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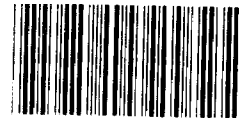
GAO

Report to the Chairman, Subcommittee on  
Environment, Energy, and Natural  
Resources, Committee on Government  
Operations, House of Representatives

May 1988

# NUCLEAR SCIENCE

## History and Management of the DOE/Air Force Small Reactor Project



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**Resources, Community, and  
Economic Development Division**

B-231045

May 26, 1988

The Honorable Mike Synar  
Chairman, Subcommittee on Environment,  
Energy, and Natural Resources  
Committee on Government Operations  
House of Representatives

Dear Mr. Chairman:

On February 20, 1987, you requested that we provide you with information on the joint Department of Energy (DOE) and Air Force small reactor project.<sup>1</sup> The project was intended to develop a prototype reactor to assess the possibility of using nuclear power to meet the secure power needs of the Air Force. We subsequently agreed to provide you with this report summarizing the origin, history, and funding of the small reactor project.

In summary, the project ran for a period of 4 years (between 1983 and 1987) and cost about \$3.75 million. Despite the time and money spent, it made little progress toward its intended goal, and the Air Force decided to terminate the project on May 22, 1987. We believe several problems with DOE's and the Air Force's management of the project contributed to its termination, including the following: (1) the feasibility of using nuclear power was not clearly established and documented prior to the decision to proceed with the project, (2) disagreements occurred between DOE laboratory staff and the Air Force project management that may have contributed to a shift in DOE field offices with responsibility for the project, (3) DOE shifted project responsibility between headquarters organizations during the course of the project, and (4) the Air Force failed to coordinate its request for project funding with the appropriate congressional committees, which resulted in the denial of funding and, eventually, in the termination of the project.

The remainder of this letter gives an overview of the project, summarizes key events that occurred, and states our conclusions regarding the management of the project. The last section presents our objectives, scope, and methodology. The appendixes present detailed information on events discussed in this letter.

<sup>1</sup>The project's goal was to develop a 10-megawatt reactor, which is small in comparison with today's commercial reactors (800-1000 megawatts). A megawatt is equal to 1 million watts.

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## Overview of the Small Reactor Project

The small reactor project was undertaken after the Air Force found that the key components of the national and international energy generation and distribution system are vulnerable to disruption. The majority of Air Force bases purchase their electric power from utilities. DOE, initially through its Los Alamos National Laboratory, pursued the possibility of using a small nuclear reactor to satisfy the Air Force's electric power needs.

In June 1983, with the approval of DOE's Office of Defense Programs, DOE's Los Alamos National Laboratory initiated the small reactor project by undertaking a study of the feasibility of using a small nuclear reactor as part of a secure energy system for military installations. The Air Force was the military service most interested in the possible application of this type of power source. Six nuclear reactor vendors participated in this study and five submitted preconceptual reactor design studies to Los Alamos. Los Alamos also formed a number of support groups for the project and was preparing a formal program plan to be submitted to DOE in order to obtain DOE funding. All of these activities were based on Los Alamos's belief that DOE would ask the laboratory to manage the project. (All Los Alamos activities related to the small reactor project were funded internally using discretionary funds.)

However, in early 1984 DOE assigned management of the project to its Idaho Operations Office. The Idaho Operations Office procured conceptual reactor designs from the same six reactor vendors used by Los Alamos. These designs were reviewed by DOE's Idaho National Engineering Laboratory and the Air Force. The Air Force then decided to proceed with the project to the next phase—preliminary design. The Idaho Operations Office solicited proposals and selected Westinghouse Electric Corporation. The next step would have involved negotiations for a fixed-price contract for the design and possible construction of a prototype; however, the Air Force terminated the project in May 1987 before a contract was negotiated. DOE and Los Alamos spent in total approximately \$3.75 million on the project prior to its termination.

The Air Force attributed the termination of the project to a lack of congressional concurrence on its use of Military Construction Program planning and design funds and to anticipated budgetary constraints. The Air Force also considered other factors, including environmental concerns, economic uncertainties, and inadequate requirement definition in its decision. (Apps. II through IV provide information on the program from inception through termination.)

## Problems With Los Alamos's Feasibility Study

Los Alamos began the feasibility study in June 1983 and completed a final draft of the feasibility study in March 1984, although the study was never formally published. The study concluded that, for most applications, nuclear reactors are technically the best option for a secure power supply and that the nuclear option is economically competitive with alternative systems. Los Alamos recommended that DOE proceed with the development of a prototype nuclear reactor for military applications. The draft feasibility study was reviewed by DOE headquarters, the Idaho National Engineering Laboratory, and the Air Force, all of whom found fault with it.

- A DOE headquarters official expressed concern that the study did not adequately address the viability of nuclear reactors as part of a secure energy system for military installations—the stated purpose of the study.
- DOE's Idaho National Engineering Laboratory, in written comments submitted to DOE's Office of Nuclear Energy, generally agreed with the study's conclusion that nuclear power is technically the best choice for secure energy system application. The laboratory commented, however, that if the Los Alamos study's requirement for isolated operation for periods in excess of 1 year were relaxed, the study's conclusions might be significantly different. In addition, the economic analyses comparing nuclear power with other alternatives were not conducted consistently and could be discredited easily.
- The Air Force manager for the small reactor project informed us that the Air Force also was not satisfied with Los Alamos's feasibility study. He stated that the study lacked credibility and sufficient input from reactor vendors. (Additional information on Los Alamos's role in the small reactor project and the feasibility study is presented in app. II.)

## Management Changes at DOE Headquarters and Field Offices

As DOE headquarters prepared to begin funding the small reactor project in 1984, the Secretary of Energy shifted responsibility for the project from the Assistant Secretary for Defense Programs to the Assistant Secretary for Nuclear Energy, who assigned the Idaho Operations Office responsibility for managing the project. Disagreements between the Air Force and Los Alamos may have been a factor in assigning the project management to the Idaho Operations Office. In addition, no coordination took place between Los Alamos and the Idaho Operations Office during the transition, resulting in some duplication of effort.

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## Responsibility for Project Transferred Within DOE

Until 1984, DOE headquarters responsibility for the small reactor project rested with the Assistant Secretary for Defense Programs. In early 1984 the Assistant Secretary for Defense Programs—who, according to Los Alamos staff and a Defense Programs official, was a strong advocate of the project—left DOE. In July 1984 the Secretary of Energy decided to move responsibility for the project to the Assistant Secretary for Nuclear Energy. The move was made after Defense Programs and Nuclear Energy officials agreed that the development of nuclear reactor technology is properly the role of the Assistant Secretary for Nuclear Energy.

Shortly before DOE headquarters responsibility for the small reactor project was shifted to the Office of Nuclear Energy, DOE assigned responsibility for managing the project to its Idaho Operations Office and the Idaho National Engineering Laboratory. DOE headquarters, field office, and laboratory officials told us that the Idaho Operations Office was assigned to manage the project because the Idaho National Engineering Laboratory performs a considerable amount of work for the Assistant Secretary for Nuclear Energy, while Los Alamos works primarily on projects for the Assistant Secretary for Defense Programs. However, both Air Force and Los Alamos project officials also told us that they had had a number of disagreements over the course of Los Alamos's involvement with the project. The Los Alamos program manager told us that he believes that those disagreements contributed to DOE's assignment of the project to the Idaho Operations Office. (Additional information on program management changes is included in app. II.)

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## Disagreements Between the Air Force and Los Alamos

According to the Los Alamos project manager, Los Alamos staff took actions that conflicted with the Air Force project manager's perceived role as the sole voice in the Air Force for secure power sources. For example, Los Alamos officials discussed the project with various Air Force commands and testified before the Congress without first clearing these actions through the Air Force. The Los Alamos program manager believes that Air Force officials spoke about these matters with officials within DOE's Office of the Assistant Secretary for Nuclear Energy and that those conversations played a role in DOE's naming the Idaho Operations Office as project manager.

The Air Force project manager confirmed that disagreements occurred between the Air Force and Los Alamos. He said that the Air Force had frequently cautioned Los Alamos officials on the need to proceed slowly, particularly when dealing with outside parties. The Air Force project

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manager said that, when asked by DOE, the Air Force did not object to DOE's plans to assign the management of the project to its Idaho Operations Office. (A detailed discussion of disagreements between program participants is included in app. II.)

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### Little Coordination Between Los Alamos and Idaho Operations Office

According to the Los Alamos project manager, after the project was assigned to the Idaho Operations Office, no one from either the Idaho Operations Office or the Idaho National Engineering Laboratory contacted Los Alamos. As a result, there were no discussions between these parties concerning the preconceptual reactor designs submitted by five of the six reactor vendors to Los Alamos during its feasibility study. In addition, the work Los Alamos performed in anticipation of being assigned the project manager role was not forwarded to the Idaho office. Because the two offices did not coordinate after the Idaho Operations Office was designated as project manager, the Idaho office duplicated some of the Los Alamos work, such as preparing a request for proposals for the conceptual design of a small reactor.

