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FUNDING AND MANAGEMENT ALTERNATIVES

FOR

ERDA MILITARY APPLICATION AND RESTRICTED DATA FUNCTIONS

An ERDA Report, Prepared in Collaboration with the Department of Defense, on the Desirability and Feasibility of Transferring to the Department of Defense or Other Federal Agencies the Functions of the Administrator Respecting Military Application and Restricted Data.

APPENDIX I - NONWEAPON DEFENSE-RELATED PROGRAMS IN ERDA

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APPENDIX I

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APPENDIX I

NONWEAPON DEFENSE-RELATED PROGRAMS IN ERDA

This appendix was prepared by the staff divisions of the ERDA Assistant Administrator for Nuclear Energy (AANE). It supplements Chapter IV with respect to the possible impact of weapon-program transfer alternatives on each of the nonweapon defense-related programs, and where appropriate, explores transfer considerations and alternatives for these nonweapon programs and activities.

1. INTRODUCTION

There are four ERDA nonweapon defense-related programs under supervision of the AANE: (1) Special Nuclear Material Production (plutonium, tritium, enriched uranium, and other special nuclear materials and isotopes); (2) Space Nuclear Systems (development, testing, and production of nuclear power systems for space applications, and the application of space and advanced energy technology to special-purpose terrestrial systems); (3) Naval Reactors (development of naval nuclear propulsion systems); and (4) Other Military Reactors (development, when required, of surface-based nuclear power plants for military use).

Each of these programs differs substantially from the weapon program, and from each of the others, in mission, operation, and other significant characteristics. At the same time, each interacts with other ERDA and DoD programs in varying ways and degrees, and has a close coupling to ERDA energy programs. Because management and funding relationships differ substantially from those in the weapon program, transfer alternatives considered here vary somewhat from those discussed for the weapon facilities.

2. SPECIAL NUCLEAR MATERIALS PRODUCTION

a. Background

The demand for nuclear materials began during World War II, when military needs led to construction of the first three plutonium production reactors at Richland, Washington, and ultimately to operation of nine production reactors at that site. In addition, five production reactors were built and operated at the Savannah River Plant to manufacture tritium as well as plutonium. The 14 reactors remained in operation until declining military requirements permitted the gradual shutdown of most of them. Today, only the N reactor is operating at Richland. At Savannah River, three are operating, and two are in standby status.

The World War II weapon program also presented an enormous demand for enriched uranium. To meet this need, the Oak Ridge gaseous diffusion plant was built. As military needs increased, additional gaseous diffusion facilities were built at Paducah, Kentucky, and Portsmouth, Ohio. For some years, the three diffusion plants were operated as an integrated complex, essentially for military requirements. In 1964, production of enriched uranium for the weapon program was terminated and overall production capacity was reduced markedly during the mid-1960's. At present, the three plants continue to operate as an integrated complex but produce predominantly low-enriched (2 percent to 4 percent U-235) uranium for the civilian domestic power program with limited production at Portsmouth to satisfy naval reactor requirements and other high-assay nonmilitary reactor uses.

Establishment of the production reactors and the gaseous diffusion plants also necessitated construction and operation of many support facilities peculiar to the nuclear program. These included capabilities for heavy water (D_2O) production to supply the moderator and coolant for the Savannah River reactors, deuterium gas manufacture at Oak Ridge Y-12, lithium isotope separation at Y-12, recovery of plutonium 238, and production of U-233 from thorium. Except for D_2O and deuterium gas production and recovery of Pu-238, these efforts essentially have been terminated because of reduced overall requirements.

The production reactors and diffusion plants required enormous quantities of uranium feed. To answer this need, a complex of manufacturing plants was constructed at Fernald, Ohio, and Weldon Spring, Missouri. These plants received uranium concentrates from domestic or foreign mills, and then purified the uranium for conversion into metallic form for the reactors or a purified uranium oxide which was then converted to gaseous hexafluoride at Paducah, Kentucky, for the diffusion plants. At the reactor sites, manufacturing facilities were constructed to produce fuel elements for the reactors and to chemically process irradiated elements to separate the plutonium product, recover unirradiated uranium, and store radioactive fission products. The Weldon Spring site was closed several years ago.

b. Current Organization, Capabilities, and Funding

No facility in the ERDA Nuclear Fuel Cycle and Production (NFCP) complex currently is operated exclusively for military purposes. Over the years, the SNM production centers have evolved into broader-purpose nuclear "energy" centers. The problems encountered in SNM production for the weapon program are like those in the commercial nuclear power reactor program. For example, the use of zirconium cladding for uranium fuel for power reactors, the Purex process for chemically processing irradiated fuel elements, and the calcining of radioactive waste are all techniques developed under the weapon program and now used in commercial power generation.

(1) Gaseous Diffusion Plants

From a project management standpoint, distinguishing operations attributable to military production from those supporting commercial supply is difficult. For example, the three diffusion plants presently are operated as an integrated complex, with the Paducah plant supplying low-enriched feed to Oak Ridge and Portsmouth. Because of the growth of civilian nuclear power production, the capabilities of ERDA diffusion plants are dedicated almost exclusively to meeting commercial requirements for enriched uranium. The slightly enriched uranium needed for power reactors (usually 2 percent to 4 percent U-235) is withdrawn from the Oak Ridge and Portsmouth plants, while all high-assay product (5 percent to 97 percent U-235), which includes material for production and research reactor operation and fuel for the naval nuclear fleet, is withdrawn only at Portsmouth. Important as this supply function is to the defense posture, the total effort expended in supplying highly enriched uranium for these purposes constitutes less than 5 percent of the Portsmouth plant operation. Attempting to operate a portion of the Portsmouth plant as a separate entity in order to supply the relatively small Navy requirements would be economically infeasible, especially since future requirements for high-temperature gas-cooled reactors (HTGRs) also must be met by enriched uranium produced at Portsmouth. Accordingly, none of the three diffusion plants can be regarded as a principal supplier of defense material to the exclusion of nonmilitary needs. If a new commercial gaseous diffusion plant were built, the stages would be tapered toward a top product of 3 percent to 4 percent U-235 because of the limited demand for highly enriched uranium in the industrial complex. Realizing this potential deficiency in matching requirements, the AEC testified to the Congress that the Portsmouth Plant would remain available to fill the highly enriched uranium requirements of industry for many years to come. The Government's investment at Portsmouth is $785 million. The operating contractor, Goodyear Atomic Corporation, employs about 2000 people.

(2) Supporting Facilities

During the period 1953 through 1955, facilities were constructed at the Oak Ridge Y-12 Plant for isotope enrichment of lithium-6, production of deuterium gas, and production of lithium deuteride and lithium hydride for thermonuclear weapons. The isotopic enrichment facilities were shut down in December 1962. Since that time, weapon and other requirements for enriched lithium-6 have been supplied from inventory and through recovery of material from obsolete weapons. One lithium separation cascade was dismantled in 1965 and one is maintained in standby. Facilities for production of deuterium gas, lithium deuteride, and lithium hydride, and the recovery of lithium deuteride from obsolete weapon parts, remain in operation. Heavy water used in the production of deuterium gas is obtained from the Savannah River Plant, and diluted heavy water recovered from obsolete weapon parts is returned to Savannah River for upgrading. Oak Ridge Y-12 provides deuterium gas used in the production of lithium deuteride, deuterium for other weapon program requirements, ERDA nonweapon needs, and DoD programs. Enriched lithium metal and various lithium compounds also are supplied for nonweapon requirements, including Savannah River needs for production of reactor products. All lithium and deuterium operations that support ERDA weapon and nonweapon requirements are funded by ERDA's NFCP Division.

In the Oak Ridge Y-12 Plant are enriched-uranium processing facilities that support a variety of users. Irradiated enriched uranium discharged from both the Idaho Chemical Processing Plant (ICPP) and Savannah River Plant (SRP) separation areas is sent to Y-12 for final purification, conversion to metal, and return to SRP for fabrication of new fuel elements. If additional uranium is needed by the SRP reactors, it is furnished by Y-12. These operations currently are funded by NFCP. Large quantities of enriched uranium were supplied to the weapon program from the gaseous diffusion plants in the form of uranium hexafluoride. This was reduced to metal at the Y-12 Plant in facilities that are now on standby. If the weapon program should require additional enriched uranium or a different enrichment (such as 97.5 percent U-235) these facilities would be reactivated to produce the metal.

(3) Production Reactors

At Richland, all production reactors except N have been shut down for four to eight years. The N reactor, though capable of producing weapon grade Pu, has been producing nonweapon Pu for other ERDA nonmilitary requirements to offset needs that would have to be met from reactors producing materials for defense purposes. The steam byproduct of N reactor operation is sold to the Washington Public Power Supply System to generate electrical energy for use in the Pacific Northwest.

