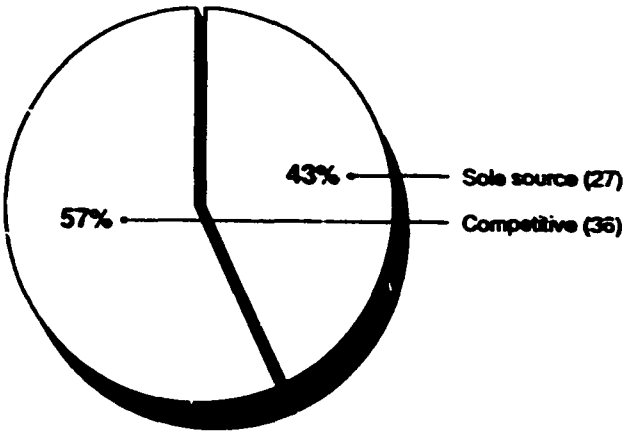
Note Totals may not add due to rounding

Note Dollar amounts for award total fiscal year 1989 amount obligated and total amou as of March 31 1989

SDIO has awarded more foreign contracts than any of the ot agencies. SDIO's contract awards amount to $156.3 million, cent of the total amount obligated to date. This large amou SDIO's interest and expertise in contracting with foreign org according to SDIO officials. The Army is second with contra of $43.9 million, or 19.2 percent, and the Air Force is third million, or 6.3 percent.

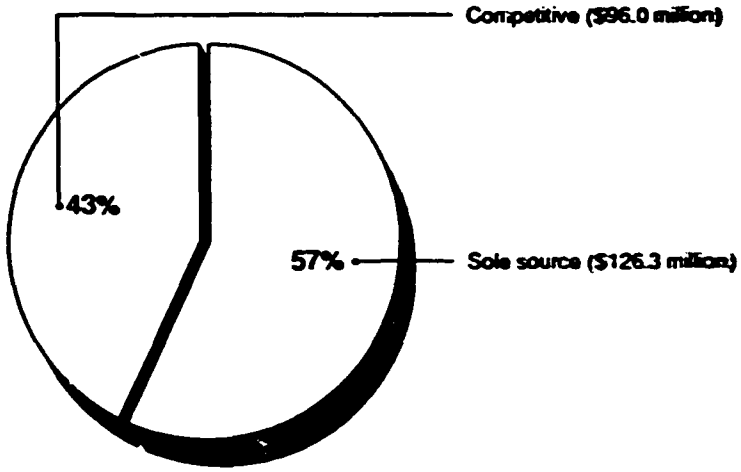
The basis of award is known for 63 of the 67 contracts awa mation regarding the basis of award for four contracts was available.) Of the 63, 36, or 57 percent, were awarded comp and 27, or 43 percent, were awarded sole source (see fig. 2. the sole-source contracts were valued (based on obligations $126.3 million, or 57 percent, whereas the competitive awa ued at $96.0 million, or 43 percent (see fig. 2.2). The basis o tract awards varied by executing agency, as shown in table

**Figure 2.1: Basis of Award by Number of Contracts**




Note The basis of award for four contracts, valued at $6 1 million, is unknown

**Figure 2.2: Basis of Award by Value of Contracts**




Note: The basis of award for four contracts, valued at $6.1 million, is unknown.

**Table 2.2: Basis of Contract Award by Executing Agency**

| Executing agency | Basis of award | | |
|---|---|---|---|
| | Competitive | Sole source | Unknown |
| Air Force | 7 | 0 | 0 |
| Army | 0 | 4 | 0 |
| Defense Nuclear Agency | 0 | 5 | 0 |
| Department of Energy | 3 | 2 | 0 |
| Navy | 16 | 1 | 0 |
| SDIO | 4 | 15 | 1 |
| Other | 0 | 0 | 3 |
| **Total** | **36** | **27** | **4** |

## International Agreements

Many countries have agreements with DOD that predate the SD
Some of these agreements are used to facilitate the exchange
tion on SDI-related projects. In addition, SDIO has developed M
MOAs that specifically address SDI issues with foreign countries
ownership of information or products and security arrangeme

According to DOD officials, MOAs with Israel, the Netherlands, a
United Kingdom are more specific than MOU's because they rel
particular project. The Netherlands' MOA details a cost-sharing
on electromagnetic launch technology. The first MOA with Isra
a cost-sharing program on an anti-tactical ballistic missile pro

second Israeli MOA addresses a cost-sharing program on a thea tic missile defense test bed.

One item covered in MOU's and MOAs, as well as in contracts, is i property rights, which determine ownership of the informatic ucts produced as a result of contractual work funded by the U States on SDI research. According to an SDIO official, backgrou mation already owned by a contractor and information develo pendently of U.S. funding, both known as proprietary informa usually remain the contractor's property; thus, SDIO cannot sh information with other contractors without permission. Howe official said that for most U.S.-funded projects, including thos costs are shared with another country, the United States recei ited rights to all information that is derived from work on the

## Flow of Technology

DOD officials told us that SDI foreign contracts allow the United not only to share technology with other countries but also ben technological developments in those countries. SDIO officials ga following examples of foreign entities that are providing the U States with technologies related to SDI research.