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### Funding Problems and Other Factors Contribute to Project Termination

In November 1986 the Air Force transferred its management responsibility for the project to a different Air Force organization, which immediately proposed to withdraw funding and participation in the project. The Air Force cited two reasons for terminating the small reactor project: (1) a Senate Appropriations Subcommittee's denial of the Air Force request to use certain funds for the design of the reactor and (2) anticipated budgetary constraints. The Air Force also considered a number of other factors internally prior to deciding to terminate the small reactor project.

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### Air Force Transfers Program Responsibility

The Headquarters Air Force Engineering and Services Center at Tyndall Air Force Base in Florida was responsible for the project from its inception at Los Alamos. In November 1986 the Air Force transferred responsibility for the project to the Engineering Division, Directorate of Engineering and Services, at Bolling Air Force Base in Washington, D.C. Immediately after assuming responsibility for the small reactor project, the Directorate of Engineering and Services proposed that the Air Force withdraw funding and participation in the project, stating that nuclear power is neither practical nor desirable.

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## Disapproval of Design Funds and Anticipated Budgetary Constraints

On April 9, 1987, the Chairman of the Subcommittee on Military Construction, Senate Appropriations Committee, disapproved the Air Force's notification of its intent to use Military Construction Program planning and design funds for its share of funding for the preliminary design phase of the small reactor project. The Chairman noted that Military Construction Program funds are not used for research and development projects and that the Air Force should seek funding from an appropriate research and development account.

The Air Force did not request funding from any other account and on April 16, 1987, the Secretary of Defense requested that the Secretary of the Air Force not obligate any funds for the small reactor project. The Air Force officially notified DOE on May 22, 1987, of its intent to terminate the project. (App. IV contains a more detailed description of (1) the Air Force's attempts to obtain funding for the project and (2) the termination of the project.)

In correspondence with Members of Congress, Air Force officials cited declining budget levels as a reason for terminating the small reactor project. One Air Force official stated that he did not believe the program could survive in a "climate of diminishing budgets."

The Air Force also considered environmental concerns, economic uncertainties, and the lack of adequate requirement definition prior to deciding to terminate the small reactor project.

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## Questions Remain Concerning Secure Power for Air Force Facilities

Although the small reactor project was terminated in 1987, the need for sources of secure power still exists at some Air Force installations. The Air Force is uncertain as to the full extent of this need because it is having a difficult time deciding which activities are truly critical to the ability of a particular Air Force base to function.

Air Force officials with the Engineering and Services Center at Tyndall Air Force base told us that the Air Force's need for secure power has not changed significantly since 1983 when the small reactor project was initiated at Los Alamos. These officials believe that it is only a matter of time until an event occurs that will highlight the vulnerability of Air Force energy supplies. The Air Force is planning a 2-year study to assess existing and emerging energy technologies for possible use as secure energy sources at Air Force installations. The study's objective is to determine the next best secure energy alternative to nuclear power. The



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study will consider nuclear power as a point of comparison for the other alternatives.

The project managers at both Los Alamos and the Idaho Operations Office believe that nuclear power is still the best alternative for supplying secure power to Air Force facilities. The Idaho office's project manager, however, was skeptical as to whether the nuclear industry would again participate in a fixed-price contract for such a project.

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## Total Program Costs

In addition to information on the history and management of the small reactor project, you requested that we provide you with a summary of the amount and sources of expenditures for the project and determine whether DOE had properly notified the Congress of any internal transfer of funds. The total cost of the project was about \$3.75 million. About \$450,000 of this amount came from internal Los Alamos Institutional Supporting Research and Development funds. DOE provided the remaining amount, about \$3.3 million. After termination of the project, the Air Force, at DOE's request, reimbursed DOE \$540,000 for its share (50 percent) of the project costs in fiscal years 1986 and 1987. (App. V contains a detailed analysis of the amounts, sources of funds, and congressional notifications of the internal DOE transfer of funds for the small reactor project.)

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## Conclusions

We observed a number of circumstances related to the management of the project that contributed to its limited progress and eventual termination. The project was not well conceived, lacked continuity in its management, and was not close to achieving any of its objectives.

For instance, the feasibility of using nuclear power was not clearly established and documented prior to the decision to proceed with the procurement of conceptual reactor designs. A draft feasibility study, criticized by DOE and Air Force officials, was never finalized. In addition, there was little continuity in both Air Force and DOE headquarters, field office, and laboratory management of the project. Different offices and managers—with differing approaches—were at various times responsible for the project. As a result, the project shed little light on the viability of using nuclear power to meet the power needs of the Air Force, despite the money and effort expended.

The stated objective of the small reactor project was the design, construction and operation of a 10-megawatt electric nuclear reactor to

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serve as a secure source of energy for key Air Force facilities. The project, after 4 years and \$3.75 million, was not close to achieving any part of this objective when it was terminated by the Air Force.

Although we are making no recommendations, we do believe that, given the circumstances surrounding this project, the Air Force's decision to terminate the project was an appropriate one. In addition, this project provides what we believe are some important lessons from which future projects can benefit. This project demonstrates the importance of

- having a solid foundation for a project by firmly establishing the need for and feasibility of the item being developed;
- formal agreements between agencies involved in projects such as this to prevent the types of misunderstandings and disagreements encountered in the early stages of this project and to further document the need for the project; and
- continuity, to the extent practicable, in project management, especially when multiple agencies and contractors are involved.

The Air Force, as discussed in appendix IV, is now planning another study of energy technologies in order to identify a potential power source to meet its secure power needs. Even today, the Air Force is unsure of the extent of its need for secure power.

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## Objectives, Scope, and Methodology

To determine the origin, history, and sources of funding for the small reactor project, we interviewed DOE laboratory, field office, and headquarters officials associated with the project. Specifically, we spoke with the Los Alamos program and project managers, officials with the offices of DOE's Assistant Secretaries for Defense Programs and Nuclear Energy, officials with DOE's Office of Budget, the project managers from DOE's Idaho Operations Office, and Air Force officials from Tyndall and Bolling Air Force bases. In addition, we reviewed project files provided us by Los Alamos, DOE's Office of the Assistant Secretary for Nuclear Energy, and the Air Force Engineering Directorate.

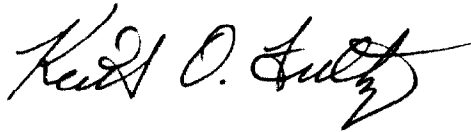
Our review was conducted between August 1987 and January 1988 in accordance with generally accepted government auditing standards. We discussed the material presented in this letter and its appendixes with Los Alamos, DOE, and Air Force officials who were responsible for the small reactor project and have incorporated their views where appropriate. However, as requested, we did not ask DOE or the Air Force to comment formally on a draft of this report.

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As arranged with your office, unless you release its contents earlier, we plan no further distribution of this report for 30 days from the date of issuance. At that time we will send copies to the Secretary of Energy; the Secretary of Defense; and the Director, Office of Management and Budget. We will also make copies available to others upon request.

Major contributors to this report are listed in appendix VI.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Keith O. Fultz". The signature is written in a cursive style with a large, stylized flourish at the end.

Keith O. Fultz  
Senior Associate Director

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**Abbreviations**

DOD	Department of Defense
DOE	Department of Energy
GAO	General Accounting Office
INEL	Idaho National Engineering Laboratory
ISR D	Institutional Supporting Research and Development
KWe	kilowatt electric
MCP	Military Construction Program
MWe	megawatt electric

# Factors Leading to the Initiation of the Small Reactor Project

Numerous studies have been done that point out the effects on Department on Defense (DOD) and Air Force facilities that could be caused by interruption of electric power supplies. The Department of Energy (DOE) and DOD, in recognition of the importance of energy to DOD activities, have established procedures providing for cooperative activities between the two agencies. One such effort was a DOE and Air Force project to assess the feasibility of designing and possibly building a prototype 10-megawatt electric (MWe) nuclear reactor to meet the secure power needs of the Air Force.

## Air Force Need for Secure Energy Sources

Numerous studies have been done by DOE, the Air Force, and others pointing out the need for and importance of secure energy sources. The majority of Air Force bases purchase their electric power from utilities. The Air Force has found that the key components of the national and international energy supply, generation, and distribution systems are vulnerable to accident, natural disaster, terrorism, sabotage, war, and politico-economic actions. Many of the Air Force's mission-critical activities are highly dependent on this vulnerable source of power.

The Air Force has gained experience with the effects of energy disruptions through unplanned outages and tests by the Air Force Inspector General's Office. Discussions with various Air Force base personnel have also provided the Air Force with insight into potential problems that could result from energy disruptions. Electrical energy disruption-related difficulties observed or projected include

- doors on some hardened (protected against external threats, such as aircraft crashes) shelters that can only be opened by force, after which they cannot be closed;
- loss of some air traffic control functions;
- impaired aircraft refueling resulting from a lack of power at fuel pumping and dispensing stations;
- inoperable attack alarm signals; and
- inoperable computers resulting from inadequate backup power and no backup power for the associated ventilation system.