The Savannah River reactors (three operating plus two on standby), along with the fuel-element manufacturing facilities, chemical processing plants, and related manufacturing support, operate primarily, but not exclusively, to satisfy military needs. Most of the SNM production facilities subject to transfer are at SRP, for which the prime contractor is duPont. Because of the versatility of the heavy-water-moderated production reactors, the associated support facilities, the Savannah River Laboratory, and the duPont technical staff, activities at SR have grown significantly beyond its original military functions. In addition to supporting the weapon program, the following activities are pursued at SR:

- Evaluating the effects on the environment of a nuclear complex (SRP is a National Environmental Park)

- Producing Pu-238 for use as an isotopic heat source in the space program and as an energy source for cardiac pacemakers and artificial heart systems, and encapsulating Pu-238 for the space program in facilities now under construction

- Making Californium-252 sources for use in the cancer radiotherapy research program

- Producing tritium and heavy water for development and startup of controlled thermonuclear (CTR) power reactors

- Exercising responsibility for the National Uranium Resource Evaluation (NURE) program in the eastern U.S.

- Shipping and storage of research-reactor spent fuel, and developing methods for processing Liquid Metal Fast Breeder Reactor (LMFBR) spent fuels

- Operating the SR ecology laboratory

- Processing irradiated fuels from ERDA and from domestic and foreign nonmilitary reactors

- Demonstrating the commercial nuclear fuel recycle process for the LWR, HTGR, and LMFBR systems.

The Government's investment at SR is approximately \$1.3 billion. The operating contractor, duPont, currently employs over 4000 people at SR. While a majority of the operating budget at SR is for SNM production, both defense-related and nondefense-related, the major future contribution will be in the nuclear energy field with a perhaps smaller contribution to non-nuclear energy programs. Although fuel reprocessing, waste management, and plutonium handling activities at SR are predominantly linked with materials production for weapons, they provide the basis for solving serious nuclear fuel cycle problems in the nonweapon field. The SR laboratory will play a leading role in defining and implementing any required demonstrations of the chemical processing and waste-management portions of the nuclear fuel cycle. In addition, SR provides an opportunity for studying environmental effects of the nuclear cycle and, as a national environmental park, provides a field-laboratory atmosphere for cooperative studies with universities and other public and private research and educational institutions. Any transfer that would deprive ERDA of primary control of the SR site could adversely affect the U.S. civilian nuclear energy program.

The feed material production operation at Fernald, Ohio (including the extrusion step in fuel manufacturing at Ashtabula, Ohio), is currently engaged in the production of metallic uranium fuel for the Richland N and Savannah River reactors, conversion of the government stockpile of uranium concentrates into normal uranium feed for the diffusion plants, and recovery of miscellaneous ERDA materials. When the concentrate stockpile has been processed, the Fernald refinery will be closed, and after FY 1977, operations there will be limited to supplying the production reactors. Accordingly, decisions on managerial responsibility for the feed material operations should be compatible with those made for production reactor operations.

(4) Chemical Processing and Waste Management Activities

Chemical processing and waste management are support services that only indirectly affect nuclear weapon activities. At both SR and Richland, radioactive waste management activities are receiving considerable public attention. Concern is primarily associated with such problems as leaking waste tanks, but the implications are much broader; they reflect upon the commercial industry and its ability to cope with high-level radioactive waste. The technology incorporated in future commercial facilities will be influenced by ERDA operating experience and by R&D programs carried out in support of ERDA's waste management activities.

Chemical processing and waste management are among several services provided at ERDA's Idaho National Engineering Laboratory (INEL) for both defense and nondefense programs. Within the INEL complex, highly enriched spent reactor fuel elements are chemically treated in the Idaho Chemical Processing Plant (ICPP). In addition to spent fuel elements from naval propulsion reactors, irradiated fuel elements from various nonmilitary test, research, and development reactors are processed at ICPP. Other significant defense-related activities at INEL are addressed below in conjunction with the naval reactors program. Any consideration of the possible transfer of defense-related programs conducted there would have to take into account their interrelationship with nonmilitary programs, services, and facilities.

c. Consideration of Alternatives

Alternatives 1 and 2 Involving ERDA Retention of Facilities and Program Funding/Management

The continuing objectives of fostering private R&D and encouraging scientific progress leading to safe and efficient peaceful use of nuclear energy, combined with long AEC/ERDA experience in successful operation of the nuclear fuel cycle and production complex, argue for retaining ERDA management of these programs. It would be difficult to separate military and nonmilitary aspects of fuel cycle activities, particularly with respect to the division of personnel and facilities throughout the integrated complex. Inefficiencies that would accompany limited use of what are now multiprogram facilities reinforce the argument against change. Collectively, these considerations need to be weighed against factors suggesting a change. These appear to be mainly managerial (purity of mission, alignment of defense-related activities under DoD) and ecopolitical (increased visibility of DoD programs and accountability for their costs). The questions of visibility and accountability for the costs of SNM production for weapons are partially resolved in Alternative 2 (improved budgeting, accounting, and reporting of ERDA costs in DoD major weapon system cost submissions to the Congress), and more completely resolved in several alternatives discussed below where DoD transfers funds to ERDA for new SNM production for weapons.

Alternatives 3 and 4 for Partial DoD Funding of the Weapon Program

Considerations favoring retention of nuclear fuel cycle and production activity management within ERDA, as expressed for Alternatives 1 and 2 continue to apply. For fuel cycle production, DoD budget and cost reporting improvements, plus DoD funding to ERDA for the cost of new SNM produced for weapons, largely resolves the issues of defense-related program visibility and DoD cost accountability. If desirable, DoD funding of new SNM production could conceivably be effected with or without the transfer of funding for weapon production and weaponization R&D costs. Once a formula for DoD payment for new SNM production had been established, it would be of little consequence whether this were tied to other elements of weapon funding transfers. Possible approaches to transfer funding of new SNM production for weapons are addressed in Appendix F. However, neither Alternatives 3 nor 4 resolves the managerial questions of mission purity and functional alignment.

Alternatives 5, 6, and 7 for DoD Management and Funding of Elements of the Weapon Program

Assuming that SNM production for weapons remained an ERDA responsibility with DoD funding, transfer of other ERDA weapon program activities to DoD would have essentially the same impact on nuclear fuel cycle and production activities as described under Alternatives 3 and 4. However, if management of programs and facilities associated with SNM production for weapons were to be transferred to DoD (thereby resolving the concern about management and functional purity) major problems would arise with respect to division of integrated multiprogram facilities. For the near term, inefficient utilization of facilities and degradation of commercial nuclear power, environmental, and safety programs allied with fuel cycle activities and facilities would be unavoidable. In the longer term, separation of these programs would produce inescapable pressures for duplication of staff and facilities that now perform both defense and nondefense SNM production activities in a multiprogram environment, using common facilities, equipment, personnel, and overhead/support bases.

Alternatives 8 and 9 for Transfer of Management and/or Funding of the Weapon Program and Facilities to Another Federal Agency

The impact of these alternatives on ERDA nuclear fuel cycle and production activities would be essentially the same as discussed under Alternatives 3 through 7.

3. SPACE NUCLEAR SYSTEMS (SNS)

a. Background

From the beginning of the space age in the late 1950's and early 1960's, nuclear energy has been importantly related to the planning and execution of the space program. Both DoD and NASA have actively supported development and use of nuclear space technology as essential components of their space missions. Historically, each agency has relied upon the AEC (ERDA) for requisite nuclear space technologies. The AEC (ERDA) has successfully responded to these specific requirements while continuing to explore technologies having probabilities of meeting future space mission needs. Several of these technologies are now being considered for terrestrial applications.

Over the years, the goals, objectives, and emphases of the nuclear space program have changed. Initially there was a great emphasis on nuclear propulsion and high power reactor systems. Ambitious space plans created a requirement for these systems beginning in the late 1960's and early 1970's. Consequently, large development programs were undertaken on the nuclear rocket (NERVA) and on SNAP-50 and subsequent zirconium hydride reactor power systems. These programs evolved out of the aircraft nuclear propulsion program of the 1950's. However, as the space program matured, many of the earlier ambitious missions slipped farther into the future. The related need and emphasis on nuclear propulsion and high power reactor technologies began to diminish. This culminated in the termination or major curtailment of the space effort in the early 1970's.