- An Israeli entity working on an electromagnetic railgun (a dev electromagnetic launching to fire projectiles at very high veloc giving SDIO a demonstration of unique traveling charge and hyb concepts for accelerating small projectiles to very high velociti return, SDIO is providing this entity with barrels, capacitors, an speed camera.
- A Dutch organization working on an electromagnetic launch fa providing SDIO with research and experimental data. In return, providing a leased homopolar generator (a generator that has a tional flow between the poles of a magnet), a switch, a capacit barrels.
- An Italian company working on a "smart" electro-optic sensor ing SDIO an innovative infrared focal plane array architecture f enhanced signal processing.
- A French university working on innovative methods for proces tronic and optical materials is providing the Air Force with che anion precursors (negatively charged ions used to form other s stances) for producing superconductivity materials.

Neither the Italian company nor the French university are usin technology in their research.

Officials from two of three embassies that provided comments regarding the flow of technology concurred with DOD officials t flow of technology has been beneficial to the United States. On embassy official stated that "the flow [of technology from his c to the [United States] has been sizeable, commensurate with th of the contracts and sub-contracts awarded."

## Transfer of Technology

The flow of certain U.S. technologies, such as classified inform products, from the United States to foreign entities is controlle legislation and executive regulations. The laws and regulations not only the procedures to be followed in transferring technolo also the criteria in approving such a transfer.

The transfer of technology is provided for under the Export A tion Act of 1979, as amended, and the Arms Export Control Ac amended. The Export Administration Act is implemented by th ment of Commerce under the Export Administration Regulatio regulations primarily address "dual use" commodities and infc (i.e., commodities and information that are intended for comm nonmilitary use but may be used for military applications). Th Export Control Act, as amended, is administered by the Depart State under the International Traffic in Arms Regulations. The tions require controlled handling of specified information and related to military applications, as stipulated in the regulations tions list. DOD officials said that most transfers of SDI-related te occur under these regulations.

The National Disclosure Policy is used in approving technology sent overseas. The policy outlines criteria that are used to dete whether classified technology should be transferred to foreign The criteria, according to DOD sources, are (1) the proposed tra to be consistent with overall U.S. policy toward the recipient co (2) the positive effects of the proposed transfer is to outweigh ent risk to U.S. military security, (3) the proposed transfer is t a benefit to the United States that is at least of equal value to t technology at issue, (4) the scope of the proposed transfer—in both quality and quantity—is to be consistent with the purpos served by the transfer, and (5) the recipient country has formal agreed to afford the U.S. technology it receives a degree of pro from unauthorized disclosure that is equivalent to that provid United States. According to DOD security officials, use of the fi

criteria is largely subjective and incorporates input from vario cal-military perspectives, whereas use of the last criterion is b objective.

Foreign entities receive classified U.S. technology by acting as subcontractors to U.S. companies or prime contractors to the U ernment. Transactions between U.S. companies and foreign sub tors are subject to the International Traffic in Arms Regulation export licensing procedures, described in the next section. Fore contractors receive technical data through the U.S. governmen ing to international agreements that govern the transfer of clas technology. Such transfers to foreign prime contractors must c with all provisions of the International Traffic in Arms Regula other technology transfer criteria, although the U.S. governme does not need to actually acquire an export license.

## Export License Procedures

As stipulated under the International Traffic in Arms Regulati export license applications are made to the Office of Munitions of the Department of State. SDIO security officials said that alth Department of State usually consults U.S. agencies responsible classified technology, such as DOD, the Department of State ma final decision in approving the license.

After an export license is approved, which DOD officials said ma takes about 6 weeks, the Defense Investigative Service transfer technology to the foreign government. The foreign government transfers the technology to the foreign subcontractor.

DOD officials told us that although foreign organizations have r classified technology through the export license procedures qu process is sometimes very time-consuming. For example, an offi us that the Army received numerous complaints from U.S. cont regarding delays in obtaining export licenses for foreign subcon developing European theater missile defense studies. Army and ment of Energy officials also told us that complicated and time ing procedures have limited foreign participation in the SDI Prog

One foreign embassy official said that many companies from thi "...are of the opinion that participation in U.S. defense-related unwarrantedly limited by restrictions on technology transfer." cial from another embassy stated that U.S. export laws are perc an inhibition to working with American firms. He added that an

perception is that some bids are being rejected because of obstacl
obtaining an export license.

## Other Procedures

The International Traffic in Arms Regulations provide several ex
tions that give DOD the authority to disclose or transfer classified
mation without getting an export license. DOD officials described t
exemptions that they said could be approved by the administering
vice. The first and most commonly used exemption is a plant visit
allows the disclosure of oral or visual classified information betw
U.S. and foreign entities, provided that the visit is sponsored by D
that normal DOD security requirements have been met. The secon
exemption allows for the actual transfer of classified technical da
is subject to the same security requirements as those for a plant v
This exemption, according to security officials, has been used only
by SDIO.