## DOE and DOD Cooperative Energy Activities

The small reactor project was initiated under the authority of a general DOE and DOD Memorandum of Understanding, dated October 19, 1978, which provided for a broad range of cooperative DOE and DOD energy activities to enhance national security and achieve U.S. energy goals. This agreement also stated that specific programs and projects would be

implemented through subordinate agreements between the two agencies. In addition, it sets forth two basic goals: (1) improving energy efficiency and availability within DOD and (2) utilizing DOE and DOD expertise and facilities to carry out projects of mutual interest. Under this agreement, DOE is responsible for planning, coordinating, supporting, and managing a balanced and comprehensive energy research and development program, one of the objectives of which is to enhance national security.

DOE has been involved in several cooperative projects with the Air Force for the application of nuclear energy to specific military requirements. In addition to the small reactor project, these include a small 15- to 40-kilowatt electric (kWe<sup>1</sup>) reactor that may replace diesel generators on the Distant Early Warning radar line; the SP-100 space reactor for the Strategic Defense Initiative and other applications in the 50- to 1000-kWe range; and the Dynamic Isotope Power System, a space power source in the 1- to 10-kWe range.

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## Origin of the Small Reactor Project

The decision to investigate the potential application of small nuclear reactors to the Air Force's secure power requirements originated in two studies performed by DOE's Los Alamos National Laboratory for the Air Force and a task force formed by DOE. In 1981 the Air Force contracted with Los Alamos to perform two studies focusing on (1) evaluating the vulnerability of energy supplies, particularly electric energy, at Air Force bases and (2) developing a guide to be used by Air Force base engineers to assess the vulnerability of their bases to power supply interruption. The Los Alamos manager of the small reactor project told us that the Los Alamos staff became very familiar with the Air Force's need for secure power as a result of its involvement in these two studies. He also said that Los Alamos saw this as an opportunity to initiate a new nuclear reactor project.

In April 1983 DOE's Albuquerque Operations Office formed a task force, at the request of the Assistant Secretary of Energy for Defense Programs, to determine how DOE capabilities might better be utilized to serve DOD energy needs, particularly in the area of secure terrestrial energy supplies and systems. This task force consisted of representatives of both DOE and DOD, including the Air Force, and was charged with (1) assessing the ongoing activities of the DOE national laboratories in support of DOD energy initiatives and (2) evaluating the anticipated needs of DOD. Its efforts culminated in a series of briefings to senior Air

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<sup>1</sup>One KWe is equal to 1000 watts of electric power.

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**Appendix I  
Factors Leading to the Initiation of the Small  
Reactor Project**

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Force officials held in August through November 1983. Task force officials recommended that nuclear power be investigated as a possible secure energy source. At this time, the Air Force believed that DOE would fund the development of a prototype nuclear reactor. The Air Force, by letter dated November 28, 1983, endorsed DOE's plans to establish a prototype 10-MWe reactor to develop the data base necessary to support selections of secure energy sources. In November 1983 Los Alamos estimated the cost of developing a prototype reactor to be about \$70 million.



# Los Alamos Involvement in the Small Reactor Project

Los Alamos, with the approval of DOE's Office of Defense Programs, took the early initiative in the small reactor project by undertaking, in June 1983, a feasibility study of using small nuclear power plants as part of a secure energy system for military installations. Los Alamos's feasibility study briefly considered a variety of potential power sources and concluded that nuclear power was the best option. The study included an assessment of current nuclear reactor technology and recommended that DOE proceed with the development of a prototype nuclear reactor. In addition, Los Alamos undertook a variety of activities in anticipation of managing the small reactor project for DOE. Funding for the Los Alamos feasibility study and for other activities undertaken in anticipation of managing the development of a prototype reactor came from internal Los Alamos Institutional Supporting Research and Development funds. In the end, however, DOE assigned its Idaho Operations Office the role of managing the small reactor project.

## Los Alamos's Feasibility Study

In June 1983 Los Alamos initiated a feasibility study that included an examination of the options available to the Air Force to meet its secure power needs. The study's emphasis was on evaluating the technical and economic feasibility of using small nuclear reactors for this purpose.

As part of its feasibility study, Los Alamos issued subcontracts to GA Technologies and Rockwell International in August 1983 for the purpose of reviewing existing reactor designs for possible ground-based military application. GA Technologies was chosen to assess the application of the TRIGA power reactor concept<sup>1</sup> to military power supply, and Rockwell International was to assess the SNAP-4<sup>2</sup> reactor.<sup>3</sup> The assessment included providing Los Alamos a conceptual layout for military basing and necessary design modifications, performance characteristics for the concept selection process, cost and schedule estimates for development work and prototype construction, and key licensing and safety design issues.

<sup>1</sup>A TRIGA power system is a small, pool-type reactor. The reactor heats the pool water, which is used to vaporize freon. The freon, in turn, drives a turbine to produce electricity.

<sup>2</sup>The SNAP-4 nuclear power system consists of a boiling water reactor driving a steam turbine generator to produce electricity.

<sup>3</sup>These two contractors were chosen because of their previous involvement with these reactor concepts. The two sole source fixed-price contracts totaled \$35,000. Los Alamos justified the use of sole source subcontracts in both cases on the basis that the recommended contractors originally designed the respective power systems and accordingly were the only sources having the necessary personnel available who were knowledgeable and experienced in the particular power systems and able to perform the required services within the time available.

An official in DOE's Office of Defense Programs, which had headquarters responsibility for the small reactor project being conducted at Los Alamos, told us that the intent of his office and Los Alamos was to examine existing reactor concepts and operating reactor designs to determine whether they could be modified to meet the needs of the Air Force. This official said that his office and the staff at Los Alamos agreed that some research would still be necessary even though they were looking at existing reactor designs and concepts. He added, however, that it would consist more of the demonstration of existing concepts rather than of pure research.

The Los Alamos program manager told us that Los Alamos management felt the laboratory's mission was directed more toward advanced research than toward projects such as this, and they were wary of this project because there was virtually no research necessary.

Los Alamos contacted the four other domestic nuclear reactor vendors with demonstrated experience in light water reactor, gas cooled reactor, and liquid metal reactor technologies during the feasibility study and invited them to Los Alamos to be briefed on the small reactor program.<sup>4</sup> Subsequently, three of these vendors provided Los Alamos with preconceptual reactor designs that they had developed independent of the small reactor project. As mentioned previously, two reactor vendors, GA Technologies and Rockwell International, already had subcontracts with Los Alamos to assess two reactor concepts for possible ground-based application to military power supply. Los Alamos used these five preconceptual designs to further verify the technical feasibility of developing a small reactor to meet the Air Force's requirements.

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## **Feasibility Study Conclusions**

Although Los Alamos completed the final draft of the feasibility study in March 1984, it was never published in final form. The draft study concluded that

1. Existing military energy systems, especially the electric power systems, are vulnerable.
2. U.S. Air Force stationary power requirements are substantial (average need is greater than 10 MWe per base).

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<sup>4</sup>In total, six reactor vendors were associated with the project throughout its existence: Babcock and Wilcox, Combustion Engineering, GA Technologies, General Electric, Rockwell International, and Westinghouse.

3. For most applications, the use of a nuclear reactor as a secure power supply is technically the best option.

4. Compact nuclear reactors (10 MWe) have inherent safety advantages over their larger commercial counterparts (1000 MWe); are amenable to protection from external threats (such as airplane crashes) and to automated operations; and are cost-effective, because factory fabrication and assembly reduces their capital costs.

5. The technology exists to deploy compact reactors for military applications within this decade (by 1990).

6. The nuclear option is economically competitive with alternative secure energy systems, especially if the cost of procuring standby backup equipment (e.g., gas turbines or diesel generators, fuel storage, fuel inventory) is added to current utility costs.

In the final draft of the feasibility study, Los Alamos recommended that DOE proceed with the development of a prototype compact nuclear reactor for military applications. Los Alamos's study also included a program plan for the design and procurement of a prototype reactor. Although the feasibility study was never published, DOE and the Air Force adopted the recommendation that the program proceed. (See app. III.) The Los Alamos program manager told us that Los Alamos considered the study final. He also said that the laboratory never issued an official final study because DOE's Idaho Operations Office was in the process of taking over the management of the project and Los Alamos did not want to prejudice the Idaho office's work.

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### Comments on the Los Alamos Feasibility Study

DOE headquarters officials from the Office of Nuclear Energy reviewed a draft of Los Alamos's feasibility study. One official expressed concern that the study did not adequately address its stated purpose, i.e., to "investigate the viability of current nuclear reactor electrical generating units as part of a secure energy system for military installations." This official noted that the discussion of "Reactor Systems Suitable for Secure Energy System Applications" takes up a very small part of the report. He reviewed the final draft feasibility study again in June 1984 and concluded that previous comments (by the Office of Nuclear Energy) had not been included in any meaningful way.