Nevertheless, throughout the 1960's, these programs resulted in major accomplishments and some vital contributions to the national technology base. Much of the expertise in cryogenic handling and control, advanced turbo-machinery, very-high-temperature materials, plasma kinetics, long-life gas turbines, liquid metal technology, and compact reactor design and control evolved from these efforts. During this period of gradual stretchout and retrenchment of large-scale space missions, emphasis turned to isotope power systems.

Space isotope programs had been pursued since the late 1950's, but only in the late 1960's and early 1970's did they emerge as the primary nuclear space technology for the near term. With the exception of one experimental reactor test, isotope systems are the only nuclear space technologies that have found actual usage in space missions. These isotope systems have made possible the extended exploration of the lunar surface, the first spacecraft journeys to Jupiter and the outer planets, and the first spacecraft landing and exploration of Mars. They will make significant contributions to specialized defense satellites of the future and will enable further exploration of Jupiter, Saturn, and other distant planets. The total 1961-1977 space program encompasses 22 actual or firmly planned launches. Of these, 14 are related to NASA space exploration efforts and 8 to defense programs. An increasing proportion of ERDA space efforts is being devoted to support of civilian needs. This is apparent in the FY 1976 budget wherein $27 million is associated with civilian programs and $4 million with military programs, although this proportion is somewhat distorted by expansion of the nonmilitary terrestrial programs discussed below. Future DoD requirements in both space and terrestrial program areas are expected to increase, but not to the extent where military needs will dominate civilian applications.

b. Current Capabilities, Organization, and Funding

(1) Space-Related Activities

A significant number of NASA planetary and DoD Earth Orbital Missions are projected for the late 1970's and the 1980's. Missions currently in progress include two Lincoln experimental satellites to be launched early in 1976 and two Mariner Jupiter/Saturn spacecraft to be launched in early 1977. Advanced nuclear systems will be required to satisfy their mission requirements and related Space Nuclear advancements over the next several years. Design and fabrication of thermoelectric converters, and production and encapsulation of isotopic fuel forms will be among the major SNS efforts in support of these space missions.

(2) **Terrestrial and Undersea Nuclear Isotope Applications**

Concurrent with development of nuclear isotope space technologies, effort is also underway to utilize isotope power in special-purpose terrestrial or marine applications. Several isotopically powered electrical generators were developed and deployed in remote applications throughout the world. Efforts were undertaken to expand their use in specialized thermal or radiation applications. Significant technical progress was made but economic considerations and limited isotope availability forced de-emphasis of these terrestrial activities in the late 1960's and early 1970's. However, the country's worsening energy situation and the approaching radioisotope output of the commercial nuclear waste processing plants have prompted reinvestigation of potential terrestrial applications of radioisotopes. A process for economical separation and use of these isotope by-products could have a significant impact on the management of the nuclear fuel cycle and on unconventional, special-purpose civilian and military energy needs. Current specific terrestrial application efforts are concentrated on a potential undersea power system, the potential of using thermoradiation in the sterilization of sewage sludge, and the potential use of power or thermal systems in remote cold regions.

(3) **Organizational and Funding Arrangements**

ERDA is responsible for the development of nuclear power generators in support of the space or special needs of both military and civilian agencies of the Government. Through mutually developed interagency agreements, management of these programs through all phases has been assigned to ERDA. However, user agencies reimburse ERDA on a full-cost recovery basis for any procurements beyond the first flight system development. This reimbursement includes isotope fuel and its encapsulation for space systems, but only the encapsulation and subsequent reprocessing for terrestrial systems. Where possible, such reimbursement is handled as an integral part of each contractor or laboratory operation rather than as a separate contract. In this way, the work effort is totally integrated and only the funding is handled separately.

c. **Consideration of Alternatives**

Alternatives 1 and 2 Involving ERDA Retention of Facilities and Program Funding/Management

Selection of Alternatives 1 or 2 would not significantly affect SNS programs.

Alternatives 3 and 4 for Partial DoD Funding of the Weapon Program

Selection of Alternatives 3 or 4 would not significantly affect SNS programs.

Alternatives 5, 6 and 7 for DoD Management and Funding of Elements of the Weapon Program

Assuming that the overall SNS program remained an ERDA responsibility (with interagency funding and management similar to that customarily effected for individual programs or projects), transfer of weapon production and/or development to DoD would impact on SNS only to the extent that access to weapon laboratory and production complex facilities would be impeded. The space and special-purpose systems described herein depend heavily on technology and production efforts being pursued at the government laboratories which could be transferred to DoD—particularly LASL, Sandia, Savannah River, and Mound. Production and encapsulation of isotopic fuels are critically dependent upon weapon-related laboratory facilities at Savannah River and Mound, and could continue as ERDA programs only if adequate support were provided via a separate agreement with DoD and/or if some arrangement were made for ERDA to continue these highly specialized activities as an operating adjunct or as a tenant at the transferred facilities.

Because SNS activities are generically oriented toward the nuclear fuel cycle and are fundamentally linked with power reactor research and operation, their transfer to DoD, although not impossible, would be wholly impracticable. Analogous to the NFCR case above, transfer of SNS programs would invite suboptimal use of existing facilities and induce pressures for duplication of plant, equipment, staff, and support activities. Transfer of the SNS program to DoD might also raise concerns about militarization of the space effort, contamination resulting from a direct and continuing NASA-DoD interface for development of these space systems, and a possible detrimental effect on ancillary civilian-oriented programs. On the whole, such a transfer would entail serious complications without apparent compensating benefit.

Alternatives 8 and 9 for Transfer of Management and/or Funding of the Weapon Program and Facilities to Another Federal Agency

Impact of these alternatives on ERDA SNS programs would be essentially as discussed under Alternatives 5, 6, and 7 above, taking into account that program transfer to an agency other than DoD might raise fewer subjective (contamination) arguments, but in objective terms, would be equally infeasible and impracticable.

4. NAVAL REACTORS

a. Accomplishments, Current Priorities, Anticipated Trends

(1) Scope of the Naval Reactors Program

The Naval Reactors program is a joint undertaking of ERDA and the Department of the Navy. Within ERDA the responsibility is carried out by the Director, Division of Naval Reactors, and in the Navy by the Deputy Commander for Nuclear Propulsion, Naval Sea Systems Command. Since the inception of the program, both of these positions have been filled by the same person.

ERDA's Division of Naval Reactors is directly responsible for the design, development, construction, testing, maintenance, and safety of nuclear power plants for naval vessels and their land-based prototypes. Naval Reactors also assists the Navy in the selection, training, and qualification of personnel for operating and maintaining naval nuclear propulsion plants. Naval Reactors is also responsible in ERDA for the Shippingport Atomic Power Plant, the Light Water Breeder Reactor program, and other reactor development programs related to continued development of civilian central power station reactors. Within the Navy, Naval Reactors is responsible for all technical matters pertaining to nuclear propulsion of U.S. naval vessels. This responsibility includes, but is not limited to, the following: R&D pertaining to naval nuclear propulsion; design, specifications, construction, inspection, certification, testing, refueling, overhaul, and conversion of naval propulsion plants; design, specifications, development, procurement, test installation, maintenance, and disposition of all nuclear systems and components used in naval nuclear propulsion plants and any special maintenance and service facilities related thereto; insuring proper control of radioactivity associated with naval nuclear propulsion plants to protect the health and safety of naval personnel and the general public; all aspects of reactor plant safety related to naval nuclear propulsion plants; and providing, as appropriate, technical assistance to the Chief of Naval Personnel in the selection, training, and qualification of personnel for operating and maintaining naval nuclear propulsion plants. Specific agreements between ERDA and the Navy for execution and funding of these responsibilities are discussed later in this report.

The Naval Reactors program involves a large number of activities, including two ERDA-owned laboratories where R&D is performed in conjunction with various land-based prototypes, vendor plants where reactor plant equipment is manufactured, and private and naval shipyards where nuclear ships are designed, built, and overhauled.

(2) Accomplishments

The Naval Reactors program has developed a wide variety of reliable, high-performance naval nuclear propulsion plants. It has also contributed, through the Shippingport and Light Water Breeder Reactor programs, as well as the naval programs, to the basic technology for the U.S. civilian nuclear power program. The U.S. has received dual benefits from this highly successful venture. First, national security has been greatly strengthened by the capabilities of nuclear powered submarines and surface ships. Second, the knowledge gained in developing the nuclear powered fleet has provided the foundation for the development of pressurized light water reactors—the predominant design in current use in the civilian nuclear power industry.

In the area of national defense, the nuclear Navy has grown from the world's first nuclear powered ship, the USS NAUTILUS, which became operational 20 years ago, to a fleet of 106 operating submarines and seven operating surface ships. Nearly one-third of the Navy's major combatant ships are now nuclear powered. With over 25 different reactor designs, the 135 operating naval reactor plants have accumulated over 1300 reactor years of operation without a reactor accident.