# Description of SDI Foreign Contracts

We grouped the foreign contracts awarded through the SDI Prog according to the programs that they support. These programs a ter Missile Defense; Surveillance, Acquisition, Tracking, and Kil ment; Directed Energy Weapons; Survivability, Lethality, and K Technologies; and Innovative Science and Technology. Other for contracts have been included in a miscellaneous category. Table vides information about the contracts.

**Table 3.1: Foreign Contracts by Program**

Dollars in millions

| Program | No. of contracts | Amount | % |
|---|---|---|---|
| Theater Missile Defense | 21 | $205.0 | |
| Surveillance, Acquisition, Tracking, and Kill Assessment | 11 | 58.1 | |
| Directed Energy Weapons | 7 | 18.7 | |
| Survivability, Lethality, and Key Technologies | 11 | 7.9 | |
| Innovative Science and Technology | 14 | 5.7 | |
| Miscellaneous | 3 | 1.7 | |
| **Total** | **67** | **$297.1** | |

## Theater Missile Defense

SDI research and development for the Theater Missile Defense p focuses on interception of enemy missiles before they reach the targets, known as active defense, and related command, control nications, and intelligence. Theater Missile Defense projects incl Architecture Studies, the Arrow Experiment, Foreign Technolog port, Test Bed, Command Center/System Operation and Integra Functions, and Combined Allied Defense Experiment/Invite, Sh Test. The goal of these projects is to form a foundation for a lay defense against ballistic missiles. This program accounts for $20 lion, or 69.0 percent, of the total SDI foreign contract amount.

### Architecture Studies

The initial focus of foreign participation in theater missile defe to establish architecture studies in different regions to determin need for missile defenses and identify an effective defense syste each region. Architecture studies describe the functional activit performed to achieve a desired level of defense and include a de tion and performance levels of those system elements making up functional activities.

In support of these studies, the United States awarded seven cont totaling $50.3 million to allied contractors participating in SDI rese to focus on active defense and command, control, communications intelligence issues. The studies included analyses of the missile th the European countries of the North Atlantic Treaty Organization (NATO), the United Kingdom, the Middle East (Israel), and the West Pacific Basin (Japan).

## NATO Europe

Countries participating in SDI research in NATO Europe are conduct architecture studies to evaluate theater missile defense from a con tional tactical viewpoint. Seven companies were competitively sel and given contracts by the Army. Three were contractors from Fr Italy, and West Germany, which together received $23.8 million. I tion, NATO Europe subcontractors of four American firms received million.

The studies have two phases. Phase I, completed in 1987, focused alternate architecture concepts, critical technologies, and missions theater defense system, considering near-, mid-, and far-term threa posed by tactical ballistic missiles. Five of the seven contractors w selected to continue into phase II; the two contractors that were dr were both from the United States. Phase II is focusing on developi detailed system specifications; identifying detailed battle manage and command, control, and communications requirements; and dev ing implementation plans in post-Intermediate Nuclear Forces Trea scenarios. It was scheduled to end in September 1989.

## United Kingdom

A British government agency received two contracts from SDIO tot $13.2 million. One contract is for a European Architecture Study a a sole-source award for $12.7 million. This study is to provide a Eu perspective on a European strategic global nuclear defense, in cont to the NATO Europe studies, which are from the perspective of an in pendent European defense system. The study is to look at the defe of independent strategic retaliatory forces of the United Kingdom France. The other contract is for artificial intelligence research, w to discriminate decoys and other objects from actual targets (re-en vehicles). This is a cost-shared contract in whi the United States providing $500,000 in funding and the British government is provi $185,000 in funding and labor.

## Middle East

An Israeli government agency received $10.3 million from SDIO to s theater missile defense issues in the Middle East. The objective of study is to develop a threat assessment and a defense architecture

design. The contract also provides for developing an Israeli test bed cept definition program and defining the overall concept of the Isra test bed and the approach that will be followed in the test bed's dev ment and implementation. A test bed is a facility that provides the bilities to compare, evaluate, and test alternative architectures; dev command center/system operation and integration functions; and p vide the simulation for a strategic defense system.

### Western Pacific Basin

This study is designed to develop a complete threat assessment to t Western Pacific region, emphasizing the defense of Japan and other ritories in the area. The study is also intended to characterize the th against the allied sea lines of communication in the western Pacific. tracts were awarded in November 1988 by SDIO to a Japanese contra and a U.S. contractor, each receiving $3.0 million.

## Arrow Experiment

As part of an ongoing cooperative effort to develop U.S. and allied c bilities in countering short-range missile threats, SDIO contracted wit Israeli company to demonstrate the capability of the Israeli Arrow m sile to intercept a target representing a tactical ballistic missile. The tract, awarded in July 1988, is for $150.1 million. Of this amount, th United States contributed $126.4 million and Israel contributed $23. million.