In its comments dated May 31, 1984, on a draft of the study, DOE's Idaho National Engineering Laboratory (INEL) generally agreed with Los

Alamos's conclusion that a nuclear reactor is the best overall choice to meet the secure electrical power needs of the Air Force. INEL noted, however, that its agreement with this conclusion depends primarily on the study's requirement for up to 1 year of a secure fuel supply for the power source. The 1-year independent power requirement was based on a Los Alamos consultant's study, which found that in large-scale war scenarios, a base could have to operate independent of the utility system for a year or longer. The study also found that major sabotage or terrorist activities using conventional munitions could isolate a base from commercial utility power for about 10 weeks and that scenarios that would require independent operation for longer than 90 days are highly unlikely. Finally, the consultant's study found that the costs and operational advantages of a nuclear reactor are greater if a 1-year requirement is specified, but they remain substantial for the 90-day requirement, provided that the reactor is used to provide base-load power to the base during nonemergency operating periods.

In its detailed comments, INEL stated that if the requirement for operation in an isolated mode for periods in excess of 1 year with a minimum of outside support for fuel, maintenance, and operations were relaxed or not required at all facilities, the conclusion of the study might be significantly different. The INEL reviewers determined that the Los Alamos feasibility study suffered from two primary deficiencies: (1) the objectives and goals of the project and the guidelines and requirements for meeting them were not clearly presented, and in some cases were only implied, and (2) the economic analyses of nuclear power and other alternatives contained in the report were not done consistently and could be easily discredited. The Los Alamos project manager told us that the project staff at Los Alamos never saw the INEL comments (which were transmitted to DOE over a month after Los Alamos completed its final draft of the feasibility study).

The Air Force manager for the small reactor project told us that the Air Force project staff also were not satisfied with the feasibility study conducted by Los Alamos primarily because the study lacked credibility. He added that Air Force officials had encouraged Los Alamos to work closely with the six domestic nuclear reactor vendors in order to get the vendors' best input regarding state-of-the-art nuclear reactor concepts; however, in his judgment, the feasibility study did not reflect any vendor input.

The Los Alamos project manager said that the omission of a detailed description of reactor systems suitable for secure energy system application, cited by DOE headquarters reviewers, was a conscious omission. He said Los Alamos did not include an exhaustive review of these reactor systems in its feasibility study in order to avoid prejudicing the next phase of the project—procuring conceptual reactor designs. The Los Alamos staff feared that if the study stated or implied a preference or bias towards a particular reactor concept in their feasibility study, the nuclear reactor vendors would all submit proposals to design and build that type of reactor. This, he said, would preclude a competition between reactor concepts.

The Air Force manager for the small reactor project told us that the Air Force proceeded with the project after meeting with INEL representatives in early 1984. At that time, the INEL representatives convinced the Air Force that (1) INEL was superior to Los Alamos in the area of reactor design and technology, (2) INEL had the full support of DOE's Office of Nuclear Energy, and (3) it was definitely feasible to design and build a small reactor that would meet the needs of the Air Force.

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## **Los Alamos Activities in Anticipation of Managing the Small Reactor Project**

The Los Alamos project manager told us that Los Alamos had never been formally assigned to manage the design and development of a prototype nuclear reactor for the Air Force by DOE. Instead, Los Alamos initiated the small reactor project, using its own funds, with the approval of DOE's Office of Defense Programs. However, Los Alamos officials believed DOE funding and the assignment of the project management role were forthcoming and took a number of actions consistent with that belief. The Los Alamos program manager stated that \$2 million in DOE funds were to have been forwarded to Los Alamos upon the approval of its program plan for the development of a prototype small reactor.

Los Alamos was in the process of preparing a Request for Proposals for conceptual reactor designs, as well as taking a variety of other actions in anticipation of managing the design and development phases of the small reactor project, when it completed the final draft feasibility study in March 1984. These actions included

- forming a Business Strategy Group to provide the program office with contractual, business, and procurement advice;

- establishing a Source Evaluation Board, which would, upon completion of the conceptual design phase of the project, recommend a contractor to the source selection official for the design of the prototype reactor;
- appointing DOE Office of Defense Programs, DOE Office of Nuclear Energy, Los Alamos, and Air Force officials to a review board that would have assisted the chairman of the Source Evaluation Board and the source selection official in selecting a contractor to design the prototype reactor at the completion of the conceptual design phase of the project; and
- preparing a formal program plan to be submitted to DOE for approval and to meet the condition for DOE funding.

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## **DOE Project Management Responsibilities Changed at Headquarters and in Field**

Two changes in the management of the small reactor project took place in early 1984. First, the Office of Nuclear Energy replaced the Office of Defense Programs as the DOE organization with headquarters responsibility for the project. Second, the Office of Nuclear Energy assigned the Idaho Operations Office the role of managing the small reactor program in the field. The decision was, in large part, a result of the change in DOE headquarters responsibilities. In addition, we found that disagreements between the Los Alamos and Air Force project staffs may have contributed to the shift in field management responsibility for the project.

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## **DOE Headquarters Change Precipitates Field Change**

Shortly before the final draft of the Los Alamos feasibility study was completed in March 1984, the Assistant Secretary of Energy for Defense Programs, then the headquarters official responsible for the project, left the agency. According to the Los Alamos project staff and a DOE Office of Defense Programs official, he was a strong advocate of the program and of secure military power sources in general.

In July 1984 the Secretary of Energy moved the DOE headquarters program responsibility for the small reactor project to the Office of Nuclear Energy. DOE's Office of Defense Programs and Office of Nuclear Energy agreed that the development of nuclear power technology is properly the role of the Office of Nuclear Energy. The Office of Nuclear Energy had been actively involved in the development of space nuclear power systems associated with the Strategic Defense Initiative, and had established a separate organizational unit for this purpose. As a result of this decision, that organization assumed responsibility for the small reactor project.

Shortly before the transfer of DOE headquarters responsibilities was formally implemented, Los Alamos was replaced by the DOE Idaho Operations Office and INEL as the field organizations responsible for managing the small reactor project. DOE headquarters, field office, and laboratory officials told us that the reason for this switch was that Los Alamos works primarily on projects under the auspices of DOE's Assistant Secretary for Defense Programs. INEL, conversely, performs a considerable amount of work for the Office of Nuclear Energy and has extensive experience in the development, construction, and operation of test reactors.

The decision to assign responsibility for managing the small reactor project to DOE's Idaho Operations Office and INEL appears to have been made at about the same time Los Alamos completed its final draft feasibility study. This is evidenced by the fact that on April 25, 1984, at the direction of the Idaho Operations Office, INEL submitted a Near-Term Project Management Plan for the small reactor project through the Idaho Operations Office to DOE's Office of Nuclear Energy. In addition, just prior to promulgating its management plan, INEL officials met with representatives of the Air Force to discuss Air Force intentions and interest relative to developing a 10-MWe reactor for backup power.

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## **Interagency Disagreements**

The small reactor project manager at Los Alamos told us that there were some disagreements between the project management staffs at the Air Force and at Los Alamos. He said that some Los Alamos activities conflicted with the Air Force manager's perceived role as the sole voice in the Air Force for energy security and secure power sources. Examples of these activities included discussing the project with other Air Force commands and testifying before congressional committees without first clearing its statements through the Air Force. The Los Alamos program manager believed that the project management role was moved to DOE's Idaho Operations Office as a result of conversations pertaining to this dispute between the Air Force project manager and DOE's Office of Nuclear Energy.

The Air Force project manager confirmed that some disagreements occurred between Air Force and Los Alamos project management. He said that Air Force staff talked often with the project staff at Los Alamos about the need to proceed slowly and cautiously, particularly when dealing with parties not directly involved with the project, because of the danger that inconsistent or wrong information might be

spread. The Air Force project manager said that despite this clear direction from the Air Force, Los Alamos project staff were actively seeking support for the project without notifying the Air Force of whom they contacted. The Air Force project manager stated that Los Alamos held discussions with the Office of Management and Budget, gave testimony at congressional hearings, and contacted other Air Force organizations, such as the Alaskan Air Command, regarding the small reactor project. These contacts were never cleared through the Air Force. When DOE's Office of Nuclear Energy contacted the Air Force project manager and asked whether he objected to the project being moved to DOE's Idaho Operations Office, he responded that he did not.

The Los Alamos project manager told us that, in retrospect, Los Alamos could have handled a number of things differently. First, DOE and the Air Force could have entered into a memorandum of agreement earlier in Los Alamos's involvement in the project. He said that he had prepared a draft agreement as early as September 1983 but that it was DOE's responsibility to act on it. He said that a memorandum of agreement would have (1) acted as a statement of need from the Air Force, thus better securing its commitment to the project, (2) defined the project phases, and the items deliverable to the Air Force during each phase, which would have eased the Air Force's fears that DOE would never produce a prototype reactor, and (3) eliminated the disagreements between Los Alamos and the Air Force project office by establishing guidelines for dealing with outside parties such as other Air Force commands and the Congress.

Air Force officials told us that they discussed internally the need for an agreement while Los Alamos was conducting its study but were proceeding slowly and studying what an agreement would commit them to. They added that, at this point, they felt the project was a fairly low-level effort and did not necessarily justify executing a memorandum of agreement.