The Naval Reactors program has made significant contributions in the control of radioactivity. Major accomplishments are discussed later.

Both the performance and lifetime of reactor cores have been improved over those of the first NAUTILUS core. New long-life cores are capable of propelling a submarine for over 400,000 miles instead of the 62,000 miles provided by the first core of NAUTILUS. Cores now being installed in nuclear submarines and surface ships are expected to operate 10 to 13 years between refuelings.

In July 1953, the decision was made to construct the United States' first large-scale central station nuclear power plant for the generation of electrical power using a pressurized water reactor (PWR). Because of its experience with naval pressurized water reactors and the national importance of this effort, Naval Reactors was assigned the responsibility for the PWR project, later to become the Shippingport Atomic Power Station.

Naval Reactors has developed basic technology in all areas of LWR work. Among major contributions of naval and civilian projects are the following:

- Development of a uranium dioxide fuel system, now the most widely used fuel system in nuclear power

- Pioneering of the design of a number of large PWR components, and advancement of the technology for producing and cladding large pressure vessels

- Development of containment concepts and refueling techniques for power reactors

- Submission of the first safeguards report for a commercial nuclear power station, thus establishing many precedents now required for commercial reactor licensing

- Development of a system for preventing damage to a reactor core even if failures occur in the cooling systems

- Development of the first successful method for radioactive decontamination of land-based reactor plants

- Development of zirconium and zirconium alloys as nuclear fuel cladding materials. These alloys are now the most widely used cladding materials in commercial pressurized water reactors

- Development of hafnium as a reactor control material

- Development of boron for use as a burnable neutron absorber material which would permit higher fuel loadings and longer lifetimes for a reactor of given size.

In addition, the Naval Reactors program has provided technical information and expertise to the nuclear community in such areas as corrosion and wear technology for components operating in high-temperature high-pressure water, PWR heat transfer and fluid flow technology, predicting the performance of reactors in accidents, improved numerical analysis and reactor design techniques for digital computers, and a number of important developments in reactor physics and the irradiated properties of uranium fuels. Technical advances in these areas have been made known to the industrial community in over 5000 published reports.

Naval Reactors has also played a lead role in the development of equipment specifications, fabrication standards, and quality control requirements for nuclear components for both naval and civilian applications. For example, work in the Naval Reactors program contributed heavily to the basis for Section III of the ASME Code, the structural design basis for commercial nuclear plants.

Another major contribution to industry has been the officers and enlisted technicians, trained by the Navy, who have left the service to take key posts in the growing civilian nuclear power industry. It has been estimated that the Naval Reactors program had contributed about $2.5 billion to the national economy by the training and experience of its nuclear system operators.

(3) Current Priorities

(a) Submarine Projects

Naval Reactors is currently involved in the development of two new reactor plants for new classes of submarines, the TRIDENT fleet ballistic missile submarine and the SSN 688 class attack submarines. Three TRIDENT submarines and an ERDA-owned prototype propulsion plant are currently under construction. Twenty-six SSN 688 class submarines have been authorized through FY 1975. Design and development work is proceeding in parallel with construction for these projects. In addition, Naval Reactors is currently developing advanced submarine reactor designs to provide improved performance for future classes of submarines and has undertaken supporting research for these projects.

(b) Surface Ship Projects

USS NIMITZ, the first in a class of new aircraft carriers using a two-reactor propulsion plant, was delivered to the fleet in 1975. Construction is proceeding on reactor plants for the second and third NIMITZ class aircraft carriers and four VIRGINIA class nuclear cruisers. Funds were also provided in the President's proposed DoD FY 1976 budget to begin procurement of long-lead components for a new class of nuclear strike cruisers.

(c) Fleet Support and Long-Life Cores

Naval Reactors is responsible for the continuing technical support of nuclear propulsion reactors operated by the Navy and of the seven ERDA-owned naval prototype reactors, and conducts an extensive R&D program in support of these operating reactors. Research is currently underway in such areas as irradiation effects and corrosion of plant materials in order to improve performance and resolve identified problems. A large portion of this work is devoted to the development of long-life cores to increase the refueling interval for these reactors. This continuing effort has resulted in the development of cores that are expected to operate for over 13 years between refuelings. The ultimate objective of this work is the development of cores that will last the life of the ship. In addition to the obvious military and operational advantages of these long-life cores, a major reduction in the amount of radioactive waste generated during the life cycle of these ships will result.

(d) Light Water Breeder Reactor

Naval Reactors has been assigned the responsibility for the LWBR development program. The objective is to confirm the capability of breeding in a pressurized water reactor through the design, fabrication, operation, and testing of a breeder reactor core.

This LWBR core will be installed and operated in the plant at Shippingport, Pennsylvania. Operation of the core is expected to confirm that breeding can be achieved in a LWR system using the thorium uranium-233 fuel system, demonstrate that it is feasible to install breeder cores in existing and future pressurized water reactor plants, and provide basic technology for large-scale LWBR applications. The LWBR concept is the only known approach for increasing the fuel utilization of light water thermal reactors significantly beyond the one or two percent achievable with present types of LWRs.

(4) Anticipated Trends

The Naval Reactors program is expected to continue to emphasize the same basic areas of technological development as discussed above. Three areas that will significantly influence future planning are Title VIII of Public Law 93-365, the Department of Defense Appropriation Authorization Act, 1975; the Advanced Water Breeder Applications program; and the continued support of the nuclear fleet. These are discussed below.

- Title VIII of Public Law 93-365 provides that it is the policy of the United States to modernize the strike forces of the Navy by the construction of nuclear powered major combatant vessels. Title VIII requires all newly constructed major combatant vessels for the strike forces of the Navy authorized after August 5, 1974, to be nuclear powered unless the President fully advises the Congress that construction of nuclear powered vessels for such a purpose is not in the national interest. Title VIII also requires that if the President advises the Congress that nuclear warships are not in the national interest, the President's report shall include, for consideration by the Congress, an alternate program of nuclear powered ships with appropriate design, cost, and schedule information to allow the Congress the option of authorizing nuclear ships if they so choose.

Major combatant vessels for Navy strike forces are defined as including submarines, aircraft carriers, and the cruisers, frigates, and destroyers which accompany aircraft carriers, as well as ships for independent combat missions where essentially unlimited high-speed endurance will be of significant military value.

- The Advanced Water Breeder Applications program is a follow-on to the LWBR program. Its objective is to develop information that will assist U.S. industry to evaluate and apply to existing and future LWR plants the technology developed and confirmed in the LWBR program.

- A significant amount of the effort at the Naval Reactors laboratories is directed toward support of the operating fleet of nuclear powered ships. This effort includes such areas as development of operating procedures, technical assistance in resolving identified problems, and R&D. This effort emphasizes the development of improved components and materials, particularly in the areas of long-life reactor cores, simplification of operating and maintenance requirements, and increased reliability and maintainability of reactor plant components. The effort directed toward support of the fleet is expected to increase as the number of operating nuclear ships continues to increase.

b. Critical Issues in Legislation That Created the Original Organizational Structure

The DoD operates the nuclear propulsion plants installed in U.S. Naval ships pursuant to the provisions of Section 91b of the Atomic Energy Act of 1954, as amended. The division of responsibility for design, operation, and funding of these reactors was originally delineated in joint DoD/AEC agreements, specifically the Memorandum of Understanding concerning the USS NAUTILUS, dated May 10, 1954, and the Statement of Policy for Operation of Military Power Reactors, dated November 8, 1954. These agreements make the Navy responsible for operation of nuclear powered ships, while the AEC is to provide advice and assistance on the safety aspects of reactor design and in the preparation of safety standards, procedures, and operating instructions for these plants. These responsibilities were exercised through the establishment of a joint Navy/AEC organization, the Naval Reactors Branch of the AEC, and the Nuclear Power Directorate of the Bureau of Ships.

The division of responsibility between the AEC and DoD for the Naval Reactors program was further defined by a Presidential Directive dated September 23, 1961, which states:

> Responsibility will rest with the Department of Defense for identifying and resolving health and safety problems relating to the operation of utilization facilities, or to special nuclear material for use therein, which are held by the DoD pursuant to directives of the President under Section 91b of the Atomic Energy Act. In view of the Atomic Energy Act of 1954, the AEC will participate in the identification and resolution of these problems as a matter of responsibility. In this connection, the Department of Defense or the appropriate Military Department will prepare, issue, and enforce safety standards, procedures, or instructions applicable to the location and operation of utilization facilities and to special nuclear materials for use therein. Advice and assistance will be obtained from the AEC on the safety aspects of the design of utilization facilities and in the preparation or amendment of safety standards, procedures, or instructions relating to location and operation of utilization facilities and to special nuclear material for use therein, and comment or concurrence shall be obtained from the AEC as to their adequacy. Any disagreement as to safety aspects, arising as a result of comment by the AEC, which cannot be directly resolved by the two agencies will be referred to the President for decision.