The experiment will consist of four phases, two of which have been completed. Phase I included a design feasibility study that evaluated performance requirements for the target vehicle and missile intercep Phase II involved design and test specification development for all c ponents involved in the experiment. Phase III—the current phase—sists of hardware fabrication and subsystem assembly. During this phase, laboratory and ground tests are to be conducted to flight qual and test missiles, software is to be developed, and propulsion and co trol tests are to be conducted. Phase IV will consist of three flight te of the missile. At the end of the contract period, expected to be in Ju 1991, SDIO is to receive reports on the experiments and specifications and detailed drawings for the missile, its subsystems, and componen

## Foreign Technology Support

The purpose of Foreign Technology Support is to demonstrate the fe bility of foreign technologies, leading to their integration into kinetic energy and theater defense interceptor designs. To support this activ SDIO has awarded five foreign contracts worth $14.8 million.

Three of the contracts, worth $10.4 million, involve research on elec magnetic railguns. One of these contracts is with an Israeli research center that is examining the feasibility of using a combination of ele cal and chemical energy sources to produce ultrahigh velocities need for an effective railgun weapon. According to contract records, the research, if successful, could negate the need for large costly power plies. This, in turn, could reduce the weight of space-based railguns, cooling requirements for the railguns, and the cost of placing railgun orbit. SDIO is providing equipment, such as barrels, capacitors, and a high-speed camera, to the railgun research effort.

A fourth contract is for determining the merits of an exoatmospheri radar seeker, which uses external sensors to distinguish and focus o target outside the earth's atmosphere, including assessing the lethali performance of an erectable or "pop-out" antenna. According to con tract documents, this work may confirm that radar seekers offer cer advantages over infrared seekers.

A fifth contract is for investigating the feasibility of using fluidic diverter valves, which are nozzles on a kinetic energy weapon used t control its movement. The use of this valve may lead to higher opera efficiencies and thus lower propellant requirements and overall syst weight.

## Test Bed

SDI officials are developing a National Test Bed for the United States Extended Air Defense Test Bed for U.S. forces and allies in Europe, a an Israeli Test Bed for the Middle East. Two foreign contracts with a total value of $8.4 million were awarded for this purpose.

The contract receiving the majority of the funding was awarded to a British government agency in September 1988 for $8.1 million. The I ish government is contributing an additional $6.2 million to the proje This contract is for developing an Extended Air Defense Test Bed in United Kingdom. Extended air defense is defined as defense against tical ballistic missiles, cruise missiles, and aircraft. The test bed will sist of the computer hardware and software needed to evaluate ongo extended air defense research and simulate an extended air defense Western Europe.

## Command Center/System Operation and Integration Functions

This activity is to identify targets, allocate interceptors, execute and assess the defense, and manage resources. Three foreign contracts, with a total value of $3.9 million, were awarded sole-source to support this activity.

The largest of these contracts, for $3.3 million, was awarded to a British government agency that is to derive a battle management and command control, and communications architecture to complement the European Architecture Study. According to an Army contracting official, the study, which was completed in August 1988, provided an independent perspective of a European battle management and command, control and communications system and applicable issues, technologies, systems, and concepts.

The other two contracts involved the development and validation of an architecture model for sensor data fusion in SDI systems and the design and development of computer software to support SDI network simulations.

## Combined Allied Defense Experiment/Invite, Show, and Test

This activity is to test and evaluate U.S. and allied technological systems and subsystems and make recommendations for their use as elements of an interim theater missile defense capability. After soliciting proposals for applicable technologies, the Army awarded nine contracts based on proposals from six U.S. organizations and three British firms.

All three British contracts, totaling $1.2 million, were awarded in 1988 and completed in 1989. One contract evaluated an enhanced warhead consisting of laser-guided darts through simulation, one conducted simulation testing of a missile that is used for ship defense and is to be fitted with a new guidance system and possibly converted to a point defense weapon, and one tested the surveillance and fire control capabilities of an experimental radar and simulated the electronic counter-countermeasure capabilities of the radar in a hostile environment.

## Surveillance, Acquisition, Tracking, and Kill Assessment

This program element is to provide the research and technology development efforts necessary to identify and validate various sensor concepts needed through all stages of a missile attack: boost, post-boost, midcourse, and terminal. The SDI Program has awarded 11 contracts to foreign entities under this program element (not including several Innovative Science and Technology contracts discussed later), valued at

$58.1 million. The largest of these contracts is for the Infrared Background Signature Survey. Other contracts were awarded to support several projects, including Passive Sensors, Support Technology, and Laser Radar Technology.

## Infrared Background Signature Survey

Infrared Background Signature Survey research focuses on developing a means of identifying targets by their plumes, which are created by the exhaust of vehicles. Studying the relationship between plumes and vehicles may facilitate the differentiation of decoys from missiles with warheads.

In July 1986 SDIO awarded a West German company a $48.0 million contract, but that amount may increase to $77.5 million. The company is to upgrade the Shuttle Pallet Satellite carrier (also known as SPAS-01), which the company previously used to launch experiments from the shuttle; perform the survey with an infrared spectrometer; and provide post-flight analyses. During testing the survey will analyze the plume and environment of the orbiter, scan the earth limb (a layer of dust surrounding the earth), perform celestial calibrations, and analyze chemicals and gases released from the orbiter.