In addition, the Los Alamos project manager said that Los Alamos probably should have tried a little harder to get a commitment from DOE on the assignment of the project management role before expending so much effort on project management-related activities such as developing program plans and a request for proposals. He added that many of these activities were probably duplicated by DOE's Idaho Operations Office and INEL after they took over the project since these activities are generally required for major systems acquisitions (projects that are expected to cost in excess of \$50 million).



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**Appendix II  
Los Alamos Involvement in the Small  
Reactor Project**

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The Los Alamos project manager told us that after INEL and the DOE Idaho Operations Office were assigned the management of the project, neither contacted Los Alamos to review or discuss the preconceptual nuclear reactor designs provided by the domestic reactor vendors.

# Reactor Design Procurement by DOE's Idaho Operations Office

In August 1984 DOE's Office of Nuclear Energy entered into a Memorandum of Agreement with the Air Force, which formally initiated the small reactor project. Acting under this agreement, DOE's Idaho Operations Office procured conceptual designs from the six reactor vendors previously involved with the project. They were evaluated by the Idaho National Engineering Laboratory and transmitted to the Air Force for its evaluation. The Air Force subsequently notified DOE that on the basis of its evaluation of the conceptual designs and related issues, the Air Force wished to proceed to the next phase of the project—preliminary design.<sup>1</sup>

DOE's Idaho Operations Office then solicited proposals for the preliminary design of a small nuclear reactor, with an option to design and construct the first plant. Westinghouse Electric Corporation was chosen for contract negotiations. These negotiations never began because of delays in Air Force funding and the Air Force's eventual termination of the project.

## DOE and Air Force Agreement

On August 20, 1984, DOE and the Air Force entered into a formal Memorandum of Agreement providing for a cooperative project to develop, build, and operate a prototype compact, 10-MWe nuclear reactor to provide secure energy for Air Force facilities. A program office was established at DOE headquarters within the Office of Nuclear Energy, and a project office was established at INEL. These offices were to implement the actions and agreements contained in the Memorandum of Agreement.

DOE's original position in November 1983, according to Air Force officials and documents, was to design, build, and operate the prototype reactor within DOE's own budget. When DOE's Office of Nuclear Energy took over the headquarters responsibilities for the project (from the Office of Defense Programs) and began negotiating a Memorandum of Agreement with the Air Force, DOE asked that the Air Force share the costs of the project. In signing the agreement, the Air Force agreed to share the costs, although the agreement contained no specific formula for doing so.

<sup>1</sup>The small reactor project was to have been broken down into several phases: conceptual design, preliminary design, nonsite-specific detailed design, final site-specific design, and construction.

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## Conceptual Reactor Design Procurement

DOE's Office of Nuclear Energy authorized the Idaho Operations Office to solicit proposals and select up to six contractors to prepare conceptual small reactor designs. The Procurement Request-Authorization, dated August 24, 1984, provided \$1.2 million in DOE funds to pay up to six contractors for their conceptual designs. These conceptual designs were then evaluated by INEL and the Air Force. (See app. V for a more detailed discussion of the sources of funds for the small reactor project.)

DOE's Idaho Operations Office issued a Request for Proposals to the six domestic nuclear reactor vendors on September 4, 1984. Functional and operational requirements for the plant were prepared by INEL and were issued in October 1984. All six of the vendors responded with acceptable proposals and, on October 19, 1984, all six were chosen to receive contracts to prepare conceptual reactor designs. On October 30, 1984, DOE awarded six fixed-price contracts for the conceptual design studies. Each contract was for \$200,000, which accounted for the \$1.2 million mentioned above. The conceptual designs were completed on March 29, 1985, and evaluated by INEL and by the Air Force.

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## INEL Evaluation

INEL issued a preliminary evaluation of the reactor concepts provided by the six reactor vendors in September 1985. The objective of the evaluation was to determine the technical feasibility, cost, and schedule of using nuclear power as a source of secure military power. This evaluation took into consideration such factors as the technology status, performance capabilities, safety, cost, and schedules for each of the six conceptual reactor designs. INEL drew the following general conclusions from the reactor concepts:

- a small compact nuclear power plant can be built to meet the functional and operational requirements;
- existing technology is sufficient to ensure that the first plant performance parameters can be met with a high degree of confidence;
- the first plant can be built in 5 years; and
- the cost of the first plant could range from \$103 million to \$144 million, and the cost of future plants could range from \$70 million to \$111 million (in fiscal year 1985 dollars).<sup>2</sup>

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<sup>2</sup>These cost figures include certain adjustments made by the INEL evaluation team and are discussed in more detail later in this section.

The INEL evaluation team found that four of the designs made maximum use of existing technology.<sup>3</sup> The majority of the components and systems that made up these reactor concepts were off-the-shelf or engineered items. These reactor concepts could be constructed with a high degree of confidence that the first plant tested would meet the design requirements. The other two conceptual reactor designs involved significantly more first-of-a-kind engineered components and systems. In these two cases, the industry base had not been established that could produce or make use of like equipment, nor had it been considered that a wide spectrum of manufacturers could produce the components efficiently and to high standards. These two reactor concepts would require engineering verification testing, component fabrication mock-ups, and extensive analysis to ensure that design objectives could be met reliably.

The INEL evaluation team also reviewed each conceptual reactor design to determine whether it could meet the key performance criteria specified in the functional and operational requirements. It found that

- nuclear power plants could be built to meet the siting restrictions of an air base,
- 10-MWe nuclear reactors could be built to meet the power performance requirements specified for this plant,
- a capacity factor of at least 90 percent could be achieved (i.e., the power plant is operating at its rated power 90 percent of the time), and
- special hazards protection could be incorporated into the design (protecting the plant against aircraft accidents, for example).

Another factor the INEL evaluation took into consideration was the inherent, or passive, safety features of each conceptual reactor design.<sup>4</sup> Although the functional and operational requirements did not include a passive safety requirement, there was a strong desire that the conceptual designs exhibit such features. INEL found that all of the conceptual reactor designs exhibited a high degree of passive safety.

The INEL evaluation took into consideration the cost and schedule for the construction of a first plant, which was based on each reactor vendors'

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<sup>3</sup>The INEL evaluation team consisted of personnel from INEL as well as from EG&G Idaho, Inc., Westinghouse Idaho Nuclear Company, Argonne National Laboratory-West, and independent consultants.

<sup>4</sup>Passive safety is achieved without the use of engineered safety features, which are features of the plant design that are added for the sole purpose of achieving safety and which must be activated either manually or automatically.

conceptual reactor design. The cost and schedules submitted by the vendors were compared with those independently produced by the evaluation team. The INEL evaluation noted that

- design costs for all the conceptual designs appeared high, but were justifiable because they were estimated at a very early stage of the project;
- materials, components, systems, and construction costs appeared reasonable on the basis of the evaluation team's independent cost estimates, comparisons with the DOE Engineering Economic Data Base, and intercomparison of the cost estimates provided by the vendors; and
- the proposed 5-year schedule was achievable (although a power plant of this size had not been built recently), considering the schedule to build reactors of this size in the past and the schedule of recent nuclear projects of comparable size.

The six nuclear reactor vendors' estimates of the cost to construct the first plant ranged from \$76.2 million to \$189 million. These estimates were reviewed and adjusted by the evaluation team to account for equipment costs that were not included in the estimates, high or low cost estimates for equipment, exaggerated direct to indirect cost ratios, and excessive design cost. After adjustment by the evaluation team, the cost estimates, as previously mentioned, ranged from \$103 million to \$144 million. Reactor vendor estimates of the cost of a future power plant (after the first plant) ranged from \$38 million to \$136 million. However, following adjustments by the evaluation team, these estimates ranged from \$70 million to \$111 million.

DOE transmitted the six detailed conceptual design reports and DOE's preliminary evaluation to the Air Force in May 1985. In the transmittal letter to the Air Force, DOE's Acting Assistant Secretary for Nuclear Energy noted that there are several uncertainties associated with the eventual ability of any power plant to perform in the manner indicated as possible at the conceptual design phase. These uncertainties included plant cost, length of construction time, and plant capacity factor. He concluded, however, that the proposed reactor designs were within the technological capability of the U.S. industry to produce and indicated that a plant could be built to meet military energy requirements.

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## Air Force Evaluation

The Air Force conducted its own evaluation of the six conceptual reactor designs and other related issues. The Air Force evaluation considered technical feasibility, nuclear surety, security, siting considerations, economics, and other issues. The Air Force decided, on the basis of its

review of the six conceptual reactor designs and pertinent issues, to proceed to the next phase of the project—preliminary design. The Air Force notified the Acting Assistant Secretary of Energy for Nuclear Energy of this decision by letter dated November 20, 1985.