On the basis of this Directive, the AEC and DoD evolved a working relationship in which the Director, Division of Naval Reactors, functioning also as the Navy's Deputy Commander, Nuclear Propulsion, is responsible for all technical aspects of the naval nuclear propulsion program.

These responsibilities are delineated in OPNAVINST 0300.5, dated November 12, 1966. The original version of OPNAVINST 0300.5 was coordinated with the AEC, including the Advisory Committee on Reactor Safeguards. The version finally agreed upon was transmitted to the Joint Committee on Atomic Energy and received its concurrence. On numerous subsequent occasions the Joint Committee has expressed its continuing approval of the manner in which the Naval Reactors program has been managed utilizing this dual assignment of responsibility. For example, the foreword to the Joint Committee hearing on the Naval Nuclear Propulsion Program—1971 states:

> The outstanding success of the Naval nuclear propulsion program has been achieved under the technical direction of Vice Admiral H. G. Rickover, U.S. Navy. The Joint Committee continues to be convinced that continuity of stewardship of this vital and expanding program by Admiral Rickover and his joint AEC-Navy organization is more important than ever and that all aspects of it must be maintained and supported. The accomplishments of the naval nuclear propulsion program are extremely impressive.

In disestablishing the Atomic Energy Commission and creating the Energy Research and Development Administration, the Energy Reorganization Act of 1974, specifically Section 104d, assigned the AEC's Division of Naval Reactors to ERDA; and, in support of the need for continuing the joint nature of the Naval Reactors Program, the House Committee on Government Operations Report on the Act, dated November 7, 1973, states:

> Your committee is well aware that the Division of Naval Reactors' early work in reactor development provided the technological base for the civilian nuclear power plants currently in use. Your committee also knows that this Division has trained many of the engineers and technicians now engaged in the design, manufacture or use of nuclear plants for generating central station power on utility systems.
>
> The Division of Naval Reactors is currently conducting a light water breeder reactor project, aimed at determining the capability of breeding in a pressurized water reactor. This is still another important part of the AEC's developmental mission in regard to breeder reactors.
>
> The outstanding success of the Naval Reactors Division, from the standpoint of both the civilian reactors program and the common defense and security, is well known. The dual scope and contributions of this program in classified and non-security areas continue. Your committee wants to express clearly its conviction that if the functions of the Naval Reactors Division had not been under the jurisdiction of the AEC, most of its accomplishments in both the peaceful and naval ships areas probably would not have materialized.

c. Current Organizational Arrangement

(1) General Organization and Facilities

To carry out the joint ERDA/DoD responsibilities delineated above, the Naval Reactors program uses various organizations and facilities. The Naval Reactors headquarters organization consists of approximately 250 naval officers and civilian scientists and engineers, jointly assigned to ERDA's Division of Naval Reactors, and the Nuclear Propulsion Directorate, Naval Sea Systems Command. Within Naval Reactors, engineers and scientists work concurrently on both civilian and naval related projects.

Naval Reactors directs the design and development of the naval nuclear propulsion plants and civilian projects at the Bettis and Knolls atomic power laboratories. Work performed under ERDA and Navy contracts with these laboratories is administered by two field offices. The ERDA managers of these offices report directly to the Director, Division of Naval Reactors, to ensure close liaison between the laboratories, ERDA headquarters, and the Naval Sea Systems Command. As in the headquarters organization, the same individuals represent both ERDA and the Navy in the field, minimizing duplication and assuring that the requirements of both agencies are met.

In addition to those associated with the laboratories, there are Naval Reactors field offices at the various shipyards, reactor prototype sites, and prime contractors associated with Naval Reactors. Each of these types of organizations, as well as the laboratories, is briefly discussed below.

(a) **Bettis Atomic Power Laboratory**

The Bettis Atomic Power Laboratory includes two ERDA-owned sites which are operated by the Westinghouse Electric Corporation. The principal site, known as the Bettis Site, performs R&D for naval nuclear propulsion plants and the Shippingport pressurized water and LWBR projects. The second site, the Naval Reactors Facility (NRF), is at the Idaho National Engineering Laboratory. This installation includes four prototype naval reactor plants and a facility for post-operational examination of expended naval reactor cores. The entire Bettis effort is under the direction of the Division of Naval Reactors. The annual operating budget for the Bettis Laboratory is about $150 million, of which approximately 20 percent is funded by the Navy and 80 percent by ERDA. The employment ceiling is about 4300 people. The authorized plant and capital equipment investment at Bettis and NRF is about $225 million.

(b) **Knolls Atomic Power Laboratory**

The Knolls Atomic Power Laboratory (KAPL) includes three ERDA-owned sites. The General Electric Company operates the laboratory for ERDA, as well as land-based prototypes of shipboard pressurized water reactor plants at two other sites. With the exception of approximately $0.6 million for the Physical Research program, the entire KAPL program is under the direction of the Division of Naval Reactors. The annual operating budget for KAPL is approximately $110 million, of which approximately 30 percent is funded by the Navy and 70 percent by ERDA. The employment ceiling is about 3100 people. The authorized investment for plant and equipment at the three sites operated by KAPL is about $310 million.

(c) **Naval Reactor Plant Prototypes and the Shippingport Power Station**

Naval Reactors, through its laboratories, operates seven land-based naval prototype reactors. Two additional prototypes are under construction. These are owned and operated by ERDA primarily to provide research and test facilities for the Naval Reactors laboratories. The reactor cores and plant are highly instrumented, and comprehensive test programs are carried out throughout the life of each reactor core. Planning for operation and testing is coordinated for all the prototypes to support the development of basic technology and new reactors, as well as to confirm existing designs. The prototypes are also used for training of naval personnel to operate the Navy's nuclear powered ships. Instruction is provided by naval personnel and by civilian personnel from the Naval Reactors laboratories. The Navy supplies most of the operating crew for the prototype plant. ERDA in turn makes the plant available for training in conjunction with the testing being conducted. Naval Reactors has a field office at each prototype site to maintain direct technical control over site operations and to supervise the training.

The Shippingport Atomic Power Station is a joint project of ERDA and the Duquesne Light Company. ERDA owns the nuclear plant portion of the station and Duquesne owns the conventional turbine-generator portion. The reactor portion was designed and developed by Bettis under the direction of Naval Reactors. The primary objective of the Shippingport Station continues to be advancement of basic technology for pressurized LWR's by actually designing, developing, fabricating, operating, and testing reactor cores for extended periods of time. Numerous tests have been conducted in the highly instrumented nuclear plant to evaluate reactor core design and performance. Naval Reactors maintains a field office at Shippingport to oversee operation of the nuclear portion of the plant. A Naval Reactors representative is always present in the control room when the reactor is operating and has the authority to shut down the reactor if safety conditions warrant.

(d) Reactor Plant Component Prime Contractors

Naval Reactors uses two prime contractors, Westinghouse and General Electric, for the procurement of reactor plant components for naval ships, prototypes, and the Shippingport Station, including the LWBR. The contractors are under the direction of Naval Reactors and, in cooperation with its laboratories, are responsible to both the Navy and ERDA for developing and enforcing the technical specifications used in the procurement of reactor plant components. They are particularly involved in quality assurance, and assist Naval Reactors in its cooperative program with the Defense Contract Administration Service in frequently auditing the quality assurance performance of reactor plant component vendors. Resident prime contractor quality control offices are maintained at certain key vendors.

(e) Shipyards

The Naval Reactors laboratories have overall design responsibility for naval reactor plants. A shipbuilding contractor is, however, given the responsibility for plant arrangement, naval architecture, and overall propulsion plant design. Naval Reactors provides technical direction and coordinates the activity of both of these design agencies. Currently, the Electric Boat Division of General Dynamics and the Newport News Shipbuilding and Drydock Company are involved in the design of naval nuclear propulsion plants.

Construction, repair, maintenance, and refueling of nuclear-powered naval ships is carried out at three private and six naval shipyards. While these shipyards are not directly responsible to Naval Reactors, a field office is maintained at each shipyard. These offices follow nuclear propulsion plant work in the shipyards, oversee reactor safety and radiological aspects of shipyard operations, and maintain day-to-day liaison with the Division of Naval Reactors. The cognizant Naval Reactors laboratories also maintain resident personnel in the shipyards to follow the construction, overhaul, refueling, and test programs, to carry out responsibilities in reactor safety and radiological control matters, and to provide technical advice to the shipyard on problems arising in the propulsion plant.