The space shuttle launch for the Infrared Background Signature Survey is scheduled for July 1990. All work, including analyses derived from experiments performed during the launch, is scheduled to be completed by November 1990.

## Passive Sensors

A passive sensor can be used for making discrimination measurements during various phases of a missile's flight by measuring the ultraviolet, visible, and infrared energy received from targets. SDIO awarded two contracts, totaling $4.5 million, to foreign contractors under the Passive Sensors project.

The purpose of one contract is to establish the feasibility of an infrared focal plane array structure capable of improved clutter rejection and target detection. The ultimate goal is to design an electro-optical sensor that can distinguish between a target missile and decoys and other clutter with a high detection rate coupled with a low false alarm rate. The purpose of the other contract is to demonstrate the feasibility of long wavelength infrared detectors that operate in the 8 to 12 micrometers

waveband and at temperatures around 200 degrees Kelvin. These detectors are also to have a high detection rate. The design and fabrication of such sensors are also being undertaken.

## Support Technology

SDIO awarded two contracts valued at $3.3 million to foreign contractors for the Support Technology project. The largest of these contracts, which is ongoing, is with a British government agency for $2.8 million. The contract was awarded to initiate development of suitable low-temperature carbon monoxide catalysts for use in carbon dioxide laser systems. Such lasers have the potential for use in radar systems. Low-temperature catalysts have advantages over high-temperature catalysts in space-based systems.

## Laser Radar Technology

The overall goal of the Laser Radar Technology project is to support both fire control and discrimination functions for a strategic defense system. Four foreign contractors received a total of $2.1 million for work under this project. Some of the work performed by the contractors includes conducting a feasibility demonstration of carbon dioxide laser programmable delay lines using hollow waveguide technology, researching ways to improve the performance of laser radar systems by use of distributed aperture laser radar receivers, and developing a method for simultaneously grinding and polishing a mirror.

## Other Contracts

Two other contracts, totaling $299,000, were awarded under other Surveillance, Acquisition, Tracking, and Kill Assessment projects. The larger of these contracts was awarded by SDIO to a Canadian firm in 1987 for $269,045 to produce plans for an atmospheric platform.

# Directed Energy Weapons

The Directed Energy Weapons program element supports engagement and destruction of attacking objects through identification and validation of the most promising directed energy concepts, such as ground- and space-based lasers and space-based particle beams. Seven foreign contracts, totaling $18.7 million, were awarded to support the Neutral Particle Beams project and other Directed Energy projects.

## Neutral Particle Beams Project

A neutral particle beam is a beam of energy consisting of neutral (no electric charge) atoms and can be used to identify targets and/or disable a target with lethal energies. Neutral particle beam projects fall into two

areas of research and development: continuous wave and p
A continuous wave beam functions without interruption; a
operates periodically in short bursts.

Two contracts were awarded for continuous wave research
ment. U.S. obligations for the two contracts total $10.3 milli
tion. one subcontract, discussed in chapter 4, was awarded
continuous wave research and development.

A British laboratory received $8.9 million through an Air F
to develop a high-current, low-emittance negative ion sourc
tinuous wave and will be tested on an accelerator. The acce
magnetic force to accelerate charged particles to nearly the
light, then neutralizes them to form a neutral particle beam.
delivered to the United States include an ion source produci
ous wave negative hydrogen ion, a low-energy beam transp
an ion source test stand, and a design of a low-energy beam
the radio frequency quadropole and a high-energy beam tra
the radio frequency quadropole. Analyses of the work are a
performed.

Another neutral particle beam contract is for an internation
tive program based on a cooperative effort that began in fis
1986 between a Canadian laboratory and the Los Alamos N
ratory in New Mexico. The Canadian effort focuses on techi
lems confronting neutral particle beams, particularly contin
and radio frequency quadropole experiments. The Canadiar
is building an accelerator and a beamline and is sharing infc
with contractors in the United States and the United Kingdc
working on similar projects and with the U.S. government. T
U.S. share of the contract is $1.5 million.

## Other Directed Energy Projects

Five foreign contracts, totaling $8.4 million, were awarded t
various other Directed Energy projects. One contract, for $4
was awarded by the Air Force to a West German company, a
Chemical Lasers project, for fabrication of a lightweight hig
mirror. The finished product will be a 70-centimeter mirror
lightweight, uncooled glass ceramic material with no therma

Two contracts, totaling $1.7 million, were awarded under th
Definition Technology Integration project. One of these cont
conduct research on a chemical laser that could be made sm

lighter than current lasers and would operate at short wavel
other contract is to analyze the capabilities of a satellite pou
tem. According to this contract's statement of work, Directe
experiments require significantly better pointing accuracy a
than provided by the space shuttle.