The Air Force, with the assistance of DOE and INEL, was also conducting preliminary site assessments at a number of Air Force bases. The purpose of these assessments was to obtain additional data on the feasibility of placing nuclear reactors on actual Air Force bases and to develop criteria to be used in choosing Air Force bases to receive reactors. The latter included assessing the power needs of each base and identifying all site-specific technical and legal issues that could reasonably be expected to be encountered. The site assessments also would provide data to help in the preparation of environmental studies for the small reactor project. The Air Force chose to assess seven typical large domestic Air Force bases that consume large amounts of power: Shemya Air Force Base, Alaska; Mountain Home Air Force Base, Idaho; and five Air Logistics Centers at Hill Air Force Base, Utah; Kelly Air Force Base, Texas; McClellan Air Force Base, California; Robbins Air Force Base, Georgia; and Tinker Air Force Base, Oklahoma.

Air Force officials at the Headquarters Engineering and Services Center said that no decision had been made regarding the eventual placement of the prototype reactor. These officials told us that it would have been built at one of these seven Air Force bases, had the project proceeded, because these bases were large power consumers. They added that the Air Force would have had information on each of the sites as a result of the preliminary site assessments, which would facilitate the preparation of environmental studies.

## Westinghouse Electric Corporation Selected to Design the Reactor

DOE's Idaho Operations Office prepared a Notice of Intent to Contract on Other Than Full and Open Competition Basis for the design of a 10-Mwe nuclear secure military power plant, which was published in the Commerce Business Daily on December 9, 1985. The notice justified the use of less than full and open competition on the basis that (1) a very limited number of sources are capable of performing the work, (2) the design contract is considered follow-on work to the conceptual design contracts, and allowing others to compete would result in duplication of costs to the government, and (3) a request for proposals cannot be written without the inclusion of classified data.

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**Appendix III  
Reactor Design Procurement by DOE's Idaho  
Operations Office**

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In March 1986 the Idaho Operations Office sent requests for fixed-price proposals to design, construct, test, and start up a 10-MWe nuclear power plant to the six domestic nuclear reactor vendors. The office received five vendor proposals in June 1986. (According to DOE officials, General Electric Corporation did not wish to participate because of the proposed use of a fixed-price contract, and did not submit a proposal.) On October 30, 1986, Westinghouse Electric Corporation was selected for contract negotiations. DOE did not award the contract because of delays in the Air Force's obtaining congressional approval to use certain funds for the Air Force's share of the design phase of the project.

# Termination of the Small Reactor Project

A variety of factors contributed to the Air Force's decision to terminate the small reactor project in May 1987. The factors cited by the Air Force were (1) a Senate Appropriations Subcommittee's disapproval of the use of Military Construction Program (MCP) design funds and (2) anticipated budgetary constraints. Other factors the Air Force considered in deciding to terminate the project include environmental concerns, economic uncertainties, and inadequate requirement definition.

## Events Leading to Air Force Withdrawal From Project

The Air Force considered withdrawing from the small reactor project in early 1985 but did not because Air Force officials felt it would be premature to do so at that time. The Air Force shifted responsibility for the small reactor project to a different Air Force organization in November 1986. Almost immediately thereafter, this organization proposed that the Air Force withdraw from the small reactor project. In April 1987 a congressional subcommittee denied the Air Force's request to use certain funds for its share of the preliminary reactor design to be procured by DOE. Shortly thereafter the Secretary of the Air Force notified the Secretary of Defense that he had decided to terminate the project because of projected Air Force budget levels, the concerns of the Secretary of Defense, and congressional objections to the use of MCP design funds.

## Air Force Considered Terminating the Project Earlier

Air Force officials considered terminating the project as early as January 1985, after DOE informed them that continuation of the project beyond the conceptual reactor designs being prepared by the six nuclear reactor vendors would have to be funded by the Air Force. According to internal Air Force documents, the Air Force did not terminate the project at that time for several reasons. First, Air Force officials believed it would be premature to do so prior to receiving and evaluating the six conceptual reactor design reports from DOE (due in the period of March through May 1985). Second, officials believed that any decision to proceed with or terminate the project would be more fully defensible after the Air Force had completed an objective evaluation of institutional issues, the conceptual reactor designs and cost estimates provided by DOE, and other factors such as Air Force energy security resources and requirements. Finally, these officials believed that DOE would have funds for the project reinstated in the DOE budget if the Air Force decided to proceed with the next phase of the project—preliminary design.

As was stated in the previous section, the Air Force decided in November 1985 to proceed with the project through the next phase. DOE then



issued the request for proposals, received five proposals, and in October 1986 selected Westinghouse Electric Corporation for negotiations in anticipation of awarding it a contract for the design and possible construction of a prototype reactor.

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## Air Force Project Management Reassigned

The Air Force responsibility for the small reactor project was moved in November 1986 from the Headquarters Air Force Engineering and Services Center, Tyndall Air Force Base, Florida, to the Engineering Division, Directorate of Engineering and Services, Bolling Air Force Base, Washington, D.C. The project focal point at Bolling told us that this move was made after the staff from Tyndall briefed the Directorate staff in support of the Tyndall group's request for future MCP funds.

The Bolling official said that the project falls somewhere between being a research and development project and a construction project, thus falling within the area of responsibility of either the Bolling or the Tyndall organization. The energy group at Tyndall has a broad charter, with general responsibility for energy matters at Air Force facilities. This has generally resulted in the Tyndall group's having an operations and maintenance orientation as well as having responsibility for overseeing the majority of energy-related research and development within the Air Force. The official added that the Tyndall energy group is oriented towards the future in that it is looking at emerging energy technologies, and cited the energy technologies assessment Tyndall is planning to conduct as a good example of the type of work the organization has done (this is discussed in greater detail later in this app.).

The Bolling official told us that the utilities group at Bolling has a more near-term focus. The group's responsibilities include developing criteria for constructing facilities, such as how to minimize the life-cycle costs for maintaining facilities (of which energy costs are one of the largest). The utilities group is also responsible for developing criteria for constructing utility plants for Air Force facilities. This group provides advice and guidance on constructing facilities to the Air Force Regional Civil Engineering Centers, who are responsible for the actual construction of facilities.

The Bolling official said that the project was not following normal Air Force channels for an MCP project. In most cases a major command (such as the Strategic Air Command or Alaskan Air Command) must sponsor the construction portion of an MCP project in order to receive MCP funds. MCP construction funds are approved for individual projects as line items

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in the Air Force's MCP congressional budget request. In the case of the small reactor project, no major command had stepped forward to sponsor the construction portion of the project, although some major commands were very interested in the potential application of nuclear energy to their secure power needs.

He added, however, that MCP planning and design funds are available for projects without a major command sponsor. These funds are approved by the Congress in a lump sum. The Air Force then uses these moneys to plan and design construction projects to be included in future MCP construction project requests. The Air Force intended to fund its share of the design phase of the project from MCP planning and design funds, which were to have been provided without a major command sponsor. Prior congressional notification is required for the expenditure of MCP design funds in excess of \$300,000. (This is discussed in greater detail in the next section.)

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### Air Force Proposes to Withdraw From Project

On November 24, 1986, immediately after taking over management responsibilities for the small reactor project, the Bolling organization proposed that the Air Force withdraw its participation and future funding for the small reactor project. The staff of the Bolling organization strongly disagreed with the assessment that nuclear power is a viable option to provide reliable electric power to support Air Force mission requirements, adding that a sufficient number of known environmental, economic, budgetary, and technical constraints exist to indicate that nuclear power is neither practical nor desirable.

In an internal document dated December 30, 1986, the staff of the Bolling organization listed the specific reasons for their support of Air Force withdrawal from the project. These reasons were divided into three categories: (1) delays and costs resulting from the environmental process, (2) other uncertainties adding to rising costs, and (3) unclear requirements for the power plant.

With regard to delays and costs resulting from the environmental process, the staff noted that

- the utility industry is backing away from nuclear power plants because of the associated costs and delays;
- the National Environmental Policy Act process provides many opportunities for the public to use delaying tactics, including law suits, even after the process is complete;

- public sentiment against nuclear power has been high since the accident at Three Mile Island and has been reinforced by the Chernobyl accident in the Soviet Union;
- the decision not to license the plant through the Nuclear Regulatory Commission (as with a commercial plant), which was based on the military exclusion contained in the Atomic Energy Act, offers more opportunity for public opposition; and
- the issue of how to dispose of spent fuel has not been addressed.

The Bolling staff also listed a number of other uncertainties that they felt would lead to steadily rising program costs, including

- the high cost of the first plant (then estimated to be \$175 million for the design and construction of the first plant);
- the fact that as a first plant, it would not be commercially proven, even though it was considered technically feasible;
- evolving safety and environmental requirements; and
- a low estimate of the cost for completing environmental studies (\$1.5 million), which is based on the cost of other studies with a similar scope.

Finally, they noted that the requirement for the plant was not clear in that

- a nuclear reactor would be best suited for independent operation, providing continuous power for a total military base;
- the project would be contrary to the present Air Force policy of providing backup/standby power generation capability, collocated with the facility, and based on mission criticality and commercial power reliability; and
- other basic considerations were not addressed, including the vulnerability, reliability, and economics of the total power system (power plant and distribution system), logistical support (fuel, spare parts, etc.), and the maintainability and repairability of the power system.