(2) **Major Functional Areas**

(a) **Reactor Safety**

ERDA and the Navy are obligated to insure that naval reactor plants can be operated without endangering the public. This obligation is met in a number of ways, most importantly through care in the design, construction, testing, operation, and maintenance of these plans under the direction of the Division of Naval Reactors. ERDA and the Navy routinely consult with the Nuclear Regulatory Commission (NRC) on matters concerning reactor safety.

Historically, Naval Reactors and its involvement in the field of power reactors predates the AEC's licensing program. Reactor safety reviews of naval plants were originally conducted between the Division of Naval Reactors and the Advisory Committee on Reactor Safeguards (ACRS) and its staff. At that time, expertise in reactor safety technology and in determining and analyzing related criteria existed primarily within Naval Reactors and its laboratories. Since no power reactors existed other than naval reactors, the process of reactor safety analysis was one of establishing criteria in a field where no precedents existed. Many of the standards developed at that time, and used today in the civilian nuclear power industry, evolved from these early reviews. As civilian nuclear power began to expand, the AEC was reorganized to include a separate regulatory function. Under this arrangement, newly designed naval reactor plants continued to be reviewed by the ACRS; however, Licensing and Regulatory coordinated their reviews with the ACRS and conducted their own independent assessments. It has been through this process that the safety of naval prototype and shipboard plants has been assessed. This coordination has continued since the creation of NRC. Similar review by Regulatory, now NRC, has been obtained for Naval Reactors civilian projects, such as the Shippingport Atomic Power Station and the LWBR.

Safety is a paramount consideration throughout the design and development of each new naval reactor plant. All plant details and the assumptions, data, and calculations supporting them are submitted by the Naval Reactors laboratory to Naval Reactors for approval as the design progresses. These detailed technical reviews form the basis for a continuous safety review. On completion of a reactor plant design, a Reactor Hazards Summary Report is prepared by the laboratory and submitted to Naval Reactors for approval. This report is also sent to the other Naval Reactors laboratory for safety review of the final design. As discussed above, the report is then submitted to NRC and ACRS for review. The Navy obtains this review, and concurrence by ERDA and the NRC, before operating a new design reactor plant. ERDA and the NRC, as appropriate, also review any safety-related modifications to the design or operating procedures of existing naval reactor plants.

Naval Reactors efforts to ensure reactor safety have benefited from the research done in this area by other ERDA activities, particularly the Division of Reactor Research and Development. For example, work done in loss of coolant studies and irradiation of pressure-vessel materials has been applied in Naval Reactors programs. Continued ready access to ongoing ERDA work in reactor safety research is an important aspect in ensuring the safety of reactors under the cognizance of Naval Reactors.

(b) Radiological Controls

Radiological control aspects of reactor operations continue to be a basic consideration in personnel training, reactor design, and procedure development. Naval Reactors has developed an experience base in this area from over 130 operating reactors.

Through cooperation between the Navy and ERDA, the Naval Reactors program has been able to make significant improvements in the control of radioactivity. Until 1970, several million gallons of low-level radioactive water were discharged each year into the harbors and rivers of the world from the Navy's nuclear-powered ships and support facilities. By 1974, this was reduced to less than 10,000 gallons of water. In each of the last four years, the total amount of radioactive liquid released into all the harbors of the world was less than 0.002 curies (excluding tritium). As a measure of the significance of these data, the natural background radioactivity in the water displaced by a single fleet ballistic missile submarine is greater than that discharged into harbors each year from all these ships and support facilities.

Experience in radiological controls has been shared between agencies to the benefit of the Navy, ERDA, and NRC. This exchange of information has been used in preparation of standards for commercial reactors and the industry as a whole, and covers the areas of waste disposal, contamination control, personnel radiation exposure control, and environmental monitoring.

(c) Research and Development

- *Naval Programs.* The Naval Reactors R&D program provides for the design and development of improved naval nuclear propulsion plants and reactor cores. Development continues on improving reactor concepts, components, and materials for submarines and surface warships, with particular emphasis on obtaining long-life cores and size; simplifying operating and maintenance requirements; and increasing reliability and maintainability of reactor plant components.

- *Civilian Programs.* R&D efforts in civilian programs parallel those in the naval programs and, in many cases, are dependent upon the same basic technology. Primary effort in the civilian programs is directed toward the LWBR and Advanced Water Breeder Applications programs. Objectives of work in these areas have been previously discussed.

(d) Relationship With Other ERDA Activities

The Division of Naval Reactors has numerous interrelationships with other ERDA divisions. Many of these are administrative, but others involve technical support. Examples are:

- The Nuclear Fuel Cycle and Production Division supplies enriched uranium for both naval and civilian project reactors. In addition, the Idaho chemical processing facilities store and reprocess irradiated fuel from these reactors. Savannah River, Hanford, and the Oak Ridge National Laboratory have been involved in the fuel cycle for the LWBR.

- Advanced fuel system testing is conducted at the Advanced Test Reactor at the Idaho Engineering Laboratory. Planning requires coordination with the Idaho Operations Office and the Division of Reactor Research and Development.

- Environmental Impact Statements for the LWBR and naval prototypes are coordinated with the Assistant Administrator for Environment and Safety and other ERDA divisions whose expertise was needed in preparing the statements.

- The Division of Classification reviews and concurs in all proposed classification decisions affecting Naval Reactors work.

- The Division of Safeguards and Security is consulted in matters affecting Naval Reactors.

- Technical information, including information obtained from Navy sources, is provided to other ERDA activities. Correspondence is exchanged routinely with the Division of Reactor Research and Development.

- Divisions of International Security Affairs and International Programs are consulted on matters relating to protection of naval nuclear propulsion technology, foreign nuclear cooperation, implementation of Munition List and Department of Commerce Export Controls, and studies used to develop U.S. foreign policy regarding nuclear power that involve areas under Naval Reactors cognizance.

- Naval Reactors and its laboratories participate in reactor physics committees sponsored by the Division of Reactor Research and Development. Basic nuclear data are interchanged with other ERDA laboratories.

- Reactor physics test facilities under the control of the Division of Reactor Research and Development have been used in the LWBR program.

d. Fiscal Management

(1) Sources of Funding

The present ERDA/DoD Naval Reactors program is funded as follows: ERDA is responsible for the design and development of new reactor plants, including the fabrication and operation of land prototypes. The DoD funds the construction, operation, and maintenance of nuclear-powered ships including fabrication of the propulsion plant and special features required because of naval applications. Requests for this funding are presented to the Congress as part of the ERDA and DoD budgets, as appropriate.

Annual ERDA funding for the naval program is approximately $170 million for R&D and $5 million to $10 million for plant and capital equipment. ERDA funds prototype plants on an individual construction project basis with the most recent prototype costing about $125 million. ERDA also funds Naval Reactors' civilian reactor development programs at approximately $30 million annually.

Annual DoD funding is approximately $500 million to $700 million, depending on the ships authorized. This includes funds for the shipboard reactor plants, replacement fuel and reactor plant components, technical and logistic support, and R&D. These funds do not include DoD expenditures for non-reactor plant portions of the ships.

Through FY 1975 the DoD has invested $24.1 billion for construction of nuclear ships, including replacement fuel and components, and R&D. Through this same period, ERDA and the AEC have invested $2.7 billion for R&D and construction of prototypes and laboratory facilities for Navy related work, and $0.5 billion for civilian projects, including the LWBR and the Shippingport Atomic Power Station.

(2) Means of Funding Various Activities

(a) Naval Cores

DoD funds the manufacture of naval reactor cores for shipboard use. By use of an Economy Act Order, DoD transfers the funding authority to ERDA, which is responsible for procuring the cores. SNM contained in naval reactor cores is provided to DoD by ERDA in accordance with the Atomic Energy Act of 1954, as amended. Under this Act, custody of this SNM is transferred to DoD by periodic Presidential authorization; however, title remains with ERDA. In accordance with joint ERDA-DoD policy, the Navy reimburses ERDA for the cost of ERDA SNM consumed in the operation of naval nuclear ships and for reprocessing spent naval cores to recover the remaining SNM for return to ERDA inventory. ERDA bills the Navy for the cost of reprocessing nuclear cores at the end of core life when the cores are returned to ERDA. These are one-time costs not directly related to ship operation. ERDA bills the Navy quarterly for the cost of SNM consumed in the operation of nuclear powered ships.