## Survivability, Lethality, and Key Technologies

Many foreign contractors participate in SDI through the Surv
Lethality, and Key Technologies program element, which inc
research projects (e.g., those that support power needs, laun
space, and countermeasures) to develop a future defensive s
Eleven foreign contracts totaling $7.9 million were awarded
the Lethality and Target Hardening, Systems Survivability, :
and Structures, and Power and Power Conditioning projects.

## Lethality and Target Hardening

Two foreign contracts totaling $3.4 million were awarded fo
ity and Target Hardening project. These contracts are to dev
mates of kinetic energy weapon lethality against Soviet strat
One contract, for $2.5 million, was awarded to a West Germa
to conduct research on short-range ballistic missile lethality
energy weapons, lasers, and microwave pulses. The research
characterize the threats, including warheads, (2) determine r
ments for destroying the targets, and (3) assess the results t
facilities and vulnerability analyses.

## Systems Survivability

Once SDI systems are deployed, they may be subject to enemy
Thus, the goal of the Systems Survivability project is to ensu
effectiveness during an attack. Two foreign contracts totalin
lion were awarded under this project.

One contract is to use SDI concepts to identify potential Sovie
measures that may be used to enhance the penetration capal
short-range missiles against European defenses. The other co
develop advanced technologies for hardening optical system
continuous wave and projected pulsed laser threats.

## Materials and Structures

The Materials and Structures project is to develop and demo
advanced materials and structures technologies critical to SD
survivability, reliability, and affordability. The materials re
includes tribology (the study of design, friction, wear, and lu

interacting surfaces in relative motion), structural materials, a dynamic control of space structures. Five foreign contracts tot million were awarded.

Two contracts were awarded to a British research center to de "dry" lubricants for satellite systems and test high-strength, li bearing materials. Current U.S. lubricants are "wet" (based on grease) and can contaminate sensitive satellite systems.

The other three contracts are for studying materials that may in SDI systems. These materials include (1) a thin-walled struct of carbon-carbon that could be used to withstand the environm space and of enemy countermeasures, (2) composite spacecraf als, such as ceramic matrix composites, and (3) cryogenic indu which use substances—such as hydrogen, neon, or helium—to very low temperatures.

## Power and Power Conditioning

The Power and Power Conditioning project is to develop a pow nology base—both nuclear and nonnuclear power generation— multimegawatt regime to support SDI mission requirements. To this project, the Department of Energy competitively awarded eign contracts totaling $400,000. Both contracts involve resear method of generating multimegawatt electric power, which is r space-based systems, and using a method that will involve mag drodynamics, which relates to phenomena arising from the mo electrically conducting fluids in the presence of electric and ma fields. One approach being tried is to pass liquid metal through netic field to generate electricity. Another approach is to use a source to reflect neutrons back into the reaction chamber to in electrical conductivity.

## Innovative Science and Technology

The Innovative Science and Technology program provides fun advanced research in fundamental science and engineering, fo exploitable areas applicable to ballistic missile defense. Most o cuting agencies for the SDI Program have projects for this purp Through March 1989, 14 foreign contractors have been award of $5.7 million. Most of these awards have been competitively by the Navy to British universities and companies. One of thes sities is to calculate the rate of photoionization (the conversion cles into ions resulting from the collision of those particles with photons) of ions of SDI-related materials. The materials may be

short wavelength lasers. Another university is to manufacture uate prototype gate arrays based on nonlinear semiconductor s devices. The arrays are key to the development of digital optic puting and may enable the realization of a viable parallel comp machine. Another university is to develop new signal processin gies or adaptive sensor arrays that will enhance directional sig while reducing interference.

## Miscellaneous Contracts

One contract not part of the programs discussed previously is a $708,488 contract awarded by the Defense Nuclear Agency to a government agency to study the relationship between lasers an materials (i.e., how much energy should be directed at a target much energy is reflected).

In addition, SDIO could not provide detailed information on two pleted contracts valued at $1.0 million that were listed on the d provided by the Office of Multinational Programs.

Chapter 4

# Description of SDI Foreign Subcontracts Awarded by U.S. Contractors

We identified 86 subcontracts that U.S. contractors had awarded eign organizations in 11 countries through March 31, 1989. Thes contracts totaled about $48.4 million, of which $27.3 million has obligated. The United Kingdom leads all other countries in the nu of subcontracts (42) and the subcontract amount ($31.1 million) shown in table 4.1.

**Table 4.1: Foreign Subcontracts by Country**

Dollars in thousands

| Country | No. of subcontracts | Award total | Amount obligated FY 85-86 | FY 87 | FY 88 | FY 89 |
|---|---|---|---|---|---|---|
| The United Kingdom | 42 | $31,105 | $660 | $2,299 | $2,946 | $2,503 |
| France | 9 | 9,217 | 937 | 4,877 | 1,908 | 1,169 |
| West Germany | 13 | 5,670 | 1,369 | 1,353 | 2,033 | 915 |
| Canada | 6 | 775 | 37 | 205 | 429 | 104 |
| Japan | 1 | 650 | 0 | 0 | 650 | 0 |
| Italy | 5 | 469 | 0 | 281 | 155 | 33 |
| Israel | 6 | 310 | 0 | 131 | 160 | 19 |
| Other European countries | 4 | 193 | 56 | 137 | 0 | 0 |
| **Total** | **86** | **$48,389** | **$3,059** | **$9,283** | **$8,281** | **$4,743** |

Note: Totals may not add due to rounding.