In a January 1987 memo from the Deputy for Advanced Technology, Office of the Assistant Secretary of the Air Force for Research, Development, and Logistics, to the Assistant Secretary of the Air Force for Manpower, Reserve Affairs, and Installations, noted two arguments in support of terminating the program. First, he indicated that the support for the choice of nuclear reactors to provide secure electric power was flawed because it was based on running the alternative power sources continuously. The justification given was that if a nuclear power plant is considered for standby use, it might as well operate all the time and be

used as a primary power source for base activities. When the other non-nuclear candidates (diesel, gas turbines, etc.) are used as a primary power source, they do not appear as economical because of the cost of fuel. Second, he observed that the political aspects of proposing to proliferate nuclear power plants throughout the continental United States are obvious and represent another factor to be considered.

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### Air Force Withdraws From the Project

The Assistant Secretary of the Air Force for Manpower, Reserve Affairs, and Installations wrote to the Assistant Secretary of Energy for Nuclear Energy on March 9, 1987, committing the Air Force to pursue the small reactor project through the completion of a preliminary reactor design, assuming congressional concurrence with the Air Force's intent to use MCP design funds. In that letter he pointed out that, on the basis of projected Air Force budget levels, it was not likely that the Air Force would pursue the project beyond the preliminary design phase. He added, however, that the Air Force would conduct a complete evaluation of the project at that time. In addition, he strongly recommended that DOE incorporate appropriate procedures to permit the orderly termination of the project at the completion of the preliminary design phase, should it be required.

In a letter to the Air Force on April 9, 1987, the Chairman of the Senate Appropriations Committee's Subcommittee on Military Construction responded unfavorably to the Air Force's notification of its intent to use MCP design funds for its share of the preliminary design phase of the project. The Chairman noted that during recent hearings an Assistant Secretary of the Air Force had testified that the Air Force had no funds programmed in future military construction budgets for construction of facilities related to this request. He said that the Subcommittee's policy is to support the design of projects for which funds are programmed in future budgets. It is not the policy of the Subcommittee, he added, to use MCP design funds for projects that are essentially research and development in nature, and the project being proposed is clearly a research and development activity. Therefore, he said, the proposed project does not represent an appropriate use of MCP planning and design funds, and the Air Force should seek funding instead from the appropriate research and development account.

In a memo to the Secretary of the Air Force dated April 16, 1987, the Secretary of Defense requested that the Air Force not obligate any funds for the small reactor project and that it withdraw any funds issued for that purpose. He said that it would have been very helpful if the Air

Force had fully informed the Office of the Secretary of Defense about the small reactor project before testifying before congressional committees on the subject. He added that his office needs to know of the program details prior to promulgation as official positions. The Secretary also cited a March 30, 1987, New York Times article that, he understood, contained numerous factual errors regarding the mobility of the reactors, projected costs, and the status of the project. (This article contains references to Air Force testimony on the small reactor project before the House Science and Technology Committee's Subcommittee on Energy Research and Production. The hearing was on the fiscal year 1988 DOE Nuclear Fission Authorization and was held on March 17, 1987.) The Secretary also voiced concerns that were based on his office's preliminary review of the project that the Military Construction Program might not be an appropriate source of funds for this project.

The Secretary of the Air Force, by memo to the Secretary of Defense dated April 28, 1987, responded to the Secretary's and the Chairman's concerns by terminating the small reactor project. He said that since it was envisioned that existing technology was to be applied to produce an operating nuclear power plant, MCP funding was deemed appropriate by the Air Force. In addition, the Secretary said that funds were not programmed for the project in future budgets because the Air Force wanted to complete the preliminary design and ascertain costs and other data before proceeding further. He concluded that the Air Force would abide by the decision of the Senate Appropriations Committee and not obligate MCP funds for this project. Further, because of projected Air Force budget levels, the Secretary of Defense's concerns, and congressional objections, he decided to terminate the project entirely.

In a letter dated May 8, 1987, to the Secretary of the Air Force, the Chairman of the Senate Appropriations Subcommittee on Military Construction stated that he had received information that the Air Force had decided to terminate the small reactor project, in part, because the Subcommittee had denied the use of MCP design funds for the project. He said that the Subcommittee's action should not in any way reflect opposition to the small reactor project. He urged the Air Force to seek research and development funds rather than terminate the project. He concluded that it was unfortunate that the Air Force failed to coordinate the design request with the Appropriations Committee prior to sending the notification. If the project had been requested as research and development instead of military construction, he said, this controversy could have been avoided.

By letter on May 22, 1987, the Assistant Secretary of the Air Force for Readiness Support notified the Assistant Secretary of Energy for Nuclear Energy that the Air Force could not proceed with the small reactor project. The letter, he said, serves as the Air Force's 60-day written notice prior to formal termination of the project, as stipulated in the Memorandum of Agreement. He cited the denial of MCP design funds for the project and the climate of diminishing budgets as reasons for this action.

## Termination Proceedings

DOE informed its Idaho Operations Office of the project's termination on June 2, 1987, and asked that the office stop all work on the small reactor project, provide DOE headquarters with an estimate of project closeout costs and unobligated funds, and, at the office's convenience, provide an end-of-project report showing the use of funds.

The Idaho Operations Office transmitted an end-of-project report to DOE headquarters on September 1, 1987. The report was divided into three sections: (1) a historical perspective, (2) closeout actions, including a general description of data and documents put into storage for future use, and (3) a reconciliation of project costs (this is discussed in greater detail in app. V). The report notes that INEL is continuing work in the energy security assessments area for the Army, Air Force, and Navy. This work is being managed by the Idaho Operation Office's Office of Energy Security projects, previously the small reactor project office. The letter transmitting the report notes that many people within DOD continue to promote small nuclear reactors as a necessity of the future, although near-term DOD funding does not appear likely. The letter also contained a recommendation that DOE seek reimbursement by the Air Force for one-half of the funds expended on the small reactor project.

## DOE Sought Air Force Reimbursement

By letter dated July 16, 1987, to the Assistant Secretary of the Air Force for Readiness Support, DOE's Acting Assistant Secretary for Nuclear Energy requested that the Air Force reimburse DOE for one-half of the funds it expended on the small reactor project in fiscal years 1986 and 1987 (\$1,078,800 is the figure cited in the letter). He cited the intent and language contained in the Memorandum of Agreement between DOE and the Air Force signed on August 20, 1984, as the basis for the request. He added that although these expenditures did not result in the final design or construction of an actual nuclear power plant, they did serve to clarify the engineering basis and the economics for use of this power source

for Air Force base applications, and helped establish a base of knowledge from which future project needs may benefit.

The Assistant Secretary of the Air Force responded by letter dated August 18, 1987, agreeing with DOE that under the terms of the Memorandum of Agreement, the Air Force should reimburse DOE for 50 percent of the \$1,078,800 in costs incurred on the Air Force's behalf. DOE informed us on January 22, 1988, that it had received payment from the Air Force.

## Vulnerability Persists After Project Termination

The manager of the small reactor project at Los Alamos characterized the project as one of those rare opportunities in the nuclear area in which there is an established need for a power source, nuclear power is clearly the best option to meet that need, and the technology and industry capability exist to meet that need in a reasonable amount of time and at a reasonable cost. The project manager at the Idaho Operations Office believes that the need for secure power sources still exists at many Air Force bases and that nuclear power is still the best choice to meet these needs in many cases. He added that the idea of using small nuclear reactors to provide secure power for military bases will likely resurface in 4 or 5 years and that DOE—and particularly the nuclear reactor vendors—will be very wary about committing to such a project again. He added that it is very unlikely that the nuclear industry would again accept a fixed-price contract to develop a prototype nuclear reactor in the hope of receiving future orders for additional units.

The Headquarters Air Force Engineering and Services Center at Tyndall Air Force Base, Florida, remains the Air Force focal point for energy security matters. Officials with the Tyndall organization told us that no change has occurred in the secure power needs of the Air Force since 1983, when the small reactor project was initiated. They believe it is only a matter of time before the vulnerability of Air Force energy supplies is highlighted by an event such as a large power outage affecting a key Air Force base. Such an event will underscore the need for on-base power generating capability at some Air Force bases.

The Air Force is initiating a study to provide a documented assessment of technologies for secure energy and utility systems on Air Force installations. The study will include

- an evaluation of secure energy and utility requirements through fiscal year 2010,

- establishment of a comprehensive data base of existing/ emerging technologies,
- selection of candidate technologies for meeting projected requirements,
- assembly of technology applications guidance for Air Force major command and installation use, and
- documentation of the work in a final report.

Air Force officials told us that this study will be similar to the 1983 Defense Energy Task Force (see app. I). Their objective will be to identify the next best alternative to nuclear power. Nuclear power will be considered in the survey, at least for comparison with other technologies, since they already possess the data on that technology as a result of the small reactor project. This effort is an unfunded item in the Tyndall organization's fiscal year 1988 budget and is expected to take roughly 2 years to complete once funds are identified.