(b) Laboratories and Component Procurement

The two Naval Reactors laboratories are ERDA-owned, contractor-operated laboratories. All facilities at the laboratories are owned by the government, and work on both naval and civilian programs is funded through ERDA operating contracts with Westinghouse and General Electric. The Navy also contracts with Westinghouse and General Electric for naval project support work at these laboratories, and for procurements to support ERDA-funded programs such as the LWBR and naval prototype reactor plants, which are funded through the laboratory operating contracts.

e. Functions for Plausible Transfer/Retention

Several alternatives could be considered for organization of the Naval Reactors program. These are listed below and are discussed in the next section.

- Maintain the current ERDA/Navy organization

- Transfer the Naval Reactors Division, naval and civilian, to the DoD

- Transfer Navy-related work to the DoD and retain the civilian programs within ERDA. Transfer of the naval work to DoD could include R&D, core procurement, and prototype operations, or some combination of these areas

- Retain the current Naval Reactors program in ERDA, but transfer funding responsibility for Navy-related items to the DoD.

f. Analysis of Transfer Packages

(1) Retain the Current Joint ERDA/Navy Organization of the Naval Reactors Program

The objectives of the Naval Reactors program are to apply nuclear energy to ship propulsion and to support its civilian projects, such as LWBR. This involves basic work in many areas including nuclear physics, power plant design, thermohydraulic technology, metallurgy, chemistry, mathematics, and radiological control. Technology developed in the Naval Reactors program directly applies to the civilian nuclear energy field, as in the current development of an LWBR and work on Advanced Water Breeder Applications.

The Naval Reactors program, as currently organized, has successfully fulfilled its mission for over 25 years. The primary and most obvious advantage to maintaining this organization is the fact that it has worked well and no alternative structure is likely to be more successful. Other major advantages are:

- Lack of disruption and added costs that would accompany any change in program organization.

- Continuation of the most efficient means of carrying out this dual program with a minimum of duplication of programs, facilities, or personnel.

- Continuation of the flow of unclassified information developed as part of Navy-related reactor development to the civilian nuclear power industry. This is particularly true in the civilian programs currently assigned to Naval Reactors. Frequently, technology developed in the naval or civilian programs has application to the other, and Naval Reactors personnel work concurrently on these projects. Any change would disrupt the day-to-day interchange of information, and would affect the information made available to private industry.

- All aspects of the design, construction, operation, and maintenance of naval nuclear propulsion plants and the training of operating personnel will continue to be reviewed by ERDA in ensuring the health and safety of the public. Ready channels for consultation with NRC will be maintained in the review of reactor safety aspects. The Joint Committee on Atomic Energy and the Advisory Committee on Reactor Safeguards have stated that such review is essential in ensuring the safe operation of naval nuclear propulsion plants.

- The naval nuclear propulsion program will be able to continue the free interchange of information among DoD, ERDA, and NRC in the areas of radiological controls and reactor safety.

- The civilian programs of Naval Reactors, in particular the LWBR, will be able to continue without interruption. These areas of R&D in LWR technology are an integral part of ERDA's national energy plans and are intermixed on an ongoing basis with similar naval work that uses the same facilities and personnel.

- The technical expertise of the ERDA-owned Naval Reactors laboratories will continue to be made available throughout both the naval and civilian programs. Any division of the responsibilities of the laboratories would degrade the functions they perform in such important areas as reactor safety, quality assurance, reactor plant design and testing, technical support for operating naval reactor plants, and R&D.

- Cooperation within ERDA on matters relating to safeguarding of SNM will continue.

Concerning the structure of the Naval Reactors organization, there is no known Congressional interest in altering the present arrangement. On the other hand, there is ample evidence that maintenance of the current dual organization is considered important, as was noted in the House Report on the Energy Reorganization Act of 1974. As another example, during the confirmation hearings for the Administrator of ERDA on December 11, 1974, Senator Jackson stated:

> . . . I want to ask you, first, one question and that relates to a nuclear reactors program which this committee has followed very closely. We have kept it within the Atomic Energy Commission. Admiral Rickover has done an outstanding job because he has been independent. I think the worst thing that could happen would be for that program to go over to the Pentagon, and I for one—I don't know how my colleagues feel—I would hope that would stay within your agency, ERDA. I would like to have your comments on it.
>
> I think it is independence that has existed there that has made possible the great accomplishments that have occurred over the years.

In summary, the present organizational structure of the Naval Reactors program, in which AEC/ERDA has played an essential role in conjunction with the Navy, has been successful. Without ERDA having had such a role, the viability of the entire program could be jeopardized and the prospects for continued contributions comparable to those already achieved would be seriously diminished.

(2) Transfer All Naval Reactors Functions, Naval and Civilian, to the DoD

This is not considered a viable alternative since it would involve the DoD in civilian nuclear power programs. Such involvement is clearly outside the scope of the DoD's charter, and is in conflict with Section 103 of the Energy Reorganization Act of 1974. It is also in conflict with Section 91(b) of the Atomic Energy Act of 1954 which permits DoD involvement in the manufacture and operation of reactor plants only for military purposes. This alternative was, therefore, not given further consideration.

(3) Transfer the Navy-Related Work of Naval Reactors to the DoD and Retain the Civilian Programs Within ERDA

As previously discussed, the Naval Reactors program involves both civilian and naval projects that are closely interrelated at both the management and working levels. It would, however, be possible to transfer some or all of the Naval functions to the DoD. The functions considered for possible transfer are naval core procurement, prototype reactor operations, and naval research, development, and design work. The transfer would involve the actual transfer of personnel and facilities. The possible transfer of funding responsibility only to the DoD is discussed in the next section.

(a) Transfer of Naval Core Procurement

Reactor cores for naval nuclear propulsion plants are currently procured by ERDA, which is responsible for both the technical and financial followup of these procurements. In fulfilling its responsibilities for reactor safety, ERDA develops the technical specifications and quality assurance provisions for these cores based on its expertise in core design. The DoD is not currently capable of developing the technical requirements for these cores and to provide adequate technical followup for procurements. To obtain such a capability, the DoD would have to establish a technical organization, including laboratories, comparable to that already available in the Naval Reactors program. Such action would duplicate significant costs, manpower, and facilities unless R&D and design functions were also transferred. If this were done, either DoD would have to assume responsibility for procuring cores for the ERDA-owned naval prototypes and the Shippingport Atomic Power Station, or this capability would have to be retained in a new organization within ERDA. It would, therefore, be impractical to undertake transfer of only the naval core procurement function of Naval Reactors.

(b) Transfer of Prototype Reactor Operations

The purposes of the reactor prototypes include test and evaluation of new reactor and plant designs and equipment; development of reactor and plant technology; evaluation of layout and design of shipboard reactor plants under conditions duplicating exact shipboard constraints; and training of naval personnel to operate and maintain reactor plants under actual shipboard conditions.

Naval Reactors has always maintained a close tie between the prototype and the ships; the two are inseparable. Experience gained on prototype reactor operations is factored into ship operations and vice versa. Transfer of these ERDA-owned prototype reactors to DoD has several significant disadvantages:

- The primary purpose of the prototype plants is to test new technology and equipment, particularly new reactor core designs which are the responsibility of ERDA. ERDA would not be able to adequately design new cores unless it could maintain a continuing expertise in the design, operation, and testing of each prototype reactor plant. This is not possible without having technical responsibility for operation, repair, maintenance, and modifications of the plant. On the other hand, DoD would not be able to design new cores and equipment for the protoypes or provide the required technical support of their operation and testing without the establishment of a technical organization essentially duplicating that of Naval Reactors and its laboratories.

- The ERDA-owned prototypes are maintained and operated by the Naval Reactors laboratories. If ownership and operation of the prototypes were transferred to DoD, considerable cost and duplication of effort would be involved in obtaining DoD prime contractors to operate and maintain the prototypes. Additional administrative costs could also be incurred at the several prototypes located at the ERDA-owned Idaho National Engineering Laboratory. These prototypes rely on other ERDA facilities at the site for some general services. Continuation of these arrangements may not be practicable if DoD were to own and operate the prototypes.

- Part of the training staff for naval personnel at the prototypes is supplied by the ERDA laboratory responsible for design of the prototype. This ensures that training is performed by personnel familiar with the detailed design bases of the reactor plant. A change that would eliminate this ERDA laboratory participation would degrade the level of training available at the prototypes.

From the above it is clear that it would be costly and undesirable to transfer prototype reactor ownership and operation to DoD unless the R&D and design responsibilities for naval reactors were also transferred.

(c) Transfer of the Research, Development, and Design Responsibility for Naval Reactors

As can be seen from the above discussions, none of the various naval-related functions could be transferred unless the research, development, and design functions of ERDA are also transferred. Conversely, if the research, development, and design work were transferred, it would be impractical to retain any of the naval-related functions in ERDA. This section, therefore, discusses transfer of all naval-related work to DoD. In reviewing this section it is important to remember that Naval Reactors and its laboratories are responsible for both naval and civilian projects and that many of the same personnel and facilities are used concurrently in both areas.

As previously discussed, there are numerous advantages if the current joint ERDA/Navy organization of the Naval Reactors program is maintained. Conversely, there are many disadvantages associated with transferring its naval-related activities to the DoD including:

- A significant portion of the workload at Naval Reactors and the Bettis Atomic Power Laboratory is concerned with civilian programs, such as the LWBR. Some work on the civilian programs is also carried out at the Knolls Atomic Power Laboratory. Most of the research facilities at Bettis are used in both the naval and civilian programs. This results in many of the personnel, particularly at the supervisory levels, having responsibilities in both programs. Transfer of the naval-related portion of the work could not, therefore, be accomplished by the transfer of specific personnel groups and laboratory facilities to DoD. Such a transfer would require the duplication of many personnel and laboratory facilities. The cost of such a transfer cannot be accurately estimated without determining the detailed organization of the new programs, but it would no doubt be considerable. It is likely, since independent ERDA and DoD management of a single laboratory would at best be cumbersome, and inconsistent with any desire to terminate the military-related responsibilities of ERDA, that a new laboratory would have to be established as a result of such a transfer. This would further increase the costs of transferring this work.

- Transfer of the naval-related work to DoD would result in the fragmentation of the experienced engineers and scientists at Naval Reactors and its laboratories into new organizations. This would result in a decrease in the experience level in both DoD and ERDA, and would, at least temporarily, decrease the quality of work performed on both the naval and civilian programs.

- Division of the research, development, and design functions would result in significant disruption, delay, and consequentiy higher costs to high-priority national defense programs such as the TRIDENT submarine and civilian projects such as LWBR.

- Such a transfer could have a significant impact on reactor safety aspects of the naval nuclear propulsion program. While the DoD is responsible for identifying and resolving health and safety problems relating to naval nuclear propulsion plants, by Presidential directive it must seek the advice and assistance of ERDA, which retains statutory responsibility under the Atomic Energy Act to ensure the health and safety of the public. ERDA and the Navy also consult with the NRC on matters involving reactor safety. This relationship is now effectively carried by the joint ERDA/Navy Naval Reactors program, which has the responsibility and capability of reviewing the safety aspects of the design of naval nuclear propulsion plants and the preparation of safety standards, procedures, and instructions relating to plant operation. To separate this joint organization would result in the need to establish more complicated and cumbersome inter agency procedures to obtain ERDA or NRC review of even minor modifications to Navy operating procedures and safety standards. In such a system it would be difficult to maintain the flexibility and prompt reaction time needed to support a fleet of over 110 nuclear-powered ships.

In addition, the Advisory Committee on Reactor Safeguards and the NRC base their review of the safety of naval nuclear propulsion plants, in large part, on the continuing review and control of these plants provided by the Division of Naval Reactors. If ERDA's responsibilities in this area were eliminated, it might be determined that additional review and followup of these plants by NRC would be required. This would further increase the amount of government manpower and funds that would have to be committed to the naval nuclear propulsion program.

- The coordination of development efforts and the dissemination to industry of unclassified reactor technology developed in naval-related R&D would be made more difficult, both because the DoD lacks ERDA's systems for distributing technical information to the nuclear community and because the close working relationship between the naval and civilian reactor programs would be eliminated.

- The close cooperation that has existed between ERDA and the Navy in developing radiological control methods would be hampered by such a transfer, as would the implementation of ERDA-developed SNM safeguards.

- The involvement of ERDA in the training of Navy reactor operating personnel would be greatly diminished or terminated.

- ERDA has statutory authority under the Atomic Energy Act to determine what is restricted data, and to set requirements for controlling its dissemination. If responsibility for naval nuclear propulsion work, which involves restricted data, were transferred to DoD, interagency agreements and possibly remedial legislation would be required to permit DoD to assume total responsibility for restricted data involved in this work.

(4) Retain the Naval Reactors Program in ERDA, But Transfer Funding Responsibility for Navy-Related Items to the DoD

As previously discussed, DoD is responsible for funding actual production of naval nuclear propulsion plants. ERDA funding is primarily involved in R&D, in which Naval Reactors has both naval and civilian programs. To transfer funding responsibility to DoD for Navy-related ERDA work would have several disadvantages including:

- Technology developed in the naval and civilian programs is interdependent and directly applies to other aspects of civilian nuclear energy which are the responsibilites of other ERDA divisions. Program planning and budgeting must be coordinated. If DoD were assigned either funding or total responsibility for the naval portion of the program, an unnecessary interface would be added between DoD and ERDA when budget decisions in one agency would impact work for the other, and this would interfere with the timely availability of needed technology.

- As previously discussed, ERDA also has responsibilities for health, safety, and reactor research, development, and design matters relating to naval nuclear propulsion plants. ERDA's ability to carry out these responsibilities would be undermined if it had to depend on an outside agency to budget for and justify the necessary funding.

The present funding arrangements for the Naval Reactors program have been developed over more than 25 years. They have been adequate to support development of the nuclear fleet and civilian power reactor technology as well. The Naval Reactors program is an intimate part of the development of nuclear energy, providing benefits to and deriving benefits from the development of civilian nuclear power. Transferring funding authority to another agency offers no obvious benefits. The agency tasked with doing the work on this continuing program should also be responsible for budgeting, reviewing, and justifying the funding. To do otherwise would add uncertainty to the program and reduce its effectiveness.

5. OTHER MILITARY REACTORS

a. Background

In 1954, the Secretary of Defense designated the Department of the Army to be responsible within DoD for developing nuclear power plants to supply heat and electricity at remote and relatively inaccessible military installations. Pursuant to this authority, an Army Nuclear Power Program (ANPP) was established within the Army Corps of Engineers, drawing upon organizational precedents of the existing Navy/AEC propulsion reactor program. The ANPP mission was broadened in 1963 to include R&D on nuclear devices for generating mechanical power, energy conversion systems, training of nuclear power plant crews, technical support to military users of nuclear power, operation of nuclear power plants, and nuclear health and safety.

The ANPP program fostered significant technological advances in small pressurized water reactor systems, gas-cooled reactors and associated power conversion subsystems, and a compact, high-power mobile reactor concept for providing electric power to dispersed tactical forces. Eight nuclear power plants, including stationary, portable, land-mobile, and water-mobile types have been built and operated. Today, only the Army's Floating Nuclear Power Plant STURGIS (containing the MH-1A reactor) located in Gatun Lake, Canal Zone, remains in operation. The other plants were deactivated after technological objectives were achieved and/or operating experience indicated that their miniaturized military reactor designs were not economically competitive with conventional power sources. Recent fuel shortages and increases in conventional power costs have reopened the need for exploratory research of small nuclear power plants. DoD plans to continue monitoring nuclear and energy conversion progress within industry and ERDA, evaluating technology improvements for potential military application.

b. Current Capabilities, Organization, and Funding

This program is being maintained at a minimum-activity level in order to retain a capability for responding to peacetime or wartime military power needs. This entails maintaining a small staff with the necessary technical and administrative expertise to enter into a major nuclear power development program if the advantages to DoD warrant.

Within ERDA, the ANPP mission is carried out by the Assistant Director for Army Reactors, Division of Reactor Research and Development (RRD). The Assistant Director is an active-duty officer of the Army Corps of Engineers.

Projects are executed by both contractors and national laboratories. Administration is primarily through ERDA field offices as stipulated in each interagency project agreement. DoD has occasionally provided personnel to supplement ERDA field office project management efforts.

ERDA develops and funds essentially all new types of reactors (excluding the related power conversion equipment) suitable for use in military nuclear power plants. This includes design and technical feasibility studies, construction and test operation of the first complete prototype of new power plants, and production and supply of SNM. DoD develops and funds power conversion equipment associated with the reactor, and also all follow-on field plants. System integration is accomplished and funded jointly by ERDA and DoD.

c. Consideration of Alternatives

Although the military reactor program currently is in a minimum activity status, ERDA remains responsible for support of DoD requirements for development of "other military reactors" should the need arise. Because this program is not linked to or dependent on the weapon program, transfer Alternatives 1 through 9 do not impact its nearly dormant operations. As explained above, funding for military reactor activities is shared under existing interagency agreements which are completely separate from weapon program budget and allocations.

Recognizing that military reactor development, when needed, will depend almost entirely upon nuclear power R&D and other programs conducted in nonmilitary-related sectors of ERDA, continuation of the current mode of ERDA management appears highly desirable and the only really practical alternative.