Note: Dollar amounts for award total, fiscal year 1989 amount obligated, and total amount obligated as of March 31, 1989.

[a]Obligations of $1,599,000 have been made but could not be allocated by fiscal year.

[b]Obligations of $302,000 have been made but could not be allocated by fiscal year.

The major foreign subcontracts of U.S. contractors have been gro according to the programs they support. These programs are Dire Energy Weapons; Kinetic Energy Weapons; Innovative Science an nology; and Survivability, Lethality, and Key Technologies. The s tracts for projects in these programs account for $40.9 million of foreign subcontract total. The remaining $7.5 million consists of $ million for Theater Missile Defense subcontracts (discussed in par ch. 3), $0.3 million for Systems Analysis and Battle Management s tracts, and $0.5 million for subcontracts for which information wa readily available.

## Directed Energy Weapons

Foreign subcontracts have been awarded for two Directed Ener projects: the Ground-Based Free Electron Laser project and the Particle Beams project. These subcontracts amount to $27.3 mi 56 percent of the foreign subcontract total.

## Ground-Based Free Electron Laser Project

The ground-based laser system concept is to fire a free electron beam generated on the ground to a mirror relay system in spac mirror relay system redirects the beam to a satellite (via an ing scope) that focuses the beam on the target (via an output teles Foreign participation in this project is based almost entirely on tracts with companies from five European countries and Cana subcontracts amount to $13.3 million.

To provide ground-based support for the project, a French firm plying klystrons (electron tubes used for generation and ampli ultrahigh frequency current) and other equipment at a total co million. Subcontractors from other countries are providing gro services, such as magnets for the creation of magnetic fields, th tubes (gas-filled hot cathode electron tubes with a trigger cont start of a continuous current), and rectifier diodes for converti nating current into direct current.

West German subcontractors have provided or are providing s based support for the free electron laser. One constructed a mi of zerodur (a glass ceramic with zero thermal expansion) to be one of the beam-directing telescopes for $2.3 million. Another researching and developing accelerator modules for the High E Modular Components program under a subcontract for $1.7 mi

## Neutral Particle Beams Project

A major task of the Neutral Particle Beams project is for the C Wave Deuterium Demonstrator to research and develop a cont wave beam using deuterium (an ion of hydrogen). The demons low-energy requirements and is cryogenic (i.e., uses substance hydrogen, helium, or neon to obtain low temperatures).

One subcontractor, a British laboratory, is expected to receive lion for research and development related to the demonstrator the subcontractor's expected contributions include developmen ion injector subsystem, the High Energy Beam Transport (inch bending and focusing magnets), the beam stop (including cooli tem), and a megawatt radio frequency power system to be use

front end accelerator operation. The demonstrator is designed to b taken apart and transported as a deliverable item at the completio the contract, expected to be in May 1992.

## Kinetic Energy Weapons

An Air Force contractor has awarded two subcontracts, totaling $ million, to two foreign companies for a Kinetic Energy Weapons pr The first subcontract, awarded to a British company, is for two pr type inertial measurement units for the Space-Based Interceptor. T second subcontract was awarded to a Canadian company to build ammonia laser and a carbon dioxide laser for the interceptor.

## Innovative Science and Technology

Foreign subcontractors are involved in five Innovative Science an Technology contracts—four with the Air Force and one with the N The subcontracts are valued at $3.7 million.

The subcontractors, mostly British and Canadian universities, are engaged in various research efforts. Examples of these efforts incl (1) conducting research on polymers to find materials that can det range of threats and trigger appropriate countermeasures, (2) exa ing insulating materials subjected to nuclear radiation and extrem perature, and (3) examining the effect of the earth's atmosphere o path transmission spectra (ultraviolet to microwave), which could used in communication systems with space platforms.

## Survivability, Lethality, and Key Technologies

Foreign subcontracts totaling $1.7 million support Survivability, L ity, and Key Technologies projects. Two subcontracts for Power an Power Conditioning were valued at almost $1.4 million and awarde British companies. One subcontract is for technical expertise for th design of a nuclear reactor based on gas and fast neutron spectrum cooled reactor technology, and the other is for high-power switche addition, an Army Systems Survivability contract involved three f subcontractors from France, West Germany, and the United Kingdo These subcontractors performed a survivability analysis of propos theater missile defense architectures against various threats under contracts that totaled $354,000.

Appendix I

# Comments From the Department of Defense

Note: GAO comment supplementing those in the report text appears at the end of this appendix

DEPARTMENT OF DEFENSE
STRATEGIC DEFENSE INITIATIVE ORGANIZATION
WASHINGTON, DC 20301-7100

December 14, -

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

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "Strategic Defe Initiative Program: Extent of Foreign Participation," dated November 3, 1989 (GAO Code 392481), OSD Case 8172. The DoD c curs with the draft report.

See comment 1

This report accurately characterizes the difficulties th Strategic Defense Initiative Organization (SDIO) has had in m taining historical records of contracting activities that are outside formal reporting requirements. These historical reco sometimes erroneously referred to as a "Data Base," have prov very useful in the management of the Allied program within th SDIO, as well as informing non-DoD activities of the nature a extent of Allied participation. As noted in the GAO report, numerous significant improvements in the system are underway.

The DoD has separately provided several technical correc tions to members of your staff. The DoD appreciates the opp tunity to comment on the draft report

Sincerely,

ANSON W. SCHULZ
Brigadier General, USA
Acting Deputy Director

The following is GAO's comment on the Department of Defense letter dated December 14, 1989.

## GAO Comment

1. We recognize that no formal requirement exists for maintaining t information. We use the word "database" in the general sense to describe a comprehensive collection of related data organized for qu access by computer.

Appendix II

# Major Contributors to This Report

| | |
|---|---|
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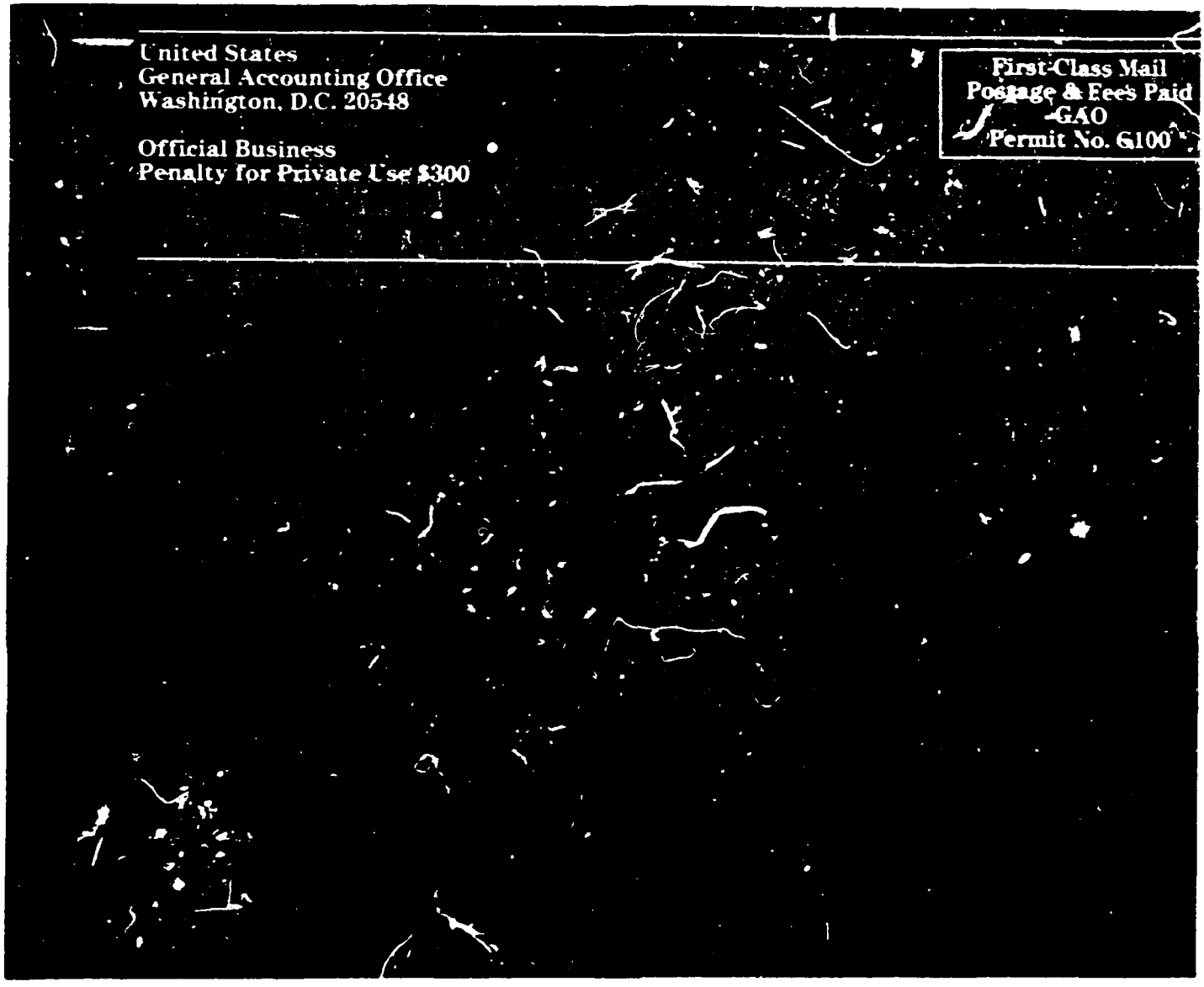
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