# Amounts and Sources of Funding for the Small Reactor Project

DOE and its Los Alamos National Laboratory spent approximately \$3.75 million from fiscal years 1983 through 1987 on their investigation of nuclear energy as a possible source of secure power for the Air Force. Funding for the Los Alamos study of the feasibility of using small nuclear reactors to meet the Air Force's secure power needs, and other activities in anticipation of eventually managing the project, consisted of approximately \$450,000 in internal Los Alamos Institutional Supporting Research and Development funds. DOE funding for the small reactor project in fiscal years 1984 and 1986 was made available through the transfer of funds within and between DOE's appropriations accounts. Such transfers require appropriate congressional notifications and approvals prior to the transfer. We found that DOE met these requirements. The Air Force has, at DOE's request, reimbursed DOE for one-half (\$540,000) of the fiscal years 1986 and 1987 expenditures made on the Air Force's behalf (\$1,078,800). These were the only moneys expended by the Air Force on the project under the August 20, 1984, Memorandum of Agreement.

## Los Alamos Funding of the Feasibility Study and Activities in Anticipation of Managing the Small Reactor Project

In June 1983 Los Alamos initiated a study, using internal funds, of the feasibility of using small nuclear reactors to meet the secure power needs of the Air Force. Funding for the feasibility study, and other activities in anticipation of eventually managing the development of a prototype small reactor, came from Los Alamos Institutional Supporting Research and Development (ISR D) funds. The Los Alamos project manager estimated that \$250,000 of the \$450,000 in ISR D funds Los Alamos spent was applied to the feasibility study while roughly \$200,000 was spent on other activities in anticipation of Los Alamos's eventually managing the development of the prototype reactor.

According to Los Alamos and DOE officials, ISR D expenditures are an allowable overhead cost and are administered by the laboratory director. Funds are collected by taking a percentage of all operating funds provided Los Alamos and setting them aside for research and development projects. The expenditure of these funds is authorized by the laboratory director.

Los Alamos officials we spoke with said that the laboratory's ISR D program has three objectives:

- to strengthen and broaden the science and technology base,
- to help maintain scientific vitality, and
- to provide seed money to develop new programs of national importance.

According to Los Alamos officials, it was the last of these objectives that served as the basis for using ISRD funds for the small reactor project at Los Alamos.

## DOE Funding of Reactor Design Procurement in Fiscal Year 1985

DOE's Office of Defense Programs provided \$2 million in fiscal year 1984 funding for the procurement of conceptual nuclear reactor designs and associated activities by DOE's Idaho Operations Office. These funds were spent in fiscal year 1985 and were made available by reprogramming within DOE's Atomic Energy Defense Activities Appropriation.<sup>1</sup> In this case, the \$2 million was reallocated from sludge irradiation activities to the small reactor project within the Defense Waste and Byproducts Management program under the Byproducts and Beneficial Use category. DOE policy is to require that proposals for the reprogramming of funds be transmitted to the appropriate congressional committees and to abide by the views expressed by those committees. Table V.1 shows the congressional concurrences obtained by DOE for the reprogramming of these funds for the small reactor project.

**Table V.1: Congressional Concurrence  
 on DOE's Fiscal Year 1984  
 Reprogramming of Funds for the Small  
 Reactor Project**

Committee/subcommittee	Type of concurrence and date
Senate Appropriations Comm. Subcommittee on Energy and Water Development	Verbal concurrence on March 26, 1984
House Appropriations Comm. Subcommittee on Energy and Water Development	Concurred by letter dated May 30, 1984
Senate Armed Services Comm.	Verbal concurrence on June 29, 1984
House Armed Services Comm. Subcommittee on Procurement and Military Nuclear Systems	Concurred by letter dated March 26, 1984

It is DOE's policy to abide by the views expressed by the congressional committees from whom it seeks concurrence on reprogramming actions. In the case of the small reactor project, the Chairman of the House Armed Services Subcommittee on Procurement and Military Nuclear Systems insisted that the \$2 million that was reprogrammed be the only unreimbursed DOE Defense Programs funds expended on this project and that further DOE development efforts, if any, be reimbursed by the Department of Defense. In addition, the Subcommittee insisted that none of the reprogrammed funds be obligated or expended for a small reactor conceptual design until a memorandum of understanding between the

<sup>1</sup>Reprogramming was defined by DOE Order 5160.1 as including "the reallocation of funds from one budget activity, program, or function to another within an appropriation."

Department of Defense and the Department of Energy has been concluded and a copy provided to the Subcommittee. DOE and the Air Force entered into a Memorandum of Agreement for the small reactor project dated August 20, 1984.

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## DOE Funding of Small Reactor Project Activities in Fiscal Years 1986 and 1987

Fiscal year 1986 funding for the small reactor project was provided by DOE's Office of Nuclear Energy and was obtained by an appropriations transfer. The funding for the year totaled \$3 million although, according to the project closeout report, only about \$765,000 was actually spent on the small reactor project. An appropriation transfer, according to DOE Order 5160.1A governing such actions, is "the permanent movement of budget authority or balances from one appropriation account for credit to another." The order further states that an appropriation transfer may be effected only when authority to do so is specifically provided in an appropriation or other act.

In this case, the \$3 million was part of a larger transfer of funds from the Uranium Supply and Enrichment Activities Appropriation to the Energy Supply Research and Development Appropriation. DOE documents implementing the appropriation transfer cite general language contained in the acts providing DOE's fiscal years 1986 and 1987 appropriations as the authority for doing so.<sup>2</sup> This language allows for the transfer of up to 5 percent of an appropriation to another appropriation so long as neither appropriation is increased or decreased by more than 5 percent. In addition, the appropriation acts require that any such proposed transfers be promptly submitted to the House and Senate Committees on Appropriations. Officials of DOE's Office of Budget said that even in cases in which they have the authority to transfer appropriations, their policy is still to notify the appropriate congressional committees. They added that the Office of Budget will not process appropriation transfer requests until it has heard from the committees.

Table V.2 shows the congressional concurrences DOE obtained for the appropriation transfer that included funds for the small reactor project.

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<sup>2</sup>P.L. 99-141 and P.L. 99-591, General Provisions, section 302.

**Appendix V  
Amounts and Sources of Funding for the  
Small Reactor Project**

**Table V.2: Congressional Concurrence  
on DOE's Fiscal Year 1986 Appropriation  
Transfer for the Small Reactor Project**

<b>Committee/subcommittee</b>	<b>Type of concurrence and date</b>
Senate Appropriations Comm. Subcommittee on Energy and Water Development	Verbal concurrence on October 28, 1986
House Appropriations Comm. Subcommittee on Energy and Water Development	Concurred by letter dated August 7, 1986
Senate Committee on Energy and Natural Resources	Concurred by letter dated November 6, 1986
House Committee on Science and Technology	Concurred by letter dated August 8, 1986
House Committee on Interior and Insular Affairs	Partial concurrence by letter dated August 7, 1986 <sup>a</sup>
House Committee on Energy and Commerce	Concurrence assumed

<sup>a</sup>Subsequent discussions between DOE and the Committee staff indicated that the partial concurrence included the funds for the small reactor project.

Under DOE's fiscal year 1987 appropriations, an additional \$3 million was intended to be used for the small reactor project. According to the end-of-project report, DOE spent about \$393,000 of these funds prior to the termination of the project.

## **Disposition of Funds Remaining Upon Termination of the Small Reactor Project**

DOE's Idaho Operations Office closeout report for the small reactor project, dated September 1, 1987, indicates that \$1,157,500 of the \$6 million in DOE funds available for the small reactor project in fiscal years 1986 and 1987 was spent on the project. DOE's Financial Information System shows that the small reactor project costs totaled \$1,080,717 as of the end of fiscal year 1987. DOE officials told us that \$1.3 million was actually obligated for the project, the differences being attributable to costs incurred, but not paid, as of the end of the fiscal year.

DOE's fiscal year 1987 Supplemental Appropriation, P.L. 100-71, directed DOE to increase funding for the Advanced Control Test Operating Program at its Oak Ridge National Laboratory by \$500,000 and to provide \$200,000 to the National Academy of Sciences to carry out additional work on the facility design process for the planning and siting of low-level radioactive disposal facilities. Funds to comply with this direction were transferred to the programs from the unobligated funds remaining after the termination of the small reactor project. The remaining \$4 million of unobligated small reactor project funds was originally placed in a DOE controller's reserve account to be used to offset DOE's fiscal year 1989 Energy Supply Research and Development Appropriation. These funds, however, are now included in a planned reprogramming of funds to DOE's Office of Environment, Safety, and Health.

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**Appendix V  
Amounts and Sources of Funding for the  
Small Reactor Project**

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The Air Force reimbursed DOE for its share of the fiscal years 1986 and 1987 small reactor project funds (\$540,000) via a Project Order dated January 19, 1988. An Air Force acquisitions official in the Office of the Secretary of the Air Force told us that these funds were provided from the Civil/Environmental Engineering Technology Program within the Research, Development, Tests and Evaluation Appropriation account. These funds were transmitted to DOE's Idaho Operations Office and, according to DOE officials, will be reprogrammed at a later date.